

Food composition of the Little Owl (*Athene noctua*) in a farmland area of Central Hungary, with particular attention to arthropod diversity^x

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Abstract The feeding of Little Owl (*Athene noctua*) was studied in a farmland area of Kiskunság, Central Hungary. For the analyses, a total of 661 Little Owl pellets were collected between February and September 2005 from three locations, corresponding known Little Owl territories situated nearby the settlements Apaj, Kunpeszér and Ladánybene. The aim of the present study was to explore the diet composition of Little Owl and to give a detailed evaluation of the arthropod diversity based on the pellet analysis. The identified prey items represented 15 vertebrate and 39 invertebrate species/taxa. In terms of prey number, dominance of small mammals was observed in two sites (Apaj – 55%, Kunpeszér – 68%), while birds and mammals shared almost equal dominance (~25%) in Ladánybene. The most numerous mammal species was the Common Vole (*Microtus arvalis*), while the Starling (*Sturnus vulgaris*) played key role among the birds. Contribution of amphibian Common Spadefoot (*Pelobates fuscus*) was considerable, while share of reptiles was marginal. Vertebrates also played a predominant role by contributing over 99% of the overall prey biomass in all study sites. Invertebrate prey dominance ranged from 24.8–30.0% while their contribution to the overall biomass was very low (0.14–0.34%). Large sized beetles (*Pentodon idiota*, *Melolontha hippocastani*) and orthopterans (*Tettigonia viridissima*, *Gryllotalpa gryllotalpa*) were preferred. Arthropod species richness and diversity were the highest in Kunpeszér, supposedly owing to the rich mosaic habitat structure.

Keywords: feeding ecology, diet, pellet analysis, Strigiformes, Coleoptera, farmland

Összefoglalás A kúvik (*Athene noctua*) táplálkozását Közép-Magyarország (Kiskunság) alföldi tanyavilágában vizsgáltuk. Az elemzésekhez 2005. február és szeptember között, összesen 661 köpetet gyűjtöttünk Apaj, Kunpeszér és Ladánybene települések közelében, amely területek egyben három aktuális kúvik revírek feleltek meg. A kutatás fő célja a faj táplálékspektrumának feltárása, valamint a köpetelemzések alapján a vizsgált területek ízeltlábú-diverzitásának összehasonlító vizsgálata volt. A köpetekből azonosított zsákmányállatok 15 gerinces és 39 gerinctelen taxont képviseltek. Az egyedszámot tekintve két helyszínen a kisemlősök domináltak (Apaj – 55%, Kunpeszér – 68%), míg a harmadik helyszínen (Ladánybene) a kisemlősök és a madarak közel azonos arányban (~25%) voltak jelen. A leggyakoribb kisemlős zsákmánynak a mezei pocok (*Microtus arvalis*) bizonyult, míg a madarak közül a seregély (*Sturnus vulgaris*) fogyasztása volt jelentős. A barna ásóbéka (*Pelobates fuscus*) jelenléte a köpetanyagban figyelemre méltó, míg a hüllők részaránya nagyrészt elhanyagolható volt a vizsgált helyszíneken. A gerinces zsákmányállatok jelentőségét a magas, 99% feletti tömeg szerinti részarányuk is bizonyítja. A gerinctelenek egyedszám szerinti részaránya 24,8–30,0% volt, tömeg szerinti részesedésük azonban rendkívül csekély (0,14–0,34%). A kúvik a területen nagyrészt a nagyobb méretű bogarakat (*Pentodon idiota*, *Melolontha hippocastani*), valamint egyenesszárnyúakat (*Tettigonia viridissima*, *Gryllotalpa gryllotalpa*) fogyasztotta. A köpetekből kimutatott rovarközösségek fajgazdagsága és diverzitása a kunpeszéri területen volt a legnagyobb, ami minden bizonnyal a változatos, mozaikos habitat-struktúrájának is köszönhető.

Kulcsszavak: táplálkozásökológia, étrend, köpetelemzés, Strigiformes, Coleoptera, tanyasi élőhely

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Introduction

The Little Owl (*Athene noctua*) is one of the strictly protected owl species in Hungary. Despite its European population is estimated to be stable, decreasing trend has been observed in several countries (Cramp 1985, Van Nieuwenhuysse *et al.* 2008, BirdLife International 2016). Population trend in Hungary is not known, former data was mainly based on estimates provided by experts (Šálek *et al.* 2013). The breeding population is estimated between 1400 and 4000 pairs (Gorman 1995, Hadarics & Zalai 2008, Hámori 2014, BirdLife International 2016).

As a consequence of the experienced population decrease, Little Owl conservation and research have become a priority in most European countries (e.g. Zerunian *et al.* 1982, Genot 1994, Angelici *et al.* 1997). Apart from the knowledge on habitat preference, it is essential to perform detailed studies also on the feeding biology so as to develop the conservation strategies. It has already been revealed that population decline is due to the limited feeding possibilities and limited food availability (Genot & Van Nieuwenhuysse 2002, Zmihorski *et al.* 2006, Thorup *et al.* 2010). Inhabiting a large area and having a wide range of hunting techniques, the Little Owl generally feed on a wide variety of foods (Mikkola 1983, Cramp 1985, Schönn *et al.* 1991, Angelici *et al.* 1997). It mainly feeds on small mammals and invertebrates but occasionally also on amphibians, reptiles and fishes (Glutz von Blotzheim & Bauer 1980, Cramp 1985). European owl species feed almost exclusively on animal food, even occasional carrion-eating has been observed Milchev and Nikolay (2017). The Little Owl is, however, the only owl species feeding also on plant materials (Lanszki 2006, Van Nieuwenhuysse *et al.* 2008).

