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Diet of the eagle owl (*Bubo bubo*) in Braşov, Romania

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Abstract. The first detailed food study of the Eurasian Eagle Owl (*Bubo bubo*) in Braşov, the Transylvanian Basin, Romania is reported. The diet comprised of mostly mammals (20 mammal species, 83.7% by number), with a small proportion of birds (15.9%), reptiles and amphibians (0.3%) and arthropods (0.1%). Rodents dominated the diet spectrum, with rats (*Rattus* spp.) being the most frequent (38.2%), followed by the Eurasian Hamster (*Cricetus cricetus*) 16.5%, the Field Vole (*Microtus arvalis*) 8.3%, as well the group of wood mice species complex (*Apodemus* spp.) 7%. The mammalian component of the diet was the most important also in terms of biomass (83.4%). Besides the rats and the Common Hamster, the Hedgehog (*Erinaceus concolor*) and the European Hare (*Lepus europaeus*) were an important component of the diet. Smaller mammals, reptiles, birds and arthropods made up a small portion of the diet in terms of biomass. The diet composition, compared to similar studies, suggests the possible importance of habitat complexity and prey species diversity for the maintenance of eagle owl populations. The results suggest that the Eurasian Eagle Owl is also capable of exploiting species well adapted to urban environments.

Keywords: diet, Eurasian Eagle Owl, *Bubo bubo*, Braşov, Romania

Introduction

The Eagle Owl is the largest owl in the world (1500-3500g) with a wide distribution range across Europe, Asia and North Africa (Mikkola 1983). It occurs in a variety of habitats, from boreal forests to Mediterranean scrublands, from steppes to rocky gorges and riverside loess walls or sandy deserts. The Eurasian Eagle Owl has a widespread distribution in Romania, but is a rare breeding bird, reported in rocky gorges, limestone cliffs, loess walls and old-growth forests from Transylvania, Banat, Moldova and Dobrogea (Munteanu et al. 1994). Typically it is an open landscape hunter, using a wide range of food sources, such as arthropods, fish, reptiles, amphibians, birds and mammals. Its most common prey types are medium to large-sized mammals (Jánossy & Schmidt 1970, Bezzel et al. 1976, Jaksić & Marti 1984). Its diet and food selection have been the targets of numerous studies and variability was found in the diet spectra of these owls in different landscapes and regions. The species' feeding habits were intensely studied in its Mediterranean breeding range (Donázar 1987, Bayle 1996, Penteriani et al. 2002), in Central Europe (Bezzel et al. 1976,

Dahlbeck 2003) and northern Europe (Mysterud & Dunker1982, Korpimäki et al. 1990). Studies are much scarcer in south-east and eastern Europe, but even in most countries surrounding Romania there are a few studies on eagle owl ecology and diet selection (Jánossy & Schmidt 1970, Haraszty 1984, Simeonov et al. 1988, Obuch 1994, Mihelič 2002). Although the species is breeding in Romania, with certain nesting locations known for decades (Paşchovschi 1975), its food is scarcely reported and usually only in short notes (Anon 1975). There are only two studies which treat the diet in Romania in detail (Popescu and Sin 1966, Lengyel 1992). Popescu and Sin (1966) provided some insights on the feeding habits based on pellets collected in steppe regions of Dobrogea, SE Romania. The other study was performed in a forested hilly landscape, in Maramureş, N Romania (Lengyel 1992). Thus, the diet of Eagle Owls is virtually unknown in the Transylvanian Basin. The purpose of the current study is to present for the first time, detailed information on the diet of the Eagle Owl in the central part of Romania based on regurgitated pellets.

Study area and methods

The food composition of the Eagle Owl was studied based on pellets collected from two sites used for breeding by the owls: an abandoned quarry and a small cliff system in a forest on the outskirts of Braşov Romania. The first site (point A, Cariera Răsăritu, see Fig. 1.) is a recently abandoned limestone quarry, where active mining ceased in 2002. The second site (point B, Pietrele lui Solomon, see Fig. 1.), presently a geological reserve surrounded by residential areas of Braşov, is a rocky area with several cliffs. Owls have been nesting at both sites for several decades (Ionescu 2005). The two sites are 2.9 km from each other. The habitat surrounding the nests is a mix of suburban residential areas, forested patches, parks, lawn covered sport and leisure sites, agriculture fields, industrial built-in sites, mining and extraction areas.

