Comparison of the Diet of Two Desert-living Owls, the Long-eared Owl (*Asio otus*) and Little Owl (*Athene noctua*) from Southern Mongolia

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Abstract

The diet of two sympatric owl species, the long-eared owl (*Asio otus*) and the little owl (*Athene noctua*) was investigated in an arid area of southern Mongolia using pellet analysis. In total 334 pellets of long-eared owl and 52 pellets of little owl were analysed, revealing the presence of five small mammal species (Dipodidae, three Muridae and one Soricidae), small birds and invertebrate fragments. Accumulative composition plots indicated a batch size of 35 - 60 pellets was sufficient to reveal representative diet composition. Small mammals comprised the largest component of the diet of long-eared owls with four species recorded, *Phodopus* was the most frequently occurring (85 %), followed by *Meriones* (33 %). Bird and invertebrate remains were also found in long-eared owl pellets but comprised less than 2 %. In contrast, invertebrates were the highest occurring component of the diet of little owls (35 %), with small mammals occurring in only 40 % of pellets. *Meriones* was the most frequently recorded small mammal in little owl pellets (23 %) and contributed the greatest in terms of overall rodent biomass. There was a highly statistically significant difference in the diet of the two species ($x^2 = 2043$, d.f. = 4, P < 0.001). Levin's measure of niche breadth was greater for little owls (0.71) than long-eared owls (0.51), but overall the two species had low niche overlap using Levin's index (0.22). These results are discussed in relation to previous findings of these two species.

Key words: desert, diet, little owl, long-eared owl, Mongolia, niche

Introduction

The competitive exclusion principle states that two species with identical requirements cannot coexist in the same place, at the same time (Gause, 1934). Competition will occur between species that overlap in their resource requirements. One mechanism of species coexistence is differences in feeding ecology, such as predatory behaviour and/or dietary separation (Capizzi *et al*., 1998; Csermely *et al*., 2002). A species dietary range can be expressed in terms of niche width, and evidence of competition and/or diet separation can be investigated by examining the niche overlap between two species (Levins, 1968).

Twelve species of owl (Strigiformes) have been recorded in Mongolia (Fomin & Bold, 1991), however they have not been subject to intensive studies and little is known about their ecological requirements such as diet (Batdelger, 1994, 2001). The long-eared owl (*Asio otus)* and little owl (*Athene noctua*) are two sympatric species found in Mongolia, which can coexist in a range of habitat types (e.g. Navarro *et al*., 2003; Martinez & Zuberogoitia, 2004). Previous investigations into the trophic niche of these species have indicated that the dietary niche overlap between these two species is intermediate, between 30 - 60% (Navarro *et al*., 2003). The long-eared owl is a widely distributed medium sized owl, found throughout central Asia, Europe, North Africa and North America. It inhabits a wide range of habitat types, from woodlands (e.g. Tome *et al*., 2004) to deserts (Brown, 1995). It is known to require a mosaic of wooded and open habitats, for roosting and hunting respectively (Klippel & Parmalee, 1982). In Europe the long-eared owl has been described as a restricted feeder specializing on mammals, which can make up to 80 - 98% of its diet (Marti, 1976; Cecere & Vicini, 2000). However, studies have also demonstrated a wider range of prey items, including small birds and bats (Speakman, 1991; Cecere & Vicini, 2000; Navarro *et al*., 2001). The study of Bertolino *et al*. (2001) in Italy described it as being "an adaptable predator that expands its food niche in the presence of diversified prey". In the North

American deserts the long-eared owl was described as an opportunistic forager, feeding on a wide range of mammal species including rabbits (*Sylvilagu* sp.) and hares (*Lepus* sp.) (Craig *et al.*, 1984).