Based on pellet analyses from European and Middle East countries, the diet of Little Owl is mostly composed of insects, however, feeding behaviour can differ according to the habitat and geographical region (Herrera & Hiraldo 1976, Cramp 1985, Gorzel & Grzywaczewski 2003, Obuch & Kristin 2004, Van Nieuwenhuysse *et al.* 2008). On the diet composition and feeding habits, several studies carried out in Mediterranean region, Western Europe and Middle East have been published (e.g. Zerunian *et al.* 1982, Angelici *et al.* 1997, Gotta & Pigozzi 1997, Obuch & Kristin 2004, Alivizatos *et al.* 2005, Van Nieuwenhuysse *et al.* 2008). Otherwise, in Hungary, the Little Owl is one of the least studied species. Apart from a more detailed work also evaluating the arthropod diet of Little Owl (Lanszki 2006), studies from the Carpathian Basin mostly focus on the small mammal diet (Marián & Schmidt 1968, Molnár 1984, Andrési & Sódor 1986, Endes 1990).

The main goal of the present research was to explore the feeding habits of Little Owl in a farmland area in the Mid-Hungarian region (Kiskunság). Further aim was to give a detailed evaluation of the vertebrate prey and the arthropod diversity based on the pellet analyses, with relation to the habitat characteristics.

Material and methods

Study area

Our studies were carried out in the Upper-Kiskunság region (Mid-Hungary), in the administrative territories of the Kiskunság National Park and the Duna-Ipoly National Park. The study sites, corresponding three known Little Owl territories, are situated nearby the settlements Apaj, Kunpszér and Ladánybene (*Figure 1*). Brief description of the studied territories is provided hereinafter.

Apaj (N47.104754; E19.054062)

The Little Owl nest itself was found under the roof of a sheep barn. The territory has a mosaic structure, mainly characterized by sheep pastures and intensive agricultural fields, but enriched with an older pedunculate oak (*Quercus robur*) alley, a mixed, semi-open forest patch and the complex of buildings designed for sheep breeding and farming. Apart from the

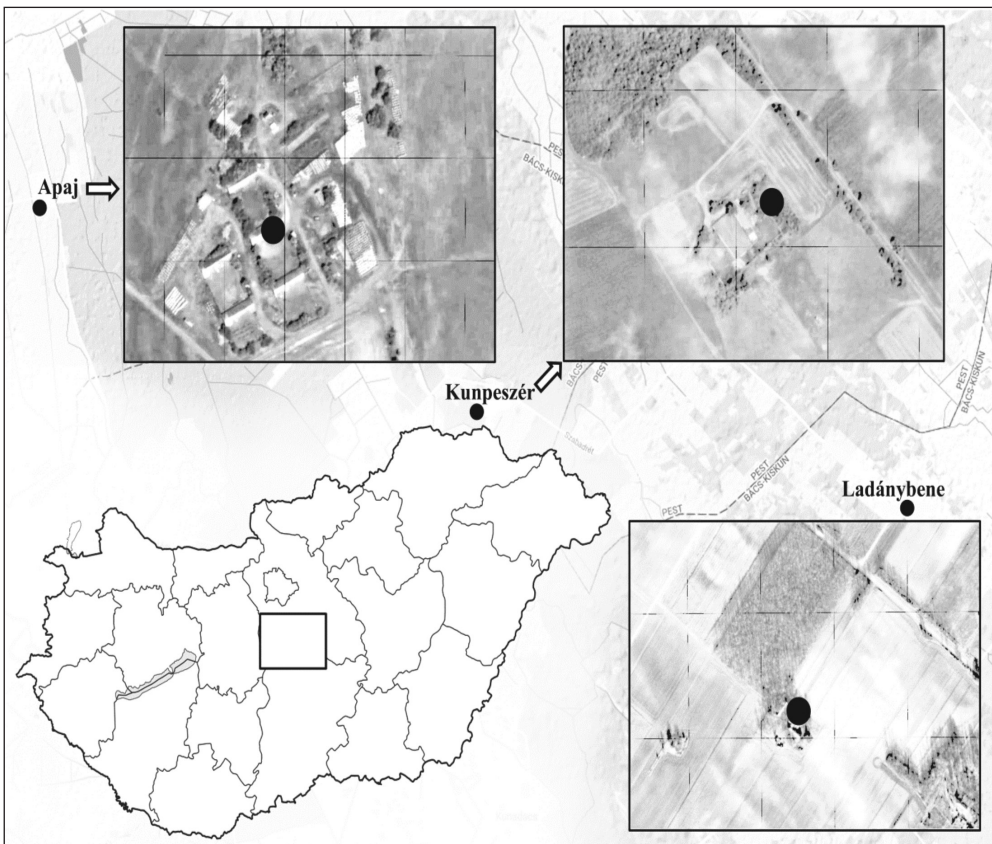


Figure 1. Map of the study area with the Little Owl territories

1. ábra A kutatási terület térképe a vizsgált kúvik territóriumokkal

pastures, mowed grasslands crossed by small canals, as well as small periodical water bodies and alkali fragments are also available.

Little Owl pellets were collected at the roosting place under the roof as well as from four stations regularly used for dropping pellets.

