EFFECTS OF URBANISM ON MALACOFUNA (NITRA, SLOVAKIA)

Barbora Holienková¹, Zuzana Krumpálová²

Abstract: Recently, the number of alien landscape species has dramatically increased, and this could be a serious threat, not only for native species but also in cases of outbreaks for farmers. Our objective was to examine the impact of the urban environment (positive or negative) on the diversity of native species; forecast biotic homogenization or diversification of urban fauna; and determine the extent to which each of the zones are affected by invasive species. To examine the effect of urbanization, we selected 16 areas (across three urban zones and one zone in the protected area for comparison) for this study in 2015 in Nitra. We found that snails in open locations had significantly greater species diversity and abundance of individuals than in closed locations. Slightly degraded areas had the most abundant snail species, but areas heavily disturbed had high species diversity and incidence of individuals. It appears that heavily disturbed areas are suitable as new types of refuge for snails, e.g., for *Helix lucorum* (Linnaeus, 1758), which was recorded in Slovakia for the first time (numerically recorded at the railway station) in 2014.

UDC Classification: 591, **DOI:** <http://dx.doi.org/10.12955/cbup.v4.766>

Keywords: urbanism, molluscs, *Helix lucorum*, invasion.

Introduction

The landscape is characterized by the dynamics of urban activities with the advancing destruction of native habitats, joined with a significant fragmentation of the original natural environment. Cities contribute a high proportion towards the penetration of alien species into natural environments (Pyšek et al., 2010) and also affect the abundance of native species, e.g., biotic homogenization (Baiser, Olden, Record, Lockwood, & McKinney, 2012). Invasion of alien species and the extinction of native species can lead to diversification in some places (Olden & Poff, 2003; Lososová, Chytrý, Tichý, Danihelka, & Fajmon, 2012a, 2012b). Molluscs are a groups of organisms that are used as a bioindicator of environmental impact on landscapes, due to their relatively limited mobility in particular types of habitat. Even the conch shell often becomes an important bioindicator (Horsák, Juříčková, & Picka, 2013).

Materials and Methods

The main method involved collecting individual specimens for a unit of time (15 min to 1hr.), consistent with similar studies in an urban environment (e.g., Horsák, Juříčková, Kintrová, & Hájek, 2009; Lososová et al., 2011, 2012a, 2012b; Clergeau, Tapko, & Fontaine, 2011). Where possible, we sampled the top layer of soil with a sieve to capture small species. The volume of soil samples from each site was approximately 2 liters of substrate. We then dried the soil air, and oven-dried samples were sorted to collect individual snails. We determined the species using identification keys (Ložek, 1956; Horsák, Juříčková, & Picka, 2013). All potential habitat types occurring in the gradient from the city center to beyond its periphery were examined in this research.

In our work, we chose to research areas of almost undisturbed habitat, forest, and rare xerothermic habitat, to compare species richness and composition of malacofauna in (semi) natural habitats in Nitra and its surroundings with that in heavily urbanized areas. The methodology was partly taken from the work of Horsák et al. (2009), which takes into account harvesting from locations slightly disturbed by humans.

We also recorded the disruption to the habitats. We chose a scale from 1 to 5, where '1' was slightly disturbed and '5' was very strongly disturbed habitat. The scale for distinguishing places was binary (0 - open habitat, 1 - closed habitat). This part of the methodology was also adopted from the previously mentioned work. The areas examined were divided into the following areas: 1) The Centre and continuously built-up areas, with a minimum of potentially suitable refuge areas; 2) Wider Centre (discontinuous area, islands of greenery, and other refuge areas); 3) Peripherals (residential areas,

¹ Barbora Holienková, University of Constantine the Philosopher in Nitra and University of Constantine the Philosopher in Nitra, Slovakia, barboraholienkova@gmail.com

² Zuzana Krumpálová, University of Constantine the Philosopher in Nitra, Slovakia, zkrumpalova@ukf.sk

older neighborhoods, gardens, vineyards, and orchards); and 4) Natural sites. The exact location of surveyed sites was recorded by a global positioning system (GPS) device. Refuge areas were characterized on the basis of vegetation, degree of distortion, degree of isolation, and age. For analyzing the characteristics of the population or community (generic similarity, species balance, species diversity, and species richness of molluscs communities), we used the statistical software, PAST, version 3.6 (Hammer, Harper, & Ryan, 2001). Gastropods were categorized according to Horsák (unpublished) by slightly modifying the environmental groupings of Lisický (1991). Depending on the occurrence and frequency of the species in the research areas, the species were divided into types according to Tischler (1949) as follows: accidental to random occurrences, 0 to 25% of total; ancillary, 25 to 50%; constant, 50 to 75%; and euconstant, greater than 75%; the last two categories being significant for synecology of the species. Slovak nomenclature was used in the context of Országh, Čejka, & Országhová (2012).