The little owl, the smaller of the two species, also inhabits a wide range of environments from open habitats, such as steppe (Navarro *et al.*, 2003), to rocky areas and desert (Obuch & Kristin, 2004). However, in contrast to long-eared owls this species strongly avoids wooded areas and prefers open grassland for foraging (Kitowski & Kisiel, 2003). It has been shown to be largely insectivorous, with over 50% of the diet being comprised of invertebrates in northern Italy (Gotta & Pigozzi, 1997). However in terms of biomass, the diet is dominated by small mammals (Capizzi & Luiselli, 1996; Goutner & Alivizatos, 2003) and it will also take small birds (Obuch & Kristin, 2004). Several authors have described its diet as opportunistic, reflecting temporal variations in prey availability (Goutner & Alivizatos, 2003).

The aims of this study were to i) assess the summer diet of two desert-living owl species, ii) investigate dietary width and overlap between the two species to assess competitive pressure and coexistence mechanisms and iii) compare these findings with previous studies to investigate the impacts of locality on the diet composition.

Materials and Methods

The study was conducted between June and July 2004 in the arid Little Gobi Strictly Protected Area 'A', in southern Mongolia. Climate in this area is continental with winter temperatures dropping to -10ºC, and summer temperatures up to 40ºC. Annual rainfall is less than 50 mm, and mainly falls between July and August. Habitat types in the area include rocky outcrops, sparsely vegetated gravel plains and meandering wadis dominated by *Tamarix* sp. and *Haloxylon ammodendri*.

Four batches of pellets were collected from roosting sites of each species within a 3 km zone surrounding N 42º 11' 30" and E 105º 20' 40". From the four individual long-eared owl roosts, 124, 100, 71 and 39 pellets were collected, and from the little owl roosts, batches of 8, 9, 13 and 22 pellets were collected. Pellets were analysed separately, using only complete pellets, with prey species being identified using the skull and/or dentaries. The total number of individual prey items in the pellet was determined using the total number of dentaries or

skulls, whichever was greater (Yalden & Morris, 1990). Pellets with skulls present that could not be identified due to extensive damage or partial recovery were excluded from the analysis. Prey items were categorised into small mammals, birds or invertebrates. Species were identified to genus where possible by comparing skulls to a museum reference collection.

To confirm small mammal species present in the area, opportunistic live trapping was undertaken using Sherman traps (23cm x 9cm x 7.5cm). For the bipedal Dipodidae, hand capture with butterfly nets was undertaken whilst spotlighting at night (Scott & Dunstone, 2000). These surveys were undertaken in representative habitats in parallel with the pellet collection. To determine the number of pellets required from a single roost site to assess the representative diet composition, accumulative average composition of pellets was plotted against increasing pellet sample size for each species. The point at which the graph stabilises and levels out is considered an appropriate sample size. The importance of each rodent species in the diet, in terms of biomass, was calculated using average body weight determined from live trapping; *Meriones* = 60g, *Dipus* = 80g, *Cricetulus* = 45g and *Phodopus* = 15g. Species biomass was multiplied by the number of individuals found within each pellet. Overall biomass contribution per rodent species was then summed for all pellets and expressed as a percentage. Niche was determined by calculating Levin's measures of niche breadth for each species and Levin's index of niche overlap between the two species based on percentage frequency occurrence data (Waite, 2000). A chi-squared test was applied to test the difference in diet composition between the two owl species.

Results

All roost sites for long-eared owls were in trees close to, or on the edge of, a riverbed. Roost sites appeared to be extensively used, with numerous pellets (over 400 pellets were found at one roosting site). Little owl roosting sites were more difficult to locate, usually amongst rocky outcrops with relatively fewer pellets found per site. A total of 334 pellets were analysed for long-eared owls and 52 pellets for little owls. Prey items found within the diet were Dipodidae (*Dipus sagitta*), three species of Muridae (*Cricetulus migratorius*,

Phodopus roborovskii and *Meriones meridianus*), one species of Soricidae, birds, and invertebrates (which included solifuges (*Galeodes galeodulus*)). Twenty-one percent of little owl pellets had no skulls or identifiable remains present. Accumulative composition plots (Fig. 1 and Fig. 2) indicated a batch of 60 or more pellets was sufficient to provide a representative composition of diet for long-eared owls inhabiting this area, but fewer pellets (35 or more) were required for little owls. As a consequence of these findings, all pellet data from little owl roosts were pooled to enable dietary comparisons with the long-eared owl.