Successfully fledged young owls: 4

Kunpeszér (N47.080801; E19.245475)

The breeding took place in an artificial nest box installed on an old black locust (*Robinia pseudoacacia*) tree, surrounded by numerous farm buildings designed for cattle, sheep and geese. This site is characterized by high coverage of pastures and regularly mowed grasslands, while alkali patches with small temporary water bodies are less typical here. Apart from wayside black locust and poplar (*Populus* spp.) trees, scots pine (*Pinus sylvestris*) forest patches are also present, associated with a wide channel passing through the site.

Pellets were collected from the nest box, next to the clutch, and also from further two steady pellet-stations within the territory.

Number of successfully fledged young owls: 6

Ladánybene (N47.021768; E19.472589)

An artificial nest box installed on an old oak tree and occupied by the Little Owl is situated near to the settlement Ladánybene. A number of periodically occupied holiday properties are located within this site while animal husbandry is less prevalent. As a consequence just a few pastures and meadows have been maintained. More characteristic are, however, the abandoned fields with ruderal vegetation and plantations of black locust, poplar and black pine (*Pinus nigra*).

Pellets were collected both from the nest box and from two regularly used pellet-stations.

Number of successfully fledged young owls: 6

Pellets of Little Owls were collected from February to September 2005. In each sites, prior to the first samplings, old pellet remnants had been removed. Each site was visited 5 times during the study period. The most important sampling parameters are summarized in *Table 1*.

Pellet analysis

A total of 661 Little Owl pellets were analysed. The pellets were dried and processed by standard methods (Schmidt 1967, Ruprecht *et al.* 1998). The remains were analysed by using a stereo microscope. Small mammals were assessed from skulls, mandibles and teeth following the works of Schmidt (1967), März (1987), Ujhelyi (1989) and Diesener and Reicholf (1997). Birds were determined on the basis of skulls and feathers (Brown *et al.* 1993). Insects were identified to species level and quantified by head capsules, elytra and other remains on the basis of the collection of the Hungarian Natural History Museum and following the keys in Laibner (2000), Móczár (1984), Müller-Motzfeld (2004), Rheinheimer and

Hassler (2010). Pellet material from all three sites was also tested for Annelida presence by detecting their chaetae. For determining biomass, weight of most of the prey species was derived from the literature (Dely 1967, 1978, Petrescu 1994, Fattorini *et al.* 1999, Grzywaczewski *et al.* 2006, Bihari *et al.* 2007, Kitowski & Pawlega 2010, Romanowski *et al.* 2013), while biometric data and specific equations were used to calculate the weight of the remaining species (Rogers *et al.* 1976, Jarošík 1989).

Data analysis

To assess and compare the arthropod diversities in the diet of Little Owl, three measures of diversity were given for each site: species richness, the Shannon index (Shannon & Weaver 1949) and equitability (Pielou 1966). To compare diversity values of two assemblages a modified *t*-test was used (Hutcheson 1970). Rényi diversity profiles (Tóthmérész 1997) were applied for partial diversity ranking of the arthropod communities as reflected in the owl pellets. To evaluate the similarities of species composition, Jaccard's similarity coefficient (Jaccard 1901) and the Bray-Curtis index (Bray & Curtis 1957) were calculated. All analyses were carried out with Past 2.17c (Hammer *et al.* 2001).

Results

Overall food composition

The prey items identified from the 661 pellets represent 15 vertebrate species (1 amphibian, 2 reptile, 5 bird and 7 small mammal species) and 38 arthropod species. In addition, annelid presence was also detected, although their number was not assessed due to the limitations of methodology. Based on the identified prey number, dominance of small mammals can be observed in two sites (Apaj – 55.2% and Kunpezsér – 68.5%), while in Ladánybene, avian and small mammal preys shared equal dominance (~25%). Among small mammals, the most numerous species was the Common Vole (*Microtus arvalis*), but also the Wood Mouse (*Apodemus sylvaticus*) and in Apaj and Kunpezsér also the House Mouse (*Mus musculus*) proved to be considerably abundant. Other rodent species include the Eurasian Harvest

Table 1. Summary of Little Owl pellet sampling parameters
1. táblázat A kúvik köpetminták gyűjtésének fontosabb adatai

| Site | Location of pellet collection | Date of collection | Number of collected pellets |
|------------|---|-----------------------|-----------------------------|
| Apaj | Nest under a roof of a sheep barn and further pellet-stations | 02.03.2005-09.01.2005 | 221 |
| Kunpezsér | Artificial nest box and further pellet-stations | 02.03.2005-09.01.2005 | 248 |
| Ladánybene | Artificial nest box and further pellet-stations | 02.03.2005-09.01.2005 | 192 |

Mouse (*Micromys minutus*) and the Brown Rat (*Rattus norvegicus*), both occurred in low numbers. Apart from rodents, a few individuals of two species of Soricomorpha as Lesser White-toothed Shrew (*Crocidura suaveolens*) and Eurasian Pygmy Shrew (*Sorex minutus*) were also identified from the pellets. The contribution of birds in the diet varied depending on the site. Their highest proportion was found in Ladánybene, while they were completely absent from the pellets collected in Kunpeszér. Of the passerine bird species identified the Common Starling (*Sturnus vulgaris*) was the most dominant species, but also the House Sparrow (*Passer domesticus*) had a strong contribution in Ladánybene. Amphibians were represented by a single species, the Common Spadefoot (*Pelobates fuscus*), occurring in all localities, with considerable contribution especially in Ladánybene. Reptiles were represented by two lacertid lizard species as Sand Lizard (*Lacerta agilis*) and Balkan Wall Lizard (*Podarcis taurica*) preyed only occasionally.