Results and Discussion

At 16 of the research sites, we observed 41 types of molluscs, i.e., one aquatic and 40 terrestrial species. The total number of sorted individuals, identified to species level was 828. Species diversity of snails according to the Shannon index of diversity for the whole study area was $H' = 2.491$, while species richness according to the Margalef species richness index was $R = 5.953$, and the Pielouvej index for snail territories represented a value of $e = 0.671$. Species were subsequently classified as having a frequency of a constant or accidental occurrence. Two species were constantly occurring, namely *Cepaea hortensis* (O. F. Müller, 1774) - agricola silvicol and *C. vindobonensis* (Férussac, 1821) - stepicola silvicol, apart from others that had 11 ancillary occurrence and 28 accidental occurrences. Euconstant occurrence was not noted for any gastropods. In the research, we investigated the effect of the degree of habitat disturbance on species diversity (Figure 1) and abundance of molluscs (Figure 2). Locations were divided by the degree of disturbance according to Horsák et. al. (2009).

Figure 1: The impact of the degree of disturbance on number of species

Source: Author

We found that the sites with the low disturbance had the highest species richness. However, sites identified as the most disturbed did not have the smaller diversity of species. These areas may be suitable refuges for the spreading of new species, for example, *Helix lucorum*, which was numerically recorded at two sites. In Slovakia, the occurrence of this species was recorded for the first time in 2014 in Bratislava (Čejka & Čačány, 2014).

Figure 2: Influence of the degree of disturbance on individuals

Source: Author

The highest number of individuals was recorded at the least disturbed areas. Extremely high abundance of species was found at a site in disturbed habitat where the invasive species, *Arion vulgaris* (euryvalent kind), indicated for the site L11 peak (Figure 2), accounted for more than half the number of individuals. The second most abundant species in the plots was *Helix pomatia* (*Thamnophilous* spp.) numbering 25 of the 83 overall specimens. The site L15 peaks (Figures 1 & 2) were caused by *Xerolenta obvia* (stepicola - living on dry shiny places, significant especially with grasslands), which occurred at this site, numbering 55 out of 74 individuals.

The next results showed the impact of individual isolation of habitats on biodiversity (Figure 3) and the frequency of molluscs (Figure 4). The sites were assigned a value of '0' for open habitat and '1' for closed or partly closed habitat. Methodology was adapted from work of Horsák et al. (2009).

Figure 3: The impact of isolation on biodiversity. Notes : 0 - open, 1 - isolated

Source: Author

We found that the open sites had significantly greater species diversity than the closed sites. A number of species were also arguably higher at open locations.

Figure 4: The impact of the frequency of isolation of individuals

Source: Author

After conversion of types for the sites in each zone, we found that the Wider Center area was the richest in species, and due to the number of species, could be classified as resembling a natural state. Further, toward the peripheral zone, the number of species and number of individuals decreased (Figure 5). The peripheral zone was an area that was most affected by the invasive species *A. vulgaris*.

Figure 5: Values of species and individuals in each zone

Source: Author

The slug, *A. vulgaris*, is an invasive species that has infested many European countries. This species inhabits almost all habitat types, but most commonly inhabits cultural areas (in Slovakia, it was first recorded in 1992 and today it has become a noxious pest).

Conclusion

The results of our research showed that isolation and disruption of habitat has an immense impact on biodiversity and the number of molluscs communities. We observed secondary habitats such as urban parks provide with suitable conditions for animal life and therefore consider that the near center of the

cities could support equal species richness to that of nature reservations. Furthermore, we found that the peripheral zone was the area most disturbed by invasive species.

Acknowledgement

This article was created with support of the project VEGA - > 1/0109/13 - Interaction of living organisms in anthropogenic environment.

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