Figure 3 shows that small mammals comprise the largest component of the diet of long-eared owl. *Phodopus* was the most frequently occurring small mammal (in 85 % of pellets) followed by *Meriones*

(in 33 %). All other prey items and small mammal species occurred in less than 5 % of long-eared owl pellets. In terms of overall rodent biomass (Fig 4.), *Phodopus* contributed the greatest, but was closely followed by *Meriones*. In contrast, invertebrates were the highest occurring component of little owl diet (35 %), with small mammals occurring in only 40 % of pellets. *Meriones* was the most frequently recorded small mammal in little owl pellets (23 %) and contributed the greatest in terms of overall biomass. Based on our derived data on body weights, the average biomass of a small mammal taken by long-eared owls was 25g, compared to 56g for little owls. There was a highly statistically significant difference in the diet of the two species ($\div^2 = 2043$, d.f. = 4, P < 0.001). Levin's measure of niche breadth showed little owls to have a greater
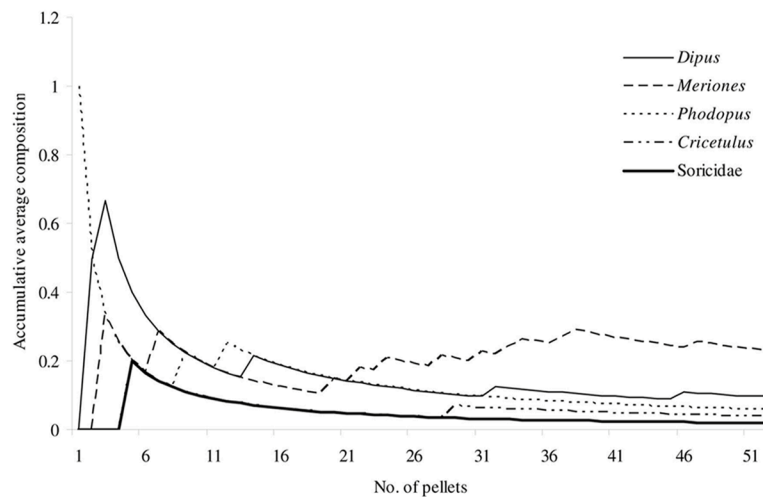

Figure 1. Plot of accumulative average dietary composition with increasing pellet sample size from four pooled little owl (*Athene noctua*) roosts.
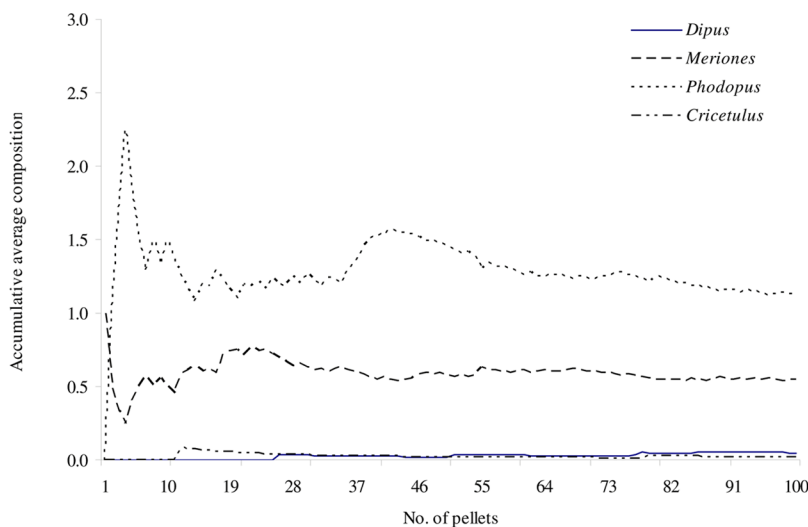