In terms of biomass, vertebrates play a predominant role by contributing over 99% of the overall prey biomass in all study sites. Within vertebrates, small mammals' contribution was the highest in Apaj (68.2%) and Kunpeszér (93.2%), while in Ladánybene, birds constituted nearly 55.9% of the total prey biomass. It is also noteworthy to mention the high contribution of amphibian species Common Spadefoot in Ladánybene, accounting for 16.3% of the total biomass.

Invertebrate prey dominance ranged from 24.8–30.0% in the studied sites. Despite of playing important role in Little Owl's food composition, their contribution to the overall biomass is only marginal (0.14–0.34%).

Arthropod preys consisted of relatively large insects like ground beetles (Carabidae), scarab beetles (Scarabaeidae) as well as crickets and bush-crickets (Orthoptera). The characteristic dominant beetle species in Apaj was *Pentodon idiota*, while the Chestnut Cockchafer (*Melolontha hippocastani*) occurred in high abundance in Ladánybene.

The most frequent orthopteran prey species, found in all studied localities, was the Great Green Bush-cricket (*Tettigonia viridissima*), which proved to be markedly dominant in Kunpeszér, while the European Mole Cricket (*Gryllotalpa gryllotalpa*) showed a high contribution among the arthropods in Apaj.

Arthropod diversity in Little Owl's diet

The most important diversity characteristics for arthropod communities derived from Little Owl pellets are summarized in *Table 2*. Species richness, Shannon diversity and evenness indicated the highest arthropod diversity in the Kunpeszér study site. Species richness in Apaj was considerably lower, notwithstanding, Hutheson's modified *t*-test yielded no significant difference between the Shannon diversities (*t*-test, $t=1.617$, *ns*). The lowest arthropod species richness was found in Ladánybene, showing marked differences in diversity both from Apaj (*t*-test, $t=2.073$, $p<0.05$) and Kunpeszér (*t*-test, $t=3.256$, $p<0.01$).

These results are well reflected also in Rényi's diversity profiles (*Figure 2*). The diversity profile of arthropod community found in Ladánybene clearly runs under the profiles of the two other locations, while the profiles of Apaj and Kunpeszér did not show clear separateness.

Table 2. Food composition of Little Owls in the study sites; *g* – grams, *N* – number of prey, *m* – prey biomass

2. táblázat A kúvik táplálék-összetétele a vizsgált élőhelyeken; *g* – gramm, *N* – zsákmányállatok száma, *m* – zsákmányállatok biomaszja tömege

| Taxa | weight (g) | Apaj | | Kunpeszér | | Ladánybene | |
|--------------------------------|---------------|--------------|----------------|--------------|----------------|--------------|----------------|
| | | % <i>N</i> | % <i>m</i> | % <i>N</i> | % <i>m</i> | % <i>N</i> | % <i>m</i> |
| VERTEBRATA total | | 75.00 | 99.8035 | 75.13 | 99.66 | 70.00 | 99.8131 |
| Class AMPHIBIA | | 5.81 | 4.3478 | 5.58 | 5.5285 | 18.33 | 16.3781 |
| <i>Pelobates fuscus</i> | 20.0 | 5.81 | 4.3478 | 5.58 | 5.5285 | 18.33 | 16.3781 |
| REPTILIA | | 1.16 | 0.8043 | 1.02 | 0.9298 | 2.50 | 1.6192 |
| <i>Lacerta agilis</i> | 12.5 | | | | | 1.67 | 0.9306 |
| <i>Podarcis taurica</i> | 18.5 | 1.16 | 0.8043 | 1.02 | 0.9298 | 0.83 | 0.6886 |
| Class AVES | | 12.79 | 26.4128 | | | 25.00 | 55.9088 |
| <i>Motacilla alba</i> | 23.0 | 2.91 | 2.5000 | | | | |
| <i>Sturnus vulgaris</i> | 82.0 | 6.98 | 21.3911 | | | 10.83 | 39.6796 |
| <i>Passer domesticus</i> | 28.0 | 1.74 | 1.8261 | | | 9.17 | 11.4646 |
| <i>Passer montanus</i> | 24.0 | | | | | 3.33 | 3.5734 |
| <i>Carduelis carduelis</i> | 16.0 | 1.16 | 0.6956 | | | 1.67 | 1.1911 |
| Class MAMMALIA | | 55.23 | 68.2385 | 68.53 | 93.2058 | 24.17 | 25.9071 |
| <i>Sorex minutus</i> | 5.0 | | | 1.02 | 0.2513 | | |
| <i>Crocodyra suaveolens</i> | 5.0 | 0.58 | 0.1087 | | | 5.00 | 1.1167 |
| <i>Microtus arvalis</i> | 32.0 | 23.26 | 27.8258 | 35.53 | 56.2903 | 10.83 | 15.4847 |
| <i>Apodemus sylvaticus</i> | 25.0 | 8.72 | 8.1521 | 19.29 | 23.8731 | 8.33 | 9.3057 |
| <i>Mus musculus</i> | 21.0 | 19.77 | 15.5216 | 12.18 | 12.6653 | | |
| <i>Micromys minutus</i> | 5.0 | 1.74 | 0.3261 | 0.51 | 0.1256 | | |
| <i>Rattus norvegicus</i> | 375.0 | 1.16 | 16.3042 | | | | |
| INVERTEBRATA total | | 25.00 | 0.2348 | 24.87 | 0.3359 | 30.00 | 0.1869 |
| Ordo COLEOPTERA | | 18.02 | 0.0394 | 17.26 | 0.0686 | 28.33 | 0.1378 |
| Fam. Dytiscidae | | 0.58 | 0.0053 | | | | |
| <i>Dytiscus marginalis</i> | 0.246 | 0.58 | 0.0053 | | | | |
| Fam. Carabidae | | 3.49 | 0.0017 | 6.09 | 0.0208 | 5.83 | 0.0140 |
| <i>Amara aenea</i> | 0.006 | | | 1.02 | 0.0003 | | |
| <i>Anisodactylus binotatus</i> | 0.017 | | | | | 1.67 | 0.0013 |
| <i>Brosicus cephalotes</i> | 0.095 | | | 1.02 | 0.0048 | | |
| <i>Calathus fuscipes</i> | 0.023 | | | 0.51 | 0.0006 | | |
| <i>Calosoma auropunctatum</i> | 0.135 | | | | | 0.83 | 0.0050 |
| <i>Calosoma sycophanta</i> | 0.184 | | | 1.52 | 0.0139 | | |
| <i>Harpalus affinis</i> | 0.015 | 0.58 | 0.0003 | | | | |
| <i>Harpalus distinguendus</i> | 0.013 | 2.33 | 0.0011 | 0.51 | 0.0003 | | |
| <i>Harpalus hirtipes</i> | 0.010 | | | 0.51 | 0.0003 | | |
| <i>Harpalus tardus</i> | 0.013 | 0.58 | 0.0003 | 1.02 | 0.0007 | | |
| <i>Poecilus cupreus</i> | 0.017 | | | | | 0.83 | 0.0006 |

