Land snail distribution patterns within a site: the role of calcium, vegetation, and moisture

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Monachoides incarnatus

Introduction:

Although many of studies have been focussed on the influence of environmental variables on land snail communities at relatively large scales, very little is known about what happens along small-scale environmental gradients within a site. The aim of our study was to analyze whether land snail assemblage patterns reflect gradients of **calcium**, **vegetation**, and **moisture** on a small scale.

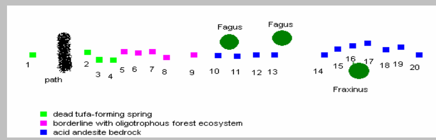
Materials and methods:

For this study two sides were chosen – **a dead tufa-forming spring** as a natural source of available calcium and **the ruin of the castle** as a man-made source of calcium for land snails. At each site a set of 20 quadrates 25 x 25 cm² was laid down in the line from the calcium-rich patch to calcium-poor matrix (acid crystalline bedrock).

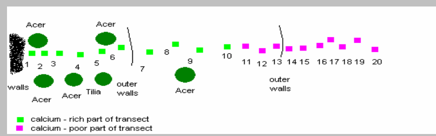
On each sampling plot we recorded:

- composition of the vegetation and its cover,
- moisture with using Ellenberg's plant indicator system,
- Ca content,
- number of molluscs.

The whole data set was processed using ordinations in the CANOCO program. Species data were logarithmically transformed.



The scheme of the set of sampling plots from the dead tufa in Čertův luh.



The scheme of the set of sampling plots from the castle ruin of Prácheň.

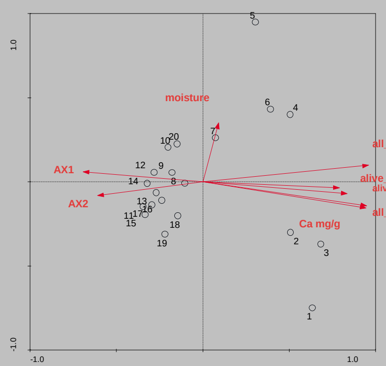
Results:

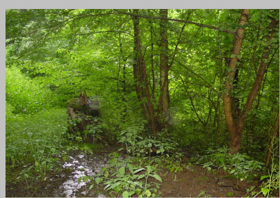
Using an indirect analysis of the species data we found out that for both sites **the calcium content was the strongest controller** of species richness and total abundance.

We used **Ellenberg's plant indicator system** in order to analyze the influence of moisture on land snails (see Horsák et al., 2007). Unfortunately, this system proved to be **unsuitable for our data** due to very low number of plant species obtained from small quadrates.

Therefore we decided to use abundances of hygrophilous snail species to show a possible gradient of soil moisture.

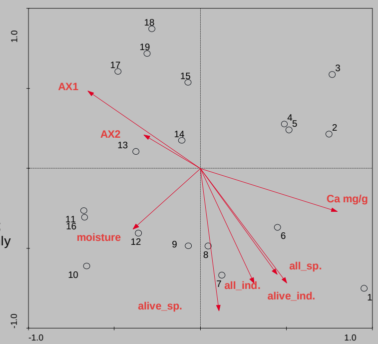
Čertův luh: natural source of calcium

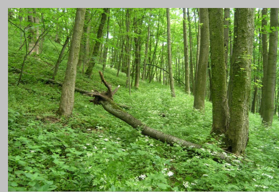




Čertův luh

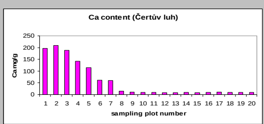
Prácheň: man-made source of calcium

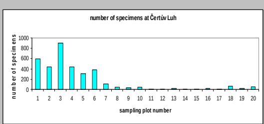


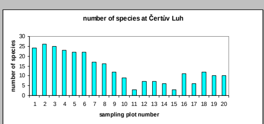


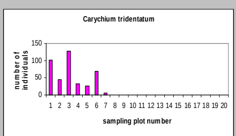
Prácheň

Indirect analysis (PCA) of quadrates based on snail data; position on the first two ordination axes. Variables were only passively plotted.
AX1, AX2 – vegetation axes
Ca mg/g – calcium content
all_ind – all molluscs found at gradient
alive_ind – alive molluscs
all_sp. – all found species
alive_sp. – alive species
1–20 – numbers of sampling plots at the site