Figure 2. Plot of accumulative average dietary composition with increasing pellet sample size from one batch of pellets from a single long-eared owl (*Asio otus*) roost.
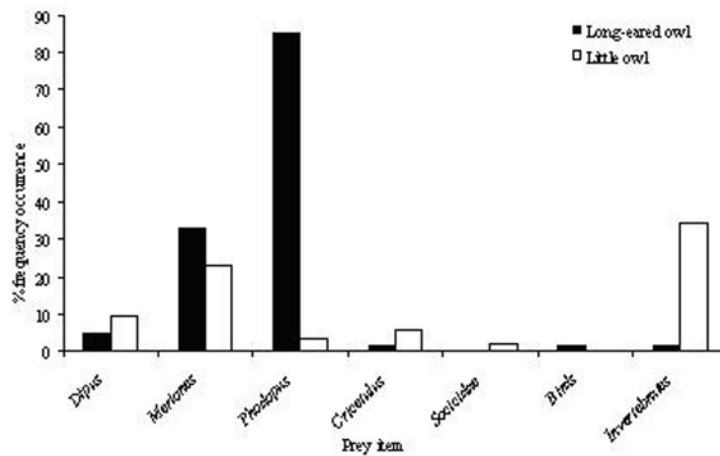
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Figure 3. The percentage frequency of occurrence of prey items in the diet of long-eared owls and little owls in a desert region of Southern Mongolia.
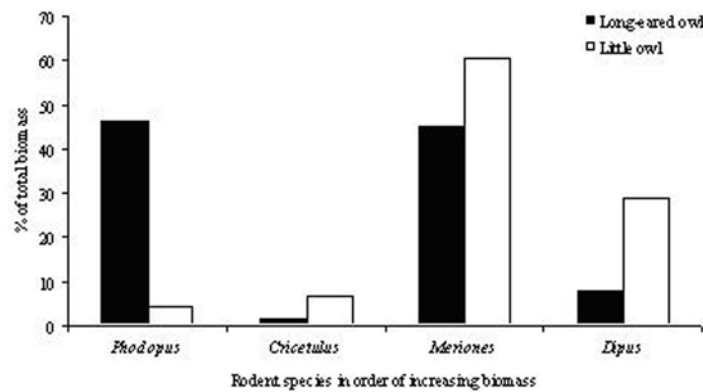

Figure 4. Relative importance of each rodent species in the diet of long-eared owls and little owls, expressed in terms of percentage of total rodent biomass.

niche breadth than long-eared owls (0.70 as opposed to 0.51), but overall the two species had a low level of niche overlap using Levin's index (0.22).

Discussion and Conclusion

Our study showed little owls to have a greater niche breadth than long-eared owls. This difference was predominately due to the specialisation of long-eared owls on a few species of small mammal, in contrast to the little owl which used a wider range of items more evenly. Long-eared owls are known to demonstrate selectivity of higher-ranking small mammal prey (Craig *et al.*, 1985; Tome, 2003). Previous studies have also reported a wide dietary niche width for little owls and high prey diversity due to its common utilisation of invertebrate prey items as well as small mammals (Navarro *et al.*, 2003; Goutner & Alivizatos, 2003). Solifugae have also been found in the diet of little owls inhabiting desert regions (Obuch & Kristin, 2004) however,

contrary to other desert studies no Lacertidae were recovered from pellets in our study. We did find invertebrates in the long-eared owl diet but at very low occurrence. Little owls have been reported in some areas to be largely insectivorous (Obuch & Kristin, 2004), with over 50 % of their diet being comprised of invertebrates in northern Italy (Gotta & Pigozzi, 1997). In our study invertebrates occurred in 35% of pellets. However in terms of biomass, the diet is dominant by small mammals (Capizzi & Luiselli, 1996; Goutner & Alivizatos, 2003). In our study no biomass data were derived for birds, invertebrates or Soricidae, therefore the importance of these prey items in the diet may be under or over estimated based on frequency occurrence data alone. When looking at our relative biomass of the rodent species, it is evident that *Meriones* is an important prey item for both little owls and long-eared owls. However, *Dipus* was found more frequently in the diet of little owls than long-eared owls and the inverse was true for *Phodopus*. The two species evidently utilise the

available rodent prey base to different extents. Little owls have previously been reported to take *Meriones*, *Cricetulus* and *Dipodidae* in middle-eastern and Asian deserts (Obuch & Kristin, 2004).

