Micro-habitat scale survey of land snails in dolines of the Alsó-hegy, Aggtelek National Park, Hungary

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Abstract

We present results of a micro-habitat scale land snail survey replicated in 16 dolines (karstic depressions, sometimes referred as sinkholes with larger extent) in the Aggtelek National Park, Hungary. Snails were collected by time restricted direct search. We found that micro-habitat types greatly influenced the land snail assemblages. Most of the species preferred single micro-habitat type, and few species were generalists. Besides micro-habitat types, doline morphology also affected the richness and abundance of land snails. We also found that the inclusion of the dead shells in the analyses confounded the results.

Key words

Gastropoda, Pulmonata, faunistics, habitat structures, north-south transect, moisture gradient.

Introduction

The mollusc fauna of the Aggtelek Karst area and its surroundings has been intensively studied in recent years (Delli 2002; Delli et al. 2002; Farkas 2005, 2008). Due to its varied geomorphology and being the part of the Northern Carpathian fore-mountains, the area is characterized by a diverse mountainous snail fauna (Sólymos 2008). The Alsó-hegy plateau of the Aggtelek Karst area consists of hundreds of dolines, which provided us a unique opportunity to conduct a replicated field experiment to study the interacting effects of aspect and vertical moisture gradient on invertebrates in these dolines. The results of terrestrial isopod sampling of this “Dolina 2007” project has been published by Vilisics et al. (2008), while in the recent paper, we list the primary results regarding land snails.

In the “Dolina 2007” project, we sampled four different micro-habitat types (litter, live wood, dead wood, rock) and registered life stages (Domokos 1995) of the collected snail individuals as live (adults or juveniles), fresh empty shells, and broken/degraded shells. This micro-habitat scale surveying of land snails pos-
es new kinds of methodological challenges because of different shell accumulation rates in the different micro-habitats (discussed elsewhere by Sólymos et al. 2009a). In this paper, we present land snail abundances for the certain microhabitat types as primary results of our field experiment. We conclude to micro-habitat preferences of the species and relate the data to geomorphology of the dolines.

Material and methods

The Alsó-hegy (UTM: DU78) is situated in the eastern part of the Aggtelek Karst area that is geologically connected to the Slovak Karst (forming together the Gömör-Torna Karst) and is a part of the Aggtelek National Park. The sampling area is characterized by numerous depressions (sinkholes and dolines) in Triassic limestone (Kovács et al. 1988). The area is covered by deciduous forests with dominating species of oak (Quercus), hornbeam (Carpinus), beech (Fagus), ash (Fraxinus) and maple (Acer). Geographic coordinates of the surveyed dolines are provided by Vilics et al. (2008). Field work was carried out from August 16 to 18, 2007.

We sampled litter (collectors: PS and MK), live wood (coll.: ZK), dead wood (coll.: BPG) and rock (coll.: RF) micro-habitats separately. Seven samples of the litter micro-habitat were collected in a north-south transect in each dolines. Positions of these samples were the outside, edge and middle of each dolines in both northern and southern sides, plus the bottom. For the other three kinds of micro-habitats, we selected three random spots in each dolines for each micro-habitats. Aspect and position (edge, middle or bottom) for each sample were also registered.

This design resulted 16 samples from each dolines that is 256 in total. Each sample consisted of a litter+soil sample part. In the timed samples, we included surfaces of micro-habitats, e.g., bark of dead wood, mosses on rocks, cavities, boulder bottoms, live tree surfaces and crevices on it. Here we publish only the timed search results, because the litter samples have not been fully processed by the time of preparing the present paper. The timed search is biased towards large bodied species, but provides comparable results among micro-habitat types (Sólymos et al. 2009a).

We used the nomenclature of the Fauna Europea (Báns 2007), except for generic distinction of Alinda biplicata where we followed Nordsieck (2007). For species identification, we followed Kerney et al. (1983). For problematic species, Aegopinella minor, BPG made anatomical investigations of genital organs to avoid misidentification with Aegopinella nitens (Michaud, 1831) and Aegopinella epipedostoma (Faust, 1879).

Samples are stored as dry material in the collection of the Institute for Biology at the Szent István University, Faculty of Veterinary Science, Budapest, Hungary. For data processing we used the 3.0–3 version of the mefa package (Sólymos 2009). All analyses were done by the R software and environment (R Development Core Team, 2009, ver. 2.9). The data in electronic format and the data processing and analytic code used in this paper are available in the Dataverse Network (Sólymos et al. 2009b, hdl:1902.1/12731).

Results

We identified 3437 land snail specimens of 33 species (plus the Clausiliidae indet. group) collected from 16 dolines of the Alsó-hegy plateau. This consisted of 606 live adults, 449 live juveniles, 674 fresh shells and 1708 broken shells. Abundance (including both live individuals and dead shells) of snails was highest in the rock micro-habitat (mean abundance per samples: 30.17 ± 0.261 SE), and abundance decreased in the dead wood (18.08 ± 0.172 SE), live wood (10.06 ± 0.174 SE) litter (5.7 ± 0.063 SE) direction. Living snail abundance was highest in dead wood micro-habitat (4.88 ± 0.195 SE), it was similar in the rock (2.06 ± 0.063 SE) and live wood (2.0 ± 0.067 SE), and it was lowest in the litter micro-habitat (0.68 ± 0.017 SE).