The material used for dietary analysis was collected in March 2003 and constituted prey remains and old, decomposed pellets found in the nest scrapes of eagle owls and below the rocky nest-crevices. All material was collected, then it was siewed and the bones of vertebrates and the chitinous exoskeleton remains of arthropods were individually removed. For identification of prey species we used the skulls and mandibles, humeri and tibia for mammals, humeri and tarsometatarsus for birds and chelicera, telson and elytra for arthropods. Mammal and bird remains were compared to the reference collection of the author (A. S.). For additional help in species identification of birds, Cuisin (1989) was used. Paired elements of each taxon were separated and the largest number of elements was considered the minimum number of individuals (MNI) recovered from each sample. Both species of rats (Norway Rat *Rattus norvegicus* and Black Rat *Rattus rattus*) were identified in the sample, but they are treated together due to identification problems caused by the fragmentation of most prey remains. The biomass (B) was calculated by multiplying the number of individuals of each species found in the pellets by the mean body mass (weight) of the species; which originated from direct mass measurements of birds captured for banding close to the study region (Sándor A. unpublished) and bibliographic sources (Cramp 1985, Hamar and Şutova 1965). We analysed the prey diversity by using:

i.) The mean prey weight (*MPW*) was calculated by summing the product of the prey number and mean body weight and dividing by the number of prey items;

ii.) For diversity of prey species (*H*) we used the formula of Shannon and Wiener: $H = -\Sigma p_i \, lnp_i$ - where p_i is the proportion of any given prey species (Bayle 1996).

Due to the high heterogeneity and fragmentation of the remains, the results may be biased towards underestimating the occurrence of small prey (shrews, smaller passerines, insects, etc.). However, we expect that this bias is small, considering that small prey play a minor role in the Eagle Owl diet (see also Marchesi et al. 2002). Being a large sized predator, the Eagle Owl is specialized in hunting medium to large bodied mammalian and bird prey,

not favoring small prey species (Jánossy & Schmidt 1970, Bezzel et al. 1976, Jaksić & Marti 1984, Cramp 1985).

Results

The results of the analysis are presented in Table 1. A total of 1784 individual prey remains were identified, of which 985 were collected from Cariera Răsăritu and 799 from Pietrele lui Solomon. The species diversity was high (H = 2.19), with a total number of at least 62 species, representing 20 mammal species, 38 birds, at least 1 reptile and 2 amphibians and some arthropod species. By number, mammals comprised 83.7% (83.4% by biomass) of the diet, birds 15.9% (16.54%), amphibians, reptiles