Marks & Yensen's study in 1980 found that most of the prey of long-eared owls weighed between 10 and 60 g and that prey over 100 g was less important in their diet. The mean weight of small mammals ingested in this study was not similar to previous findings. Due to their smaller body mass, little owls were expected to take smaller prey items than long-eared owls. In northern Italy, Gotta & Pigozzi, (1997) found the average prey weight for little owls to be 22.3 g. In our study the average prey weight was 56 g, compared to 25 g for long-eared owls. These data may reflect the relative abundance of prey in different habitat types; for example, low levels of *Cricetulus* recorded in the diet may reflect this species relative abundance and/or its susceptibility to predation. However, these findings need further investigation.

From this and other studies it appears that habitat preferences, feeding behaviour and dietary separation are potential mechanisms for coexistence of these two sympatric species. Habitat selection of roosting sites was evident, with long-eared owls preferring wooded areas whereas little owls preferred rocky outcrops, similar to the findings of Martinez & Zuberorgoitia (2004). Dietary partitioning was evident in this study from low niche overlap (0.22), which has also been shown in phylogenetically related owl species (Capizzi & Luiselli, 1996). Sympatric owls also display species-specific specialisations in feeding and hunting behaviour techniques (Csermely *et al.*, 2002).

Both owl species have been reported as opportunistic or adaptable predators (Bertolino *et al.*, 2001; Goutner & Alivizatos, 2003), with seasonal differences occurring in their diet in relation to physiological requirements and prey availability (Alivizatos & Goutner, 1999; Tome, 1997, 2003). Long-eared owls have been shown to take more birds during the breeding season, which is reflected in their seasonal niche breadth (Bertolino *et al.*, 2001). Additionally, it is evident from the range of studies that diet also varies spatially. The distribution and diet of little owls can be affected by the surrounding landscape mosaic (Ferrus *et al.*, 2002). Our study was only undertaken in one season, in one year and over a restricted area, therefore it only provides a snapshot of the diet of the two owl species studied. Further seasonal samples over a wider area would be needed to provide a more accurate picture of dietary composition and ecological requirements.

Our preliminary analysis suggested that the sample size was sufficient to give an indication of diet composition. Limited numbers of roosting sites and pellets from the little owl did not allow for investigations into individual differences in diet.

It is suggested from the number of individual owls sighted within the study area and the number of pellets recovered from roost sites that an individual little owl may have exclusive use of a roost site, whereas the long-eared owl roosts may be used communally (Holt, 1997). As no reference collection of skulls was collected from the site, skull remains were identified by comparison with museum specimens from other areas. No museum sample was available for *Phodopus*; therefore this was identified using available literature (Allen, 1940). All species identification should be confirmed by comparisons with local specimens.

Acknowledgments

References

Alivizatos, H. & Goutner, V. 1999. Winter diet of the barn owl (*Tyto alba*) and long-eared owl (*Asio otus*) in northeastern Greece: A comparison. *J. Raptor Res.* 33: 160-163.

Allen, G.M. 1940. *The mammals of China and Mongolia. Part 2*. Publications of American Museum of Natural History. Central Asiatic Expeditions.

Batdelger, D. 1994. Conservation of Raptors in Mongolia: Current status and problems. *J. Omithol.* 135, Sonderheft: 214

Batdelger, D. 2001. Current Status and

Conservation Problems of Birds of Prey in Mongolia. Oral presentation abstract, 4th Eurasian Congress on Raptors, Seville.

Bertolino, S., Ghiberti, E. & Perrone, A. 2001. Feeding ecology of the long-eared owl (*Asio otus*) in northern Italy: is it a dietary specialist? *Canadian J. Zoology,* 79: 2192-2198.

Brown N.L. 1995. Notes on the winter roost and diet of long-eared owls in the Sonoran Desert. *J. Raptor Res.* 29 (4): 277-279.

Capizzi, D. & Luiselli, L. 1996. Feeding relationships and competitive interactions between phylogenetically unrelated predators (owls and snakes). *Acta Oecologica*, 17: 265-284.