| Taxa | weight (g) | Apaj | | Kunpeszér | | Ladánybene | |
|----------------------------------|---------------|--------------|---------------|-------------|---------------|--------------|---------------|
| | | % N | % m | % N | % m | % N | % m |
| <i>Zabrus spinipes</i> | 0.063 | | | | | 2.50 | 0.0070 |
| Fam. Histeridae | | 1.16 | 0.0001 | | | | |
| <i>Margarinotus purpurascens</i> | 0.001 | 1.16 | 0.0001 | | | | |
| Fam. Silphidae | | | | 1.02 | 0.0019 | 0.83 | 0.0014 |
| <i>Silpha carinata</i> | 0.037 | | | 1.02 | 0.0019 | 0.83 | 0.0014 |
| Fam. Lucanidae | | | | 1.52 | 0.0106 | | |
| <i>Dorcus parallelipipedus</i> | 0.140 | | | 1.52 | 0.0106 | | |
| Fam. Geotrupidae | | 0.58 | 0.0022 | 0.51 | 0.0003 | | |
| <i>Geotrupes spiniger</i> | 0.100 | 0.58 | 0.0022 | | | | |
| <i>Odonteus armiger</i> | 0.012 | | | 0.51 | 0.0003 | | |
| Fam. Scarabaeidae | | 10.47 | 0.0292 | 5.08 | 0.0325 | 20.83 | 0.1222 |
| <i>Aphodius prodromus</i> | 0.002 | 1.74 | 0.0001 | | | | |
| <i>Copris lunaris</i> | 0.089 | 1.74 | 0.0058 | 1.52 | 0.0067 | 0.83 | 0.0033 |
| <i>Oryctes nasicornis</i> | 0.226 | | | 1.52 | 0.0170 | 1.67 | 0.0168 |
| <i>Pentodon idiota</i> | 0.089 | 6.98 | 0.0232 | | | | |
| <i>Melolontha hippocastani</i> | 0.126 | | | | | 16.67 | 0.0938 |
| <i>Anomala vitis</i> | 0.044 | | | 0.51 | 0.0011 | | |
| <i>Cetonia aurata</i> | 0.051 | | | 0.51 | 0.0013 | 0.83 | 0.0019 |
| <i>Protaetia speciosissima</i> | 0.172 | | | 0.51 | 0.0043 | 0.83 | 0.0064 |
| <i>Protaetia cuprea</i> | 0.083 | | | 0.51 | 0.0021 | | |
| Fam. Elateridae | | | | 1.02 | 0.0014 | | |
| <i>Agrypnus murinus</i> | 0.028 | | | 0.51 | 0.0007 | | |
| <i>Melanotus punctolineatus</i> | 0.028 | | | 0.51 | 0.0007 | | |
| Fam. Cerambycidae | | | | 0.51 | 0.0008 | | |
| <i>Plagionotus floralis</i> | 0.031 | | | 0.51 | 0.0008 | | |
| Fam. Chrysomelidae | | 0.58 | 0.0001 | 1.02 | 0.0001 | | |
| <i>Goniocтена fornicata</i> | 0.002 | 0.58 | 0.0001 | | | | |
| <i>Oulema melanopa</i> | 0.002 | | | 1.02 | 0.0001 | | |
| Fam. Curculionidae | | 0.58 | 0.0002 | 0.51 | 0.0003 | 0.83 | 0.0003 |
| <i>Otiorhynchus ligustici</i> | 0.013 | | | 0.51 | 0.0003 | | |
| <i>Psallidium maxillosum</i> | 0.007 | 0.58 | 0.0002 | | | 0.83 | 0.0003 |
| Fam. Tenebrionidae | | 0.58 | 0.0007 | | | | |
| <i>Tenebrio molitor</i> | 0.034 | 0.58 | 0.0007 | | | | |
| Ordo ORTHOPTERA | | 6.98 | 0.1954 | 7.61 | 0.2673 | 1.67 | 0.0490 |
| <i>Gryllotalpa gryllotalpa</i> | 0.563 | 3.49 | 0.0734 | | | 0.83 | 0.0210 |
| <i>Gryllus campestris</i> | 0.081 | 0.58 | 0.0018 | 0.51 | 0.0020 | | |
| <i>Tettigonia viridissima</i> | 0.754 | 2.91 | 0.1202 | 7.11 | 0.2653 | 0.83 | 0.0281 |
| Phylum ANNELIDA | | + | | + | | + | |