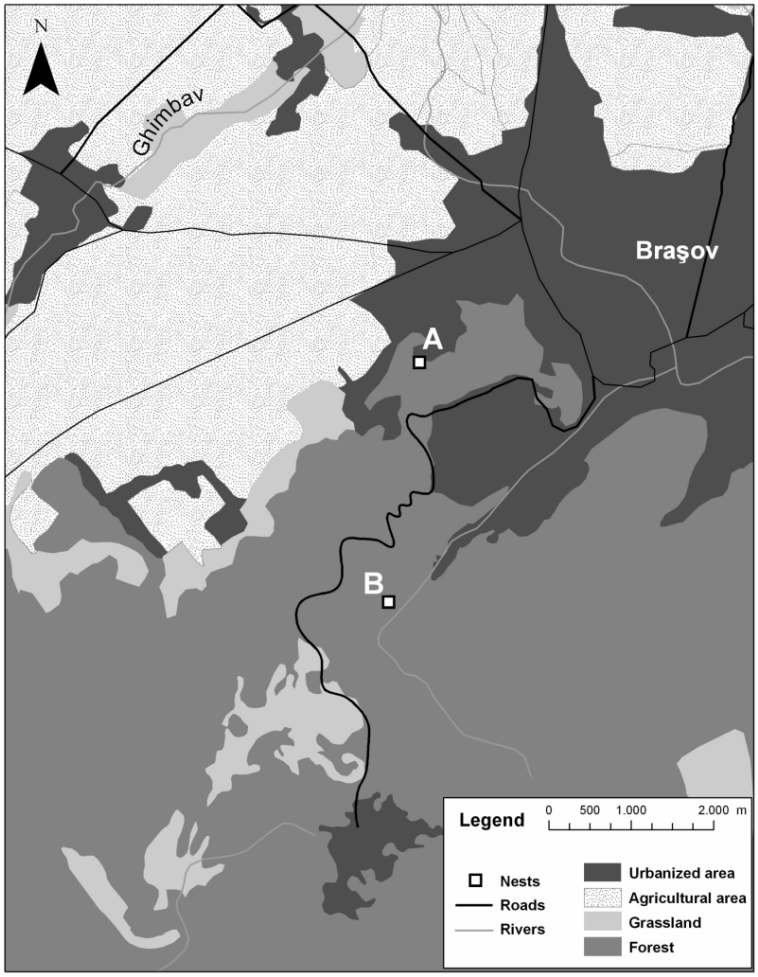

Figure 1. Map of the study area with the location of the two Eagle Owl nests.

Table 1. Identified prey remains in Eagle Owl pellets, Braşov, Romania.

Vernacular Name	Scientific Name	Number	Percent Occurrence	Percent Biomass
Parti-colored Bat	*Vespertilio murinus*	1	0.1	>0.1
Eastern European Hedgehog	*Erinaceus concolor*	76	4.3	13.7
Common Mole	*Talpa europaea*	12	0.7	0.1
Common Shrew	*Sorex araneus*	2	0.1	>0.1
House Mouse	*Mus musculus*	5	0.3	>0.1
Striped Field Mouse	*Apodemus agrarius*	4	0.2	>0.1
Wood Mouse sp.	*Apodemus* spp.	126	7.1	0.4
Rat sp.	*Rattus* spp.	682	38.2	35.0
Eurasian Hamster	*Cricetus cricetus*	295	16.5	22.7
Field Vole	*Microtus arvalis*	149	8.4	0.9
Water Vole	*Arvicola terrestris*	66	3.7	1.0
Bank Vole	*Clethrinomys glareolus*	3	0.2	>0.1
Vole sp.	Microtinae spp.	10	0.6	0.1
Red Squirrel	*Sciurus vulgaris*	4	0.2	0.1
Hazel Dormouse	*Muscardinus avellanarius*	1	0.1	>0.1
Fat Dormouse	*Glis glis*	3	0.2	0.1
Least Weasel	*Mustela nivalis*	4	0.2	0.1
Western Polecat	*Mustella putorius*	4	0.2	0.1
Marten sp.	*Martes* spp.	14	0.8	0.7
European Hare	*Lepus europaeus*	33	1.9	8.5
	Mammals	**1494**	**83.7**	**83.4**
Little Grebe	*Podiceps ruficollis*	3	0.2	0.1
Great Crested Grebe	*Podiceps cristatus*	1	0.1	0.1
Mallard	*Anas platyrhynchos*	4	0.2	1.0
Teal/Garganey	*Anas crecca/querquedula*	8	0.5	0.8
Common Buzzard	*Buteo buteo*	2	0.1	0.3
Sparrowhawk	*Accipiter nisus*	2	0.1	0.2
Kestrel	*Falco tinnunculus*	1	0.1	>0.1
Common Partridge	*Perdix perdix*	9	0.5	0.7
Quail	*Coturnix coturnix*	5	0.3	0.1
Pheasant	*Phasianus colchicus*	1	0.1	0.2
Little Crake	*Porzana porzana*	2	0.1	0.1
Moorhen	*Gallinula chloropus*	1	0.1	0.1

Table 1. (Continued)