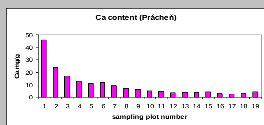


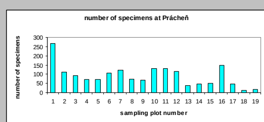
Čertův luh:

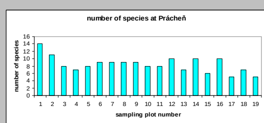
- only **one main gradient** of species composition related to both **calcium content and soil moisture**
- all species – including hygrophilous, e.g. *Carychium tridentatum* – reflected this main gradient
- strong gradient of calcium content – sharp response of snail abundance and species richness

Prácheň:

- **two independent gradients**
  snail species composition was predominantly driven by **the calcium content**
  snail abundances and richness reflected probably also **the variation in moisture**
- examples of two types of mollusc response to these gradients:
  abundance of hygrophilous species (e.g. *Carychium tridentatum*) followed the gradient of moisture
  abundance of calcicole species (e.g. *Sphyradium doliolum*) followed the gradient of calcium content (R=0.98, p<0.05)



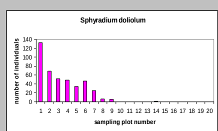


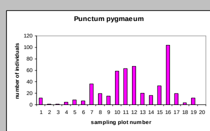


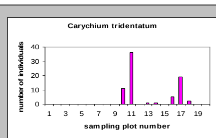
Carychium tridentatum

Punctum pygmaeum

Sphyradium doliolum







variables	Ca mg/g	all_ind.	alive_ind.	all_sp.	alive_sp.
Ca mg/g	1	0.82	0.60	0.86	0.72
all_ind.	< 0.001	1	0.83	0.96	0.87
alive_ind.	0.005	< 0.001	1	0.82	0.93
all_sp.	< 0.001	< 0.001	< 0.001	1	0.91
alive_sp.	< 0.001	< 0.001	< 0.001	< 0.001	1

Spearman correlations for Ca content and abundance of all/alive molluscs and all/alive species at Čertův luh site.
Values of correlation coefficients (upper right) and their significance probabilities (lower left) are given, N=20.

We found out that the observed pattern was nearly the same for only live individuals and both live individuals and empty shells at both sites. This confirmed that **the observed distribution of snails is stable in time**, reflecting environmental gradients even at such a small scale where individual species can easily migrate among the sampling plots.

variables	Ca mg/g	all_ind.	alive_ind.	all_sp.	alive_sp.
Ca mg/g	1	0.43	0.64	0.36	0.43
all_ind.	0.067	1	0.82	0.66	0.69
alive_ind.	0.003	< 0.001	1	0.64	0.68
all_sp.	0.134	0.002	0.003	1	0,76
alive_sp.	0.067	0.001	0.001	< 0.001	1

Spearman correlation for Ca content and abundance of all/alive molluscs and all/alive species at Prácheň site.
Values of correlation coefficients (upper right) and their significance probabilities (lower left) are given, N=19.

Conclusion:

For both sites the calcium content was the strongest controller of species richness and total abundance. Surprisingly, the observed distribution of snails was stable in time, reflecting environmental gradients even at such a small scale where individual species can easily migrate among the sampling plots. This fact also implies that even relatively small quadrates are sufficient for recording the small-scale patterns. If the assemblages of sampling quadrates are significantly biased by insufficient sampling volume and/or temporal variation, the results for live individuals and all individuals should be different.

References: Horsák M., Hájek M., Tichý L. & Juřičková L., 2007. Plant indicatory values as a tool for land mollusc autecology assessment. Acta Oecologica 32, 161–171.

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