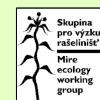


THE WEST-CARPATHIAN TUFA FENS – A 17-THOUSAND-YEAR-OLD HISTORY



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INTRODUCTION AND METHODS

Calcareous fens provide suitable sediments with good conditions for macrofossil and pollen preservation. However, only a few palaeoecological studies have dealt with these sediments. We analyzed sediments of 47 well-preserved calcareous fens (Fig. 1) to study their age and development using a radiocarbon dating and analyses of pollen, plant macrofossils and molluscs.

In the deepest part of each fen, we took the samples from the bottom of the sediment and, if wooded developmental stage was present at the bottom, also from the transition between forested and open fen that was indicated in the field by a disappearance of wood and an appearance of light-demanding mollusc species (mainly *Vallonia* spp., *Vertigo pygmaea*). All sediment samples (n = 75) were dated and calibrated ^{14}C data were used for ecological interpretations.

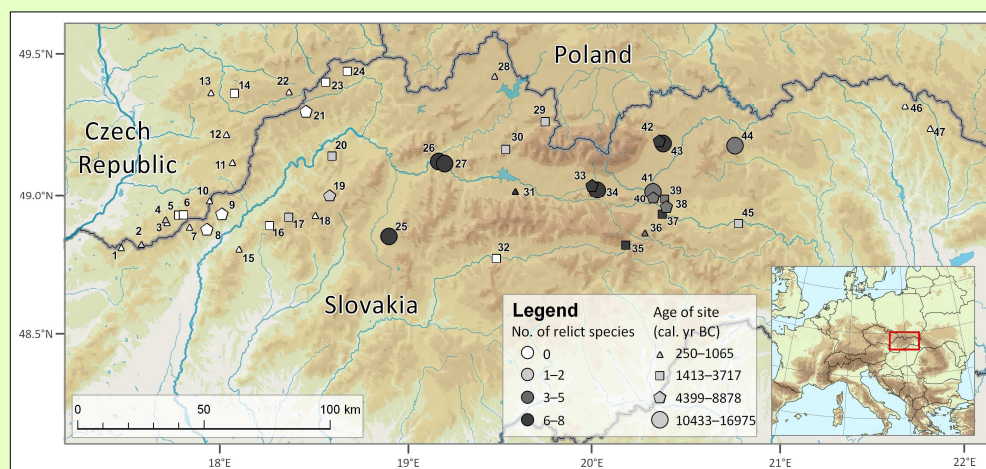


Figure 1. Distribution of 47 studied sites in the West-Carpathian Mountains. Number of possible relict species, i.e. rare species (< 15 localities) significantly linked to older fens that expected by chance in a null model is indicated by different shading, while maximum known age (radiocarbon ^{14}C dating, calibrated years BP) of a calcareous fen habitat at particular sites is indicated by different symbols and size (the larger the older).

Figure 2. Štrba site – an example of fen habitat with a long history (age 11,030 cal. yrs BP), bottom assemblage: semi-open woodland with *Pinus cembra* and late glacial snail indicators (*Vertigo genesii*, *V. parcedentata*, *V. modesta* and *Columella columella*).

RESULTS

The age of studied sites varied from 16,975 calibrated yrs BP (13,810 uncal. yrs BP) to 250 cal. and uncal. yrs BP. We found regionally clustered distribution of sites with the Late-Glacial and Early-Holocene age. Seven sites in the Inner Western Carpathians were dated back to the Late-Glacial and Early-Holocene (16,975–10433 cal. yrs BP). In contrast, site situated in the Outer part of the region were younger than 2,294 cal. yrs BP, except two sites (6,620 and 8,878 cal. yrs BP). These differences in historical development fit well to the distributional pattern of species with presumably relictual distribution in the study region (e.g. snail *Vertigo geyeri* and *Pupilla alpicola*, and plants *Triglochin maritimum* and *Primula farinosa*). All these species inhabit open sites, which perfectly matches with the obtained results based on fossil material from bottom layers (Figs 2 and 3). All those seven old sites in the Inner part started as open fens or semi-open fen woodlands and have supported the occurrence of heliophilous species. In contrast, all older sites in the Outer part started as woody fens and were deforested by humans during recent centuries (mostly only 700 years ago). Originally open fens in this area developed due to human impact to the landscape, such as tree cutting and burning, which has increased erosion and decreased forest cover. Due to geomorphologic characteristics of flysch bedrock, many new open spring fens arose in the Outer Western Carpathians after this deforestation.

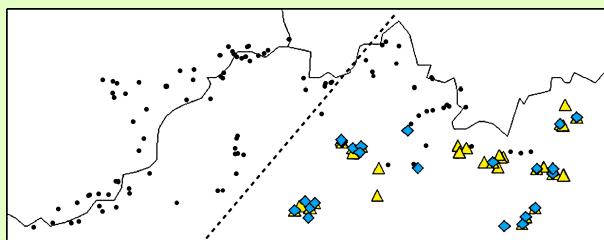


Figure 3. Distribution of *Pupilla alpicola* (diamonds) and plant *Primula farinosa* (triangles; blooming on the photo) within all 160 sites searched for modern communities in the study area.



Pupilla alpicola is an exclusive inhabitant of treeless and extremely calcareous fens. Shell up to 3.3 mm.
♦ a rare glacial relict

Vertigo geyeri is an exclusive inhabitant of various treeless fen types. Shell up to 1.8 mm.
♦ a rare relict from the Late Glacial

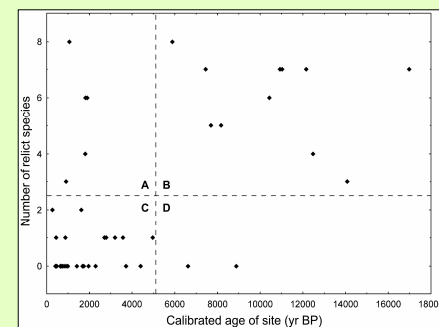


Figure 2. Number of possible relict species identified, i.e. rare species (< 15 localities) significantly linked to older fens that expected by chance in a null model, plotted against the age of deepest sediment. Recent concentration of these species generally indicates sediments older than 5,000 years (compare sections C and B), with the exception of five younger fens located close to ancient ones in the Inner Western Carpathians (section A) and two old fens located in the Outer Western Carpathians where long deciduous-forest developmental stage has occurred till recently for most of their existence (section D).