Vernacular Name	Scientific Name	Number	Percent Occurrence	Percent Biomass
Corncrake	*Crex crex*	1	0.1	0.1
Little Owl	*Athene noctua*	4	0.2	0.1
Long-eared Owl	*Asio otus*	28	1.6	1.8
Tawny Owl	*Strix aluco*	11	0.6	1.1
Ural Owl	*Strix uralensis*	3	0.2	0.5
Wood Pigeon	*Columba palumbus*	7	0.4	1.1
Feral Pigeon	*Columba livia domestica*	41	2.3	4.7
Collared Dove	*Streptopelia decaocto*	13	0.7	0.7
Turtle Dove	*Streptopelia turtur*	17	1.0	0.7
Green Woodpecker	*Picus viridis*	3	0.2	0.1
Great Spotted Woodpecker	*Dendrocopus major*	5	0.3	0.1
Crested Lark	*Galerida cristata*	2	0.1	>0.1
Dunnock	*Prunella modularis*	2	0.1	>0.1
Blackbird	*Turdus merula*	20	1.1	0.4
Song Thrush	*Turdus philomelos*	9	0.5	0.1
Blue Tit	*Cyanistes caeruleus*	1	0.1	>0.1
Warbler sp.	*Sylvidae* spp.	2	0.1	>0.1
Jay	*Garrulus glandarius*	6	0.3	0.1
Magpie	*Pica pica*	7	0.4	0.2
Rook/Carrion Crow	*Corvus frugilegus/cornix*	12	0.7	0.6
Starling	*Sturnus vulgaris*	8	0.5	0.1
House Sparrow	*Passer domesticus*	3	0.2	>0.1
Tree Sparrow	*Passer montanus*	1	0.1	>0.1
Finch sp.	*Fringilla* spp.	1	0.1	>0.1
Bullfinch	*Pyrrhula pyrrhula*	1	0.1	>0.1
Hawfinch	*Coccothraustes coccothraustes*	3	0.2	0.1
Songbird sp.	Undet. *Passeriformes* spp.	31	1.7	0.2
	Birds	**280**	**15.8**	**16.5**
Lizzard p.	*Podarcis/Lacerta spp.*	1	0.1	>0.1
Green frog sp.	*Rana spp.*	2	0.1	>0.1
Common Toad	*Bufo bufo*	2	0.1	>0.1
Insects	*Coleoptera*	2	0.1	>0.1
	TOTAL	**1784**		

and arthropods 0.4% (0.06%). The rats were the most common prey by number as well as by biomass. This group was followed by the Eurasian Hamster (*Cricetus cricetus*), the Field Vole (*Microtus arvalis*) and the of wood mice species complex (*Apodemus* spp.). A total of five Muridae, four Arvicolidae, one Sciuridae and two Gliridae species were recorded.

Birds belonging to five different ecological groups (waterfowl, raptors and species of grassland/agriculture areas, forest and urban areas, see Tab. 1.) were amongst the prey of the eagle owls. The most important group in terms of species number (14) and individual occurrence (5.6%) was the group of forest birds, although this was the least important in terms of biomass (1.4%). In terms of biomass (5.4%) the most important group was the urban-living species (pigeons, doves and sparrows). Another group, with a high species number and biomass percentage was the raptors (both diurnal and nocturnal).

Medium to large-sized prey (both mammals and birds) was an important component of the diet. Prey mass ranged from 1g (*Coleoptera*) to 1500g (hares, martens and mallards), although prey < 50g accounted for less than 20% of the diet. The mean prey weight was 215.6 ± 20.0g, similar to the average weight of an adult Norway Rat, the most common prey in the sample collected.

Discussion

The sample collected from Braşov is diverse, accumulated over several decades, and thus the present study is more a representation of the actual state of the local prey fauna than a study of prey selection.

Although rodents dominated the overall diet, the most important prey groups by biomass were the medium and large-sized species. Rats composed the bulk of the prey, together with the Common Hamster. This agrees broadly with the results of most otherstudies performed in the central and south-eastern European region, where medium sized mammals were the most important prey species, but there were several differences (Jánossy & Schmidt 1970, Simeonov et al. 1988, Mihelič 2002). The occurrence of both species of rats (Norway and Black Rat) is a unique situation, possibly explained by the high habitat heterogeneity and the close proximity of urbanized areas, which favour the occurrence of both species. Rats are typical prey species of the Eagle Owl and their occurrence is negatively correlated with the occurrence of larger prey like hares or rabbits (Bayle 1996, Dahlback 1996, Serrano 2000). The importance of rats is increasing in the diet studies performed in the last few decades in many areas (Suchy 1990, Dahlbeck 1996). This may be an effect of owls moving closer to urban areas, probably because of a decrease in persecution pressure (Shochat 2004, Sándor & Moldován 2009), increasing owl populations (Dahlbeck 2003) and urban sprawl (Marchesi et al. 2002).