For the litter transect, both mean species richness and mean abundance per samples increased towards the bottoms of the dolines, and both were higher in northern exposure (southern side of the dolines). Proportion of live individuals also increased towards the bottoms, and it varied greatly towards the edges of the dolines and outside of them (Fig. 1).

Micro-snails (Carychium minimum, C. tridentatum, Acanthinula aculeata, Punctum pygmaeum, Vitrea crystallina) and semislugs (Daudebardia brevipes, D. rufa) were scarcely represented by time restricted search. We focused on micro-habitat preferences of bigger sized species only, based on live counts (Table 1). For rare species (Orcula dolium, Merdigeria obscura, Aegopinella parva, Euconulus fulvus, Ce- paea vindobonensis) we were unable to determine micro-habitat preferences. Five species (Lucinariaria plicata, Petasina unidentata, Monachoides incarna- tus, M. vicinus, Euomphalia strigella) were generally present in all types of microhabitat. Alinda biplicata and Faustina faustina preferred dead wood and rock
The remaining twelve species showed distinct preference towards single micro-habitat type. Half of these micro-habitat specialist species (Discus perspectivus, Vitrea diaphana, Cochlodina laminata, Macrogastra ventricosa, Heli- codonta obvoluta) preferred dead wood. Bulgarica cana, Cochlodina cerata and Cochlodina orthostoma were most abundant near live trees. Live abundances of Morlina glabra, Clausilia dubia and Clausilia pumila were highest in rock micro-habitats, and Aegopinella minor, Petasina unidentata preferred the litter.

**Discussion**

Recently, there has been an increase in micro-scale land snail surveys addressing ecological differences regarding the relative abundances and species compositions of communities (e.g., around logs vs. leaf litter) within a site (Kappes 2005; Kappes et al. 2006, 2008; Sólymos & Páll-Gergely 2007). These works used paired samples (close to and distant to dead wood using litter samples [timed samples used in Sólymos & Páll-Gergely 2007]) and focused on the importance of coarse woody debris, one of the most important dynamic components of temperate forest ecosystems. All studies found that land snail abundance and richness was higher near and on woody material compared to the litter distant (usually 2 m apart) to it. We used balanced stratified sampling for four different micro-habitat strata. Because of these differences in sampling method and design, we can make only limited comparisons with the existing literature. Our findings also demonstrate that dead wood provides the most favored micro-habitat type in terms of snail abundance and richness. But other structures, i.e. live wood and...
rock were also occupied by specialist species, complementing both dead wood and litter micro-habitats. KAPPEL et al. (2006) also found effects of mesoclimatic differences between sites. Our results indicate that climatic differences can produce striking patterns in litter faunas on much smaller scales.

Our micro-scale inventory based on time restricted searches resulted sensible data for large bodied snail species. The time restricted search is known to underrepresent micro snails (CAMERON & POKRYSZKO 2005; SÓLYMOS et al. 2007) so our conclusions are valid only for large bodied species. We found that micro-habitat type influenced land snail abundances, but the ranking of micro-sites was influenced by the inclusion of dead shells. This can be due to different rates of shell accumulation around microhabitat types (discussed in SÓLYMOS et al. 2009a). Because dead shells can confound these small-scale patterns, the pooling of live and dead abundances is generally not advisable when comparing different micro-habitat types. However, it can be a useful strategy within a single micro-habitat type, where different proportions of live specimens are more likely to indicate activity patterns instead of different shell accumulation rates.

With live individuals only, dead wood supported the most and litter the least individuals. This can be due to the high moisture content of the decaying woody material, the availability of shelters provided beneath the bark or under the logs, and the food sources provided by dead wood. We found that most specialist species preferred dead wood partly (with rock micro-habitats) or exclusively. Live wood and rock also provide shelter, but food sources (lichens, mosses) are less diverse and these micro-habitats are drier, because rainfall runs down on their surface. Snail abundances and richness were intermediate in these micro-habitats, with few specialist species compared to dead wood. Litter (not influenced by other micro-habitats) provides the harshest environment to land snails, with few specialists and some generalist species present, and generally low richness and abundance values. But the litter micro-habitat is also a matrix that surrounds other micro-habitat elements. In the dry season (summer), it might pose a barrier to small scale dispersal, as it is exemplified by the edge regions and samples taken outside of the dolines. Here both abundance and proportion of live snails (thus snail activity) were low. But under favorable conditions (e.g. in the more humid bottoms and middles of the dolines) litter itself can serve as a medium to small scale dispersal.

In the studied dolines, micro-habitat types had major impact on land snail communities. Most of the species showed distinct micro-habitat preferences. Besides these differences, doline morphology also affected snail communities through vertical stratification (moist bottoms, dry edges) and exposure (heat load is higher in southern exposure than in northern). Because inter-specific co-occurrence relationships are probably masked in surveys carried out on larger (100–1000 meters) spatial scales, micro-scale (few meters) surveys are more likely to be useful for analyzing biotic interactions among species, besides their relationship with the abiotic environment.

**Fig. 1.** Relationship between species richness (A), abundance (B) and proportion of live individuals (C) and transect position for the samples of the litter micro-habitat. Transect position runs from north to south (southern to northern aspect, respectively) from outside (1, 7), edge (2, 6), middle (3, 5) and bottom (4) of the dolines. Thick line: median, box: interquartile range, whiskers: range, circles: outliers.
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References


