Predictive power of vegetation and environmental factors for explaining variation of meadow snail communities

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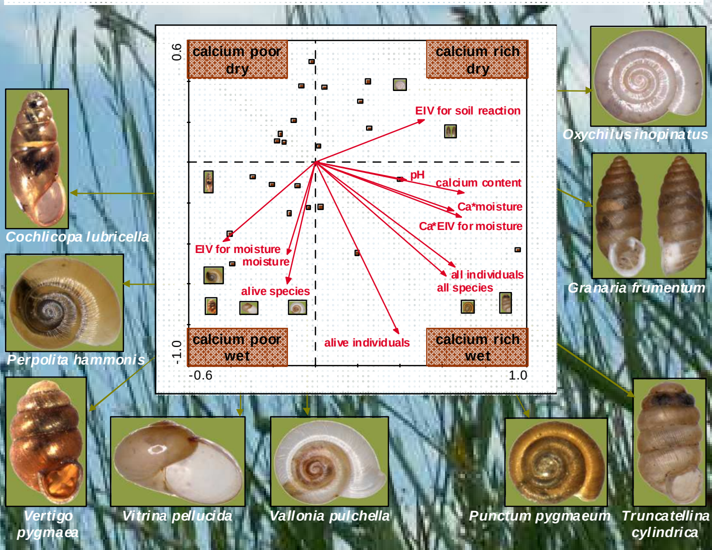
INTRODUCTION

This study deals with the meadow snail communities and their relationships with vegetation. Studied meadows are famous for their species richness of vascular plants including many rare and endangered species (Fig. 3). Nevertheless only a little work has been done on snail communities so far. Therefore we studied snail species richness and composition of these habitats. For explaining variation of snail communities, several environmental factors and factors obtained based on vegetation (i.e. Ellenberg indicator values - EIV) were used.

STUDIED SITES

A total of 22 sites were studied in dry grasslands and mesic meadows in the White Carpathians Mts. (SE Czech Republic) in 2005-2006. The sites were chosen along two main environmental gradients: the gradient of soil calcium content and soil moisture.

Figure 1. Principal component analysis: ordination plot of sites on the first two PCA axes. Species data were square-root transformed and centred by species. The shown species had the highest fit to the first two axes and they were abundant only at one of four types of sites (marked by brown colour). On calcium poor and dry sites we found only few, low abundant, common species. Calcium rich and dry sites were also species poor but they exclusively hosted steppe species (e.g. *Granaria frumentum*).



METHODS

At each 1 m² plot, vegetation was recorded and then the upper soil layer up to the depth of 5 cm was removed from 4 quadrats of 25 x 25 cm² for snail sampling. Soil samples were collected for laboratory measurements of calcium content and pH; soil moisture was measured in the field. Variables approximated from the vegetation (i.e. EIVs) were mean values of an empiric value for each plant species recorded in the plot, which reflected the ecological behaviour of plant species (Ellenberg et al. 1992). We used EIV for soil reaction and moisture.

Live snail individuals and empty shells were counted separately. Data were analyzed using Spearman's correlation coefficient and ordination techniques (Principal component analysis - PCA, Redundant analysis - RDA).

AIMS

- to investigate the influence of soil calcium content and moisture on the composition and species richness of snail meadow communities
- to compare the predictive power of these environmental factors and variables approximated based on plant composition

RESULTS

All species richness and abundances were driven by interaction between soil calcium content and moisture. Alive species richness was significantly associated only with EIVs for moisture contrary to numbers of alive individuals, which were correlated only with soil moisture (Fig. 2).

The main gradient of species composition was explained by calcium content as well as by EIVs for soil reaction (Fig. 1). Soil moisture was correlated with the second PCA axis. Using the RDA with the Monte Carlo permutation test we found only two significant factors: (1) interaction between soil calcium and moisture, and (2) EIVs for soil moisture. Surprisingly the measured soil moisture was not significant.

The RDA showed that environmental factors explained 30.5% and EIV explained 27.4% of the variation of snail species data.

	all species	all individuals	alive species	alive individuals
all individuals	****0,638**			
alive species	****0,649**	0,396		
alive individuals	****0,577**	****0,627**	****0,570**	
soil pH	0,407	***0,517**	0,060	0,121
soil calcium content	***0,502**	*****0,720**	0,089	0,292
moisture	0,287	0,263	0,395	***0,423**
EIV for moisture	0,105	0,027	***0,508**	0,265
EIV for soil reaction	0,122	0,308	-0,332	-0,250
calcium*moisture	****0,568**	*****0,748**	0,160	0,345
calcium*EIV for moisture	****0,552**	*****0,746**	0,164	0,348

Figure 2. Spearman correlations between species data and variables (including their interactions). Significance is given as: * - p < 0,05; ** - p < 0,01; *** - p < 0,001.

Figure 3. White Carpathian grasslands are famous for their species richness and the occurence of many rare and endangered species as ***Anacamptis pyramidalis.***

CONCLUSIONS

We found the positive relationship between soil moisture and alive snail species richness and their abundances. The number of alive species was explained only by the EIVs for moisture, while the number of alive individuals correlated only with soil moisture. In contrast, all species richness and abundances were better explained by soil calcium content, which can be connected with longer persistence of empty shells in calcium rich sites. Alive snail composition was mostly explained by an interaction between calcium content and moisture.

Although the predictive power of environmental factors was a little higher than that of vegetation, only EIVs were able to explain the variation of alive species richness. This can be connected with the ability of EIVs to record environmental conditions over years contrary to a one-shot measurements. Therefore, the vegetation appeared to be another important predictor for explaining variation in snail communities.

REFERENCES

Ellenberg H., Weber H.E., Düll R., Wirth W., Werner W. & Paulißen D. (1992): Zeigerwerte von Pflanzen in Mitteleuropa. Ed. 2. Scripta Geobotanica, 18: 1–258.

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