Capizzi, D., Caroli, L. & Varuzza, P. 1998. Feeding habits of sympatric long-eared owl *Asio otus*, tawny owl *Strix aluco* and barn owl *Tyto alba* in Mediterranean coastal woodland. *Acta Ornith.* 33: 85-92.

Cecere, F. & Vicini, G. 2000. Micromammals in the diet of the long-eared owl (*Asio otus*) at the W.W.F.'s Oasi San Giuliano, (Matera, South Italy). *Hystrix* 11 (2): 47-53.

Craig, T.H., Craig, E.H. & Powers, L.R. 1984. Food habits of long-eared owls (*Asio otus*) at a communal roost site during the nesting season. *Auk* 102: 193-195.

Csermely, D., Casagrande, S. & Sponza, S. 2002. Adaptive details in the comparison of predatory behaviour of four owl species. *Italian J. Zool.* 69: 239-243

Ferrus, L., Genot, J.C., Topin, F., Baudry, J. & Giraudoux, P. 2002. Distribution of little owl (*Athene noctua* Scop.) at various scales of landscape analysis. *Revue D Ecologie-la Terre et la Vie* 57: 39-51.

Fomin, V.E. & Bold, A. 1991. *Catalogue of the birds of the Mongolian People's Republic*. Nauka Press, Moscow. pp. 126.

Gause, G.F. 1934. *The Struggle for Existence*. Williams and Wilkins, Baltimore.

Gotta, A. & Pigozzi, G. 1997. Trophic niche of the barn owl and little owl in a rice field habitat in northern Italy. *Italian J. Zool.* 64: 55-59.

Goutner, V. & Alivizatos, H. 2003. Diet of the barn owl (*Tyto alba*) and little owl (*Athene noctua*) in wetlands of northeastern Greece. *Belgian J. of Zool.* 133: 15-22.

Holt, D.W. 1997. The long-eared owl (*Asio otus*) and forest management: A review of the literature. *J. Raptor Res*. 31: 175-186.

Kitowski, I. & Kisiel, E. 2003. Distribution of little owl *Athene noctua* and barn owl *Tyto alba* in the Zamoœæ Region (SE Poland) in the light of atlas studies. *Ornis Hungarica* 12-13:1-2.

Klippel, W.E. & Parmalee, P.W. (1982). Prey of a wintering long-eared owl in Nashville Basin, Tennessee. *J. Field Ornith*. 53 (4): 418-420.

Levins. R. 1968. *Evolution in changing environments*. Princeton University Press, Princeton, N.J.

Marks, J.S. & Yensen, E. 1980. Nest sites and food habits of long-eared owls in southwestern Idaho. *Murrelet* 61: 86-91.

Marti, C.D. 1976. Review of prey selection by the long-earned owl. *Condor* 78 (3): 331-336.

Martinez, J.A. & Zuberogoitia, I. 2004. Habitat preferences for long-eared owls *Asio otus* and little owls *Athene noctua* in semi-arid environments at three spatial scales. *Bird Study* 51 (2): 163-169.

Navarro, J., Sanchez-Zapata, J.A., Carrete, M., Botella, F., Gavrilov, A., Sklyarenko, S., Donazar, J.A., Ceballos, O. & Hiraldo, F. 2003. Diet of three sympatric owls in steppe habitats of eastern Kazakhstan. *J. Raptor Res*. 37 (3): 256-258.

Obuch, J. & Kristin, A. 2004. Prey composition of the little owl *Athene noctua* in an arid zone (Egypt, Syria, Iran). *Fol. Zool*. 53, 65-79.

Scott, D.M. & Dunstone N. 2000. Environmental determinants of desert-living rodent community structure in the north-east Badia region of Jordan. *J. Zool. London* 251:481-494.

Speakman, J.R. 1991. The impact of predation by birds on bat populations in the British Isles. *Mammal Review* 21(3): 123-142.

Tome, D. 1997. Diet composition of the long-eared owl (*Asio otus*) in central Slovenia - seasonal variation in prey use. *J. Raptor Res*. 28: 253-258.