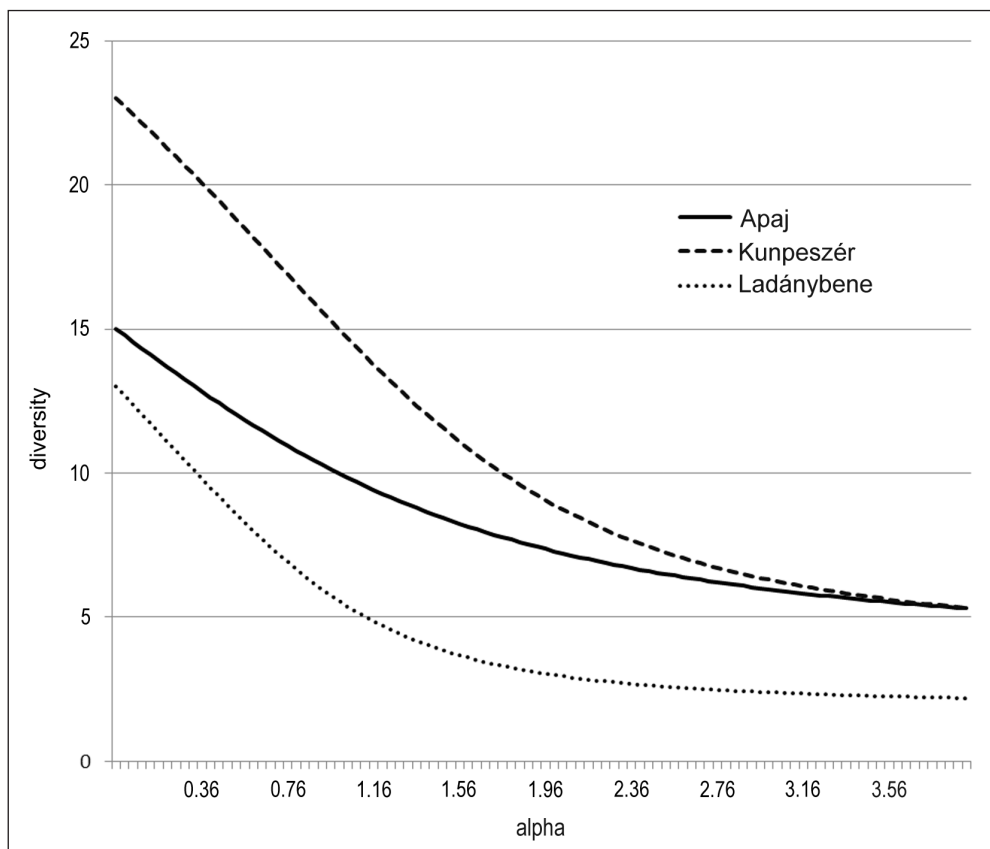


Figure 2. Comparison of arthropod diversities based on Little Owl pellets using Rényi's diversity profiles

2. ábra A kúvik köpetek alapján kimutatott ízeltlábúak diverzitási profiljai

Table 2. Characteristics of arthropod communities of the studies sites on the basis of Little Owl pellets

2. táblázat A vizsgált revírek ízeltlábú-közösségeinek karakterisztikái a kúvik köpetek alapján

| | Apaj | Kunpeszér | Ladánybene |
|--------------------------------|-------|-----------|------------|
| Species richness (<i>S</i>) | 15 | 23 | 13 |
| Shannon diversity (<i>H</i>) | 2.316 | 2.727 | 1.751 |
| Equitability (<i>J</i>) | 0.855 | 0.871 | 0.683 |

Table 3. Pairwise comparison of arthropod communities as found in Little Owl pellets using the Jaccard's similarity coefficient (normal letters) and the Bray-Curtis index (italicized letters)

3. táblázat A kúvik köpetek alapján vett rovarközösségek hasonlósága (Jaccard-féle fajazonossági index – normál betű; Bray-Curtis hasonlósági index – dőlt betű)

| | Apaj | Kunpeszér | Ladánybene |
|-------------------|------|-------------|-------------|
| Apaj | | <i>0.38</i> | <i>0.16</i> |
| Kunpeszér | 0.31 | | <i>0.57</i> |
| Ladánybene | 0.24 | 0.36 | |

Based on the Jaccard index of community composition (*Table 3*), the highest similarity (0.36) was observed between Kunpeszér and Ladánybene with 6 common arthropod species, while the lowest similarity (0.24) was found between the arthropod assemblages in Apaj and Ladánybene (4 common species). These results are confirmed by the Bray-Curtis index of similarity which takes into account also the arthropod abundance.

