

Historical development of Western Carpathian spring fens: fossil evidence and impact on modern species composition

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INTRODUCTION AND METHODS

Species distribution and composition of assemblages can be controlled by several factors and processes. On large scales it is mainly controlled by climate contrary to small scales where species distribution is controlled by environmental conditions and interactions among species. Taking history into consideration is important for understanding recent distributions and occurrences of species on both scales.

The research is based on quantitative sampling of 165 treeless fen sites scattered through the whole territory of the Western Carpathian Mountains (Central Europe) and based on dug out profiles of fossil sediments at nine calcareous fen sites (Fig. 1).

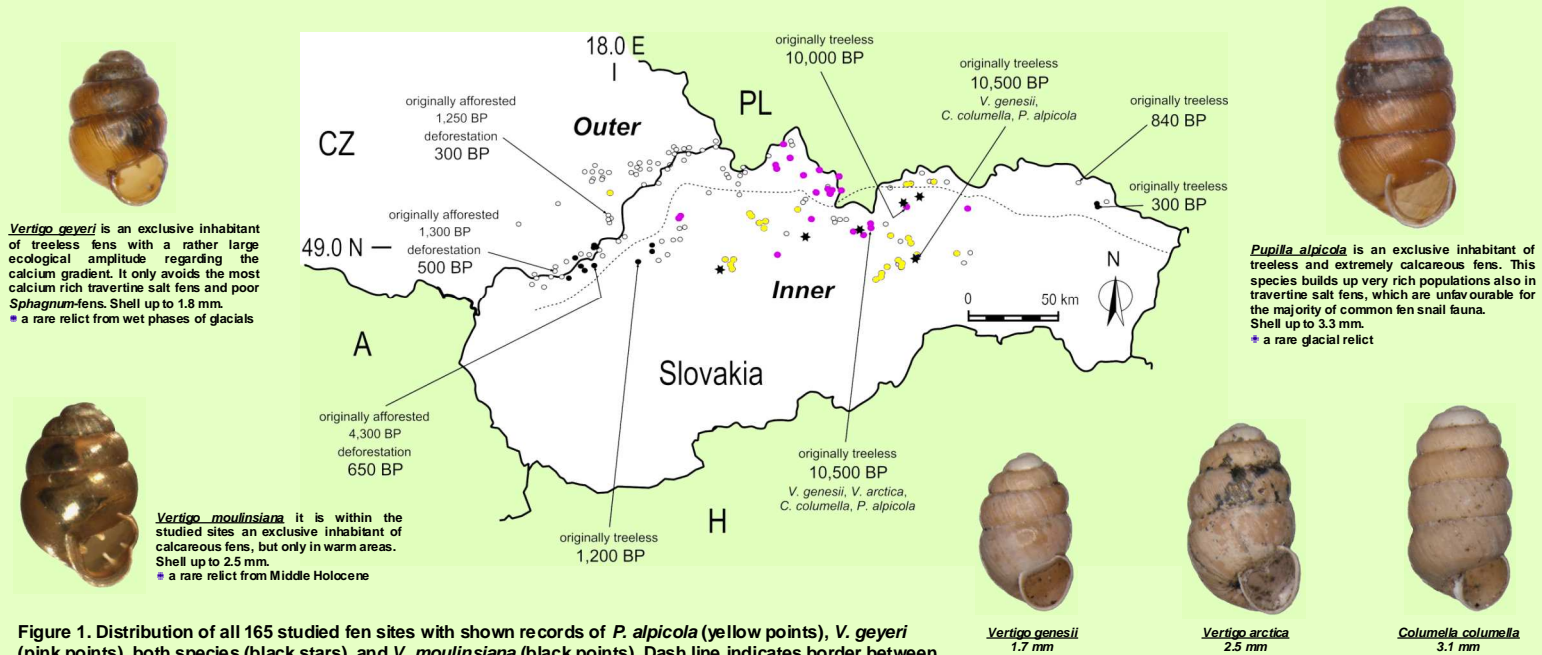


Figure 1. Distribution of all 165 studied fen sites with shown records of *P. alpicola* (yellow points), *V. geyeri* (pink points), both species (black stars), and *V. moulinsiana* (black points). Dash line indicates border between Outer and Inner Western Carpathians. Arrows show position of nine fossil profiles.

RESULTS

During this study a clear species turnover of modern snail and plant assemblages has been observed on the scale of only tens of kilometres, independently of any climate or other environmental variation. The sites in the Outer Western Carpathians, based on species composition, were nearly completely separated along the 1st axis in the partial DCA diagram from those in the Inner Western Carpathians with a rather narrow overlap zone (Fig. 2). This pattern is caused mainly by a frequent occurrence of several relict snail species (e.g. *Vertigo geyeri*, *Pupilla alpicola*) in the Inner Western Carpathians and the common presence of several woodland species (e.g. *Aegopinella pura*, *Monachoides incarnatus*) in the Outer Western Carpathians. Our palaeoecological data clearly support a hypothesis of different historical development of fen sites in these two regions. On the basis of fossil evidence it is clear that calcareous fen sites in the Outer part are much younger than those in the Inner one. The open fen-meadow state of fens in the western part is quite young. It is mainly the result of an extensive deforestation during the largest Walachian colonisation, which started 700-600 years ago. By contrast, in the Inner part at least some fens represent relict habitats from the Late Glacial period. In the deepest layer (10500 years BP) of the profile we found typical species of the Late Glacial (i.e. *Vertigo genesii*, *V. arctica*, and *Columella columella*) which are today limited to the Boreal zone and can also have isolated populations in high mountains (*C. columella* and *V. arctica*).

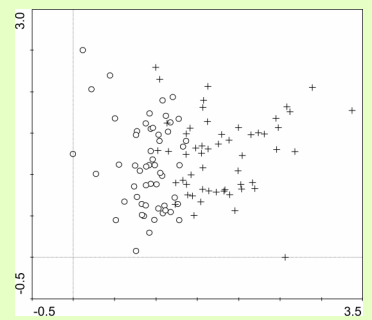


Figure 2. Partial DCA of mollusc assemblages (with water pH and conductivity as co-variables); ordination plot of sites on the first two axes. Circles - Outer region, crosses - Inner region.

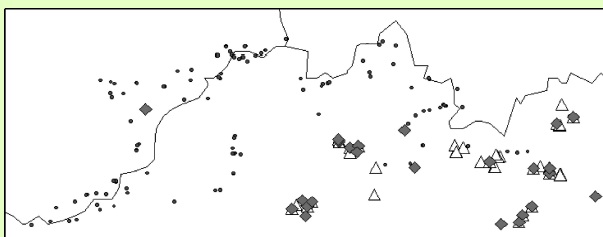


Figure 3. Distribution of *Pupilla alpicola* (diamonds) and plant *Primula farinosa* (triangles; blooming on the photo) within study sites.

We observed that snail species with the highest probabilities of co-occurring with certain plant species are exclusive fen inhabitants and even glacial relicts (e.g. distribution of species on (Fig. 3). Thus, historical development seems to be one of the most important variables constituting qualitative characters of modern fragmented snail and plant communities of the Western Carpathian fens.