Tome, D. 2003. Functional response of the long-eared owl (*Asio otus*) to changing prey numbers: a 20 year study. *Ornis Fennica*. 80: 63-70.

Tome, R., Bloise, C. & Korpimaki, E. 2004. Nest-site selection and nesting success of little owls (*Athene noctua*) in Mediterranean woodland and open habitats. *J. Raptor Res*. 38: 35-46.

Waite, S. 2000. *Statistical Ecology in Practice: A guide to the analysis of environmental and ecological field data*. Prentice Hall. pp. 414.

Yalden D.W. & Morris P.A. 1990. *The Analysis of Owl Pellets*. The Mammal Society, UK.

Хураангуй

Монгол орны өмнөд бүс нутагт тархсан явлиг ууль (*Asio otus*), хотны бүгээхэй (*Athene noctua*) зэрэг хоёр симпатрик зүйлийн шар шувууны идэш тэжээлийн судалгааг гулгидасны задлан шинжилгээний аргаар судлав. Нийт явлиг уульны 334 гулгидас, хотны бүгээхэйн 52 гулгидас цуглуулан задлан шинжилгээ хийж 5 зүйлийн жижиг хөхтөн амьтан (1 зүйл Dipodidae, 3 зүйл Muridae, 1 зүйл Soricidae овгийн) болон жижиг шувууд, сээр нуруугүй амьтдын үлдэгдлийг илрүүлэв. Идэш тэжээл хуримтлагдсан газар нутагт 30-60 гулгидасыг судлахад түүнд агуулагдах идэш тэжээлийн бүрэлдэхүүнийг тодорхойлоход хангалттай болох нь тогтоогдов. Явлиг уульны идэш тэжээлийг бүрэлдэхүүний ихэнх хэсгийг 4 зүйлийн жижиг хөхтөн амьтан эзэлж буй нь тогтоогдсон бөгөөд, *Podopus* төрлийн амьтны үлдэгдэл хамгийн их тохиолдоцтой (85%), түүний дараа *Meriones* төрлийн амьтны үлдэгдэл (33 %) мөн элбэг тохиолдож байв. Явлиг уульны гулгидсанд сээр нуруугүйтэн ба шувууны үлдэгдэл 2%-аас бага хэмжээгээр олдож байв. Харин үүний эсрэгээр хотны бүгээхэйн гулгидсанд сээр нуруугүй амьтдын үлдэгдэл хамгийн их хэмжээгээр (35%) тохиолдож, жижиг хөхтөн амьтдын үлдэгдэл нийт гулгидасны дөнгөж 40%-д нь илэрч байлаа. Хотны бүгээхэйн гулгидсанд *Meriones* төрлийн чичүүлний үлдэгдэл хамгийн их тохиолдоцтой (23%) байсан бөгөөд гулгидаснаас илэрсэн нийт мэрэгчдийн "биомасс"-ын ихэнхийг бүрдүүлж байв. Энэхүү 2 зүйл шөний идэвхтэй махчин шувууны идэш тэжээлийн бүрэлдэхүүнд статистик шинжилгээ хийхэд ихээхэн ялгаатай болох нь илэрлээ ($x^2 = 2043$, d.f. = 4, P < 0.001). Levin-ий хэмжүүрээр авч үзвэл хотны бүгээхэйн экологийн ниш буюу амьдрах орчин, амьдралын үйл ажиллагаа, идэш тэжээлийн бүрэлдэхүүний хамрах хүрээ г.м. үзүүлэлт (0.71) нь явлиг уульны экологийн ниш (0.51) буюу дээр дурдсан үзүүлэлтээс илүү өргөн хүрээтэй болох нь илэрсэн юм. Гэвч Levin-ий индексээр харьцуулж үзвэл энэхүү 2 зүйл уульны экологийн нишийн давхцал харьцангуй бага (0.22) болох нь тогтоогдов. Энэхүү судалгааны үр дүнг дээр дурдсан 2 зүйл уульны өмнөх судалгааны мэдээ баримттай холбон тайлбарласан болно.