Discussion

As literature data report, the Little Owl is a dietary generalist predator whose diet composition is linked to the abundance of potential prey species available (Cramp 1985, Schönn *et al.* 1991, Laiu & Murariu 1997, Van Nieuwenhuysse *et al.* 2008, Šálek *et al.* 2010). This fact is well reflected in marked differences in food composition of Little Owls occurring in distinct geographical regions (Obuch & Kristin 2004, Charter *et al.* 2006, Van Nieuwenhuysse *et al.* 2008, Kayahan & Tabur 2016) or inhabiting different environments and habitats within the same geographical area (Van Nieuwenhuysse *et al.* 2008). Seasonal variation in diet composition is also a known and well documented phenomenon (e.g. Hounsoume *et al.* 2004, Alivizatos *et al.* 2006, Lanszki 2006, Romanowski *et al.* 2013). In general, from central Europe towards to the South-European region, the role of small mammals in the diet of Little Owl gets less important in contrast with the insects becoming predominant in the Mediterranean region (Libois 1977, Zerunian *et al.* 1982, Mánez 1983, Mikkola 1983, Simeonov 1983, Schönn *et al.* 1991, Ille 1992, Angelici *et al.* 1997, Genot & Van Nieuwenhuysse 2002, Arcidiacono *et al.* 2007, Tomé *et al.* 2008, Kayahan & Tabur 2016). In Hungary, previous studies have shown a dominant contribution of insects (in terms of prey number) during the breeding season (Schmidt 1967, 1998, Lanszki 2006). In contrast, our result showed that vertebrate prey heavily dominated not only the overall biomass, but also the number of individuals (70–75%), in accordance with the results of Polish (Romanowski 1988, Kitowski & Pawlega 2010) and Bulgarian (Georgiev 2005) studies. This phenomenon can be considered unusual also because the climate of our study area is extremely hot and semi-arid, thereby showing a moderate similarity with Mediterranean conditions, supposedly providing high abundance and availability of arthropod invertebrates. Nevertheless, there are rare examples of vertebrate dominance in the diet of Little Owls also in the Mediterranean region (Goutner & Alivizatos 2003).

Among vertebrates the key role of Common Vole was also confirmed by our results, in accordance with other Hungarian (Greschik 1911, 1924, Schmidt 1967, Marián & Schmidt 1968, Lanszki 2006) and other studies from the central European region (Romanowski 1988, Ille 1992, Genot & Bersuder 1995, Laiu & Murariu 1997, Schmid 2003, Grzywaczewski *et al.* 2006, Romanowski & Żmihorski 2006, Šálek *et al.* 2010, Romanowski *et al.* 2013). House Mouse proved to be also numerous in sites where farm buildings are redundant (Apaj and Kunpeszér). In such environments, synanthropic small mammals can have a considerable contribution in the diet (Marián & Schmidt 1968, Romanowski *et al.* 2013, Chenchouni 2014). It has also been observed that Little Owls hunt for these preys inside the buildings (Genot & Van Nieuwenhuysse 2002).

Usually, birds do not play a key role in the diet of Little Owls (Libois 1977, Laursen 1981, Simeonov 1983, Cramp 1985, Lanszki 2006, Šálek *et al.* 2010, Romanowski *et al.* 2013). Nonetheless, a few studies reported high seasonal frequency of bird occurrence in spring-time and autumn (Hounsom *et al.* 2004), in autumn and winter (Mikkola 1983) or during the wintertime (Hell 1964). While in our study site in Kunpeszér birds were completely absent in the Little Owl pellets, their contribution was remarkable in Apaj, and especially in Ladánybene, reaching 25% in terms of number and 55.9% of the overall biomass. Avian prey in the latter sites was strongly dominated by the Common Starling. The forest patches provide optimal night roosts for starlings where they can be easily caught by Little Owls. Other bird prey items include the House Sparrow or the White Wagtail (*Motacilla alba*) are clearly linked to the farm buildings in these sites and are often falling prey to the Little Owls (Marián & Schmidt 1968, Grzywaczewski *et al.* 2006, Shao & Liu 2008, Kitowski & Pawlega 2010, Pocora *et al.* 2012). The absence of birds in pellets collected in Kunpeszér might be explained by the site characteristics, as neither the sparse Black Locust trees nor the dense pine plantations can provide night roosts preferred by Common Starlings.

Amphibian presence in the diet of Little Owl is usually scarce (Lanszki 2006, Romanowski *et al.* 2013, Chenchouni 2014) or completely absent (Laiu & Murariu 2000, Hounsom *et al.* 2010, Šálek *et al.* 2010) depending their availability and the habitat. Although occasional reports on presumed higher proportions of amphibian prey are available (Uttendörfer 1939, Festetics 1955), this phenomenon has rarely been observed. For that reason, the occurrence of the Common Spadefoot in all studied site with remarkable contribution merits a special mention. In Ladánybene this species constituted in 18.3% of all prey and represented 16.4% of the total biomass. The Common Spadefoot is a species with nocturnal activity, occurring in high abundance in the study area. It is, therefore, not a coincidence that Little Owls prefer this easily obtainable prey over the fast-moving small mammals or the less profitable arthropod prey items.