The proportion of Common Hamster in the diet was higher than in any other study performed in western and southern populations and similar findings were only registered in Hungary (Haraszty 1984), SE Russian steppes (Jánossy & Schmidt 1970, more than one hamster species recorded) and Turkey (Obuch 1994). In each of these cases the eagle owl population lived in totally different habitats (usually steppes). Here the cause may be the local or regional

abundance of the Common Hamster in the region. The species is a widespread rodent in Romania and the Braşov Basin is famous for the high abundance reported (Schnapp 1963).

Another important component of the diet was the Eastern European Hedgehog, a species whose most important natural predator is the Eagle Owl. The importance of hedgehogs in the diet is higher in the central and south-eastern European population than for other populations (Dahlbeck 2003). Their participation in the diet (4.6% by number and 13.6% by biomass) was high and similar to that reported from northern France, Czech Republic, Bulgaria and Germany (Jánossy & Schmidt 1970, Simeonov et al. 1988, Suchy 1990, Dahlbeck 2003).

The only Leporidae representative in the region is the European Hare which is common in the region of Braşov. It had a low occurrence in the diet, accounting only for 1.85% of individuals, although biomass participation was higher, reaching 8.5%, due to its size. The low percentage of hares in the diet in Braşov may be caused by the habitat composition in the region, as the primary habitats of European Hare (open landscapes, grasslands, and hedges) are scarce in the areas surrounding the nests. Other mammalian groups present in the sample have a smaller importance for the diet, even if their occurrence was high (mice, voles), because their respective body size (see Tab 1.).

Birds constitute an important component in the food of the Eurasian Eagle Owl, especially in the northern European, forest breeding populations. Moreover, their occurrence in food may correlate with the population dynamics of the owls (Korpimäki et al. 1990, Dahlbeck 2003). The most important groups in food of owls are medium to large sized Columbiformes, Galliformes, waterfowl, nocturnal raptors and large sized songbirds (Corvidae and Turdidae). In most cases, one or two of the above groups constitute the dominant bird prey of the owls. In our case two groups, pigeons and owls, had a relatively high participation in the diet (see Tab 1.). The Feral Pigeon was the most common bird prey; its relatively high occurrence is the consequence of the proximity of urban habitats (active quarry, housing estates, suburbs, etc.). Owls are complementary food for the Eagle Owl, although Long-eared Owls (*Asio otus*) are commonly preyed upon (Cramp 1985). Four owl species were found in our sample, with higher occurrence noted for the Long-eared Owl (1.5% by number and 1.08% by biomass). The rest of the bird prey was of lesser importance.

Eagle owls had a variable diet in Braşov, and the calculated diversity index was very high compared to similar studies, indicating high group and species diversity among prey species. The prey diversity value (Shannon index) places this sample somewhere between the less diverse southern ("rabbit dependent") and eastern populations ("arvicollid dependent") and the very diverse northern ("bird dependent") populations, thus indicating the utilization of a wide range of microhabitats. The evenness shows that Eagle Owls from the Braşov population do not rely on one or two abundant food type like in the Mediterranean populations; instead they use a group of 7-8 medium- to large-sized different prey types. The long sampling period made it possible to gather large quantities of prey remains, but also shadows the seasonal or temporal differences over this period (e.g. changes in local prey species populations in time), thus increasing the

chances of calculating biased diversity indices.

Assessing the diet composition is often fundamental in wildlife management, especially when assessing the impact of a predator on a conservation dependent species (Serrano 2000), or the importance of prey availability for a threatened predator (Dahlbeck 2003). Differences in diet may be caused by local habitat differences, but also by changes over time in the population dynamics, distribution and density of important prey species. In conclusion, the knowledge of food selection by Eurasian Eagle Owl may be crucial not only for the elaboration of proper species conservation measures, but as an early warning tool in case of changes occurring in prey species populations.

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