Reptiles play relevant role in Little Owl's food composition mostly in the Mediterranean (Zerunian *et al.* 1982, Angelici *et al.* 1997, Mastroiilli *et al.* 2001, Arcidiacono *et al.* 2007) and in the desert areas in Asia (Al-Melhim *et al.* 1997, Obuch & Kristin 2004, Shao *et al.* 2007). In Central Europe reptiles are less abundant, which is well reflected also in the diet composition of Little Owls (Greschik 1911, Schmidt & Marián 1968, Laiu & Murariu 2000). In our study area two lacertid lizard species were found in the pellets but with marginal contribution.

From the pellet analyses we can draw the conclusion that in contrast with the only detailed study carried out in Hungary (Lanszki 2006), arthropod preys do not play a crucial role in our study area. As stated by Schmidt (1998), utilization of this food source can be limited depending on the habitat, but researches are lacking to assess this assertion. Notwithstanding, as the relatively high species richness observed in the pellets from the study area suggested that relevance of invertebrates, especially of insects is obvious. In agreement with our result, most studies from the region of Central Europe report the domination of coleopteran beetles in the arthropod fraction over the other orders (Genot & Bersuder 1995, Fattorini *et al.* 1999, 2001, Grzywaczewski *et al.* 2006, Lanszki 2006, Kitowski & Pawlega 2010, Šálek *et al.* 2010, Romanowski *et al.* 2013). Within Coleoptera,

the preferred prey items are usually large ground beetles (Carabidae) and scarab beetles (Scarabaeidae) of higher prey item's mass (e.g. Ille 1996, Schmid 2003, Grzywaczewski *et al.* 2006, Lanszki 2006, Šálek *et al.* 2010). Such species in our study area include the Chestnut Cockchafer, as well as protected species like the Forest Caterpillar Hunter (*Calosoma syhophanta*) or the European Rhinoceros Beetle (*Oryctes nasicornis*). Common characteristics of the majority of prey insects are the nocturnal or intermediate activity and the ground-dwelling life form suitable for the hunting habits of the Little Owl (Grzywaczewski *et al.* 2006, Lanszki 2006, Šálek *et al.* 2010). Orthopterans also showed a considerable contribution among the arthropod groups, especially in Apaj and Kunpeszér, which can be explained by the great extent of mowed meadows and grasslands. In Ladánybene, the abandoned fields with mostly tall and dense ruderal vegetation can heavily decrease the availability of the otherwise abundant orthopterans, therefore the hunting efficiency is low in such habitats (Hoste-Danyłow *et al.* 2010). The Great Green Bush-cricket proved to be the most preferred species. Due to its large size, crepuscular and nocturnal stridulating and flying activity it is frequently captured by Little Owls with high efficiency (Ille 1992). Similar relatively high proportion of Orthoptera as detected in Kunpeszér (7.6% in terms of prey numbers) is quite unusual in Central Europe, while often observed in the Middle East (Obuch & Kristin 2004) and in the Mediterranean region (Goutner & Alivizatos 2003, Tomé *et al.* 2008, Kayahan & Tabur 2016), where an absolute predominance of this group was also experienced.

Although the main habitat characteristics of the studied sites show no distinct differences, the particularities in mosaic structure mentioned in the site descriptions are reflected also in the arthropod communities, as derived from the Little Owl pellet analyses. The highest species richness, diversity and evenness, found in Kunpeszér, are presumably associated with the rich mosaic habitat structure of a relatively small area, where the trophic niche of the Little Owls is usually wider (Van Nieuwenhuysse *et al.* 2008). Primary reason of the low arthropod diversity observed in the Ladánybene site is due to the extreme dominance of the Chestnut Cockchafer. This socially foraging species is habitually occurring in forest edges in large quantities and thus easily available for Little Owls (Merkel & Vig 2009). The fact that the owls effectively feed on this prey can therefore bias the diversity results. As it was previously revealed, there is not necessarily an evident relationship between the actual prey diversity and that calculated on the basis of Little Owl pellets, owing to the opportunistic feeding (Lanszki 2006).

Similarity measures showed a fair distinctiveness between the studied sites based on the pellet analyses. Correspondingly, this was also experienced by Shao and Liu (2008) when comparing diet composition of Little Owls inhabiting sites of similar habitat types. The low number of common species is likely to be related to the varied distribution of certain habitat elements. Hence, insects connected to water bodies or waterside habitats (*Dytiscus marginalis*, *Anisodactylus binotatus*), to sandy areas (*Broscus cephalotes*, *Harpalus hirtipes*, *Anomala vitis*), to salt affected soils (*Geotrupes spiniger*, *Pentodon idiota*) or to forest patches (Forest Caterpillar Hunter, *Protaetia aeruginosa*, Rhinoceros Beetle, Chestnut Cockchafer) occurred exclusively or with higher abundance in a given site with suitable habitat characteristics.

The share of earthworms (Lumbricidae) in the diet of Little Owl has been regarded as marginal (Laursen 1981, Romanowski 1988, Grzywaczewski *et al.* 2006), considerable (Petrescu 1994, Blache 2001) or significant (Juillard 1984, Bacia 1998, Hounsoume *et al.* 2004, Tomé *et al.* 2008, Schipper *et al.* 2012). In the pellets from the study sites, earthworm chaetae were present with a high frequency, albeit their number and biomass have not been calculated due to the not fully developed methodology.

In contrast with the findings of Lanszki (2006), plant materials were not detected in the Little Owl pellets from our study area.

As supported by our results, the Little Owl can be considered a typical generalist predator in the Kiskunság region. The identified 54 prey taxa represent a wide range of food types within a relatively small area and provide important information not only on the feeding ecology but also for the conservation of Little Owl.

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