Outline of Late Glacial and Holocene Vegetation in a Landscape with Strong Geomorphological Gradients

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ABSTRACT. Acid sandstone areas of the Czech Republic are specific with their poor and mostly montane flora influenced by strong geomorphological gradients due to sandstone weathering. This was an opportunity to study small-scale differences during the Late Glacial and the Holocene. Two profiles were sampled and analysed in the area of Teplické skály Mts., NE Czech Republic. The pollen analysis shows a vegetation development in the past 10,000 years for the sandstone area and some differences between the profiles. For example differerences seem to exist in the occurrence of Pinus sylvestris on local rocky habitats. The relation between transport and sedimentation of pollen, which is important for pollen spectra interpretation, should be studied in the future.

KEY WORDS: Northeastern Bohemia, palaeoecology, pollen diagrams, sandstones.

Introduction

Acid sandstone areas are a typical phenomenon in the Czech landscape. They often form complicated networks of deep and narrow valleys and gorges with specific microclimate and hydrology. Ecological specificity of the sandstones (climatic inversion on the bottom of the gorges due to very low irradiation, very low poor nutrient content) underlies strong gradients over small areas. Today's vegetation in the gorges is well defined against the rest of the landscape (Hadač and Sýkora, 1984) and constitutes a montane vegetation; in contrast, plateaus, margins of plateaus and the rest of the landscape have more or less mesic character.

Fig. 1. Investigated area (dark).

We studied changes in the vegetation cover during the Holocene by means of pollen analysis; more specifically we studied the possibility identifiable differences between gorges and their surroundings.

Methods and material studied

Two peat profiles were sampled at two locations in the area of the Teplické skály Mts. in NE Bohemia (Fig. 1) and analysed. Both have been assessed by means of palaeobotanical analysis of samples taken from a trench to the monoliths. Profiles were ^{14}C dated. Samples from the monoliths were chemically pretreated and analysed for pollen (Moore et al., 1991).

Results and analyses

The first reference profile is located in the centre of the Teplické skály Mts. in the main gorge "Vlčí rokle". Its depth reaches 410 cm and radiocarbon dating shows the age of 10,563 years BP conv. at the 357 cm level. Results of the pollen analysis (Fig. 3) show that the deepest part of the profile developed during the Late Glacial (Youngest Dryas). The second analysed profile from the "Teplické údolí (Čáp) Gorge" (Fig. 4) is located in the marginal and higher part of the sandstone area. The sedimentary record covers the interval of the last 7500 years.

Development of the vegetation cover in the Holocene can be summarized as follows (see pollen diagrams - Fig. 3 and 4):

Pleistocene - Deepest part (Fig. 3), sedimentation in a cool period (like Würm glacial), low pollen frequency, probably local dystrophic and cool water (*Pediastrum kawraiskyi, P.integrum, Botryococcus pila*), tree species of *Alnus viridis, Larix* and probably *Pinus cembra.*

Younger Dryas (DR 3) - certainly above the depth of 400 cm (Fig. 3), forest tundra vegetation - birch, willow, *Populus tremula, Juniperus* and *Pinus sylvestris*, bottoms of gorges covered by mosses and acid grasses.

Preboreal (PB) - surrounding landscape had the character of a thin taiga with birch and pine, typical tundra herbs (*Saxifraga* sp. div., *Polygonum* cf. *viviparum*, *Huperzia sellago*) in the undergrowt, moisture stands with *Filipendula, Peucedanum, Phyteuma, Polygonum bistorta, Aconitum, Thalictrum* and others, *Polypodium vulgare* on sandstone rocks, considerable oc-

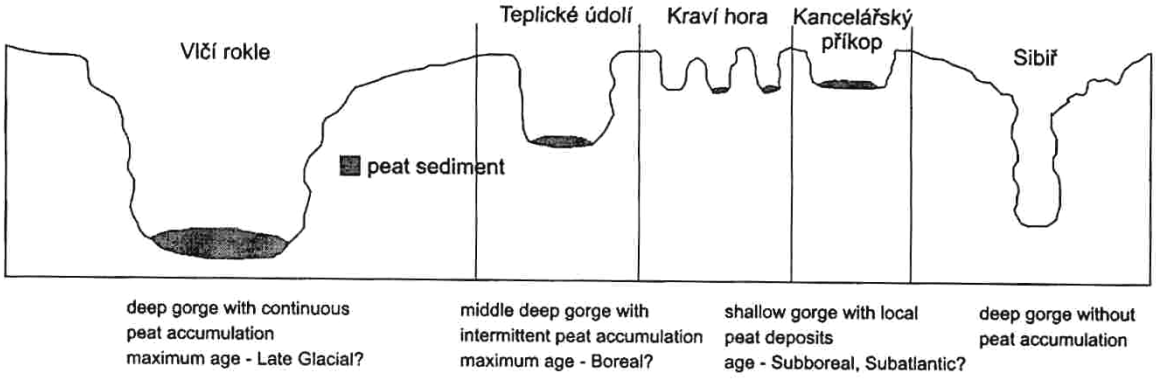

Fig. 2. Geomorphological profile of Teplické skály Mts. (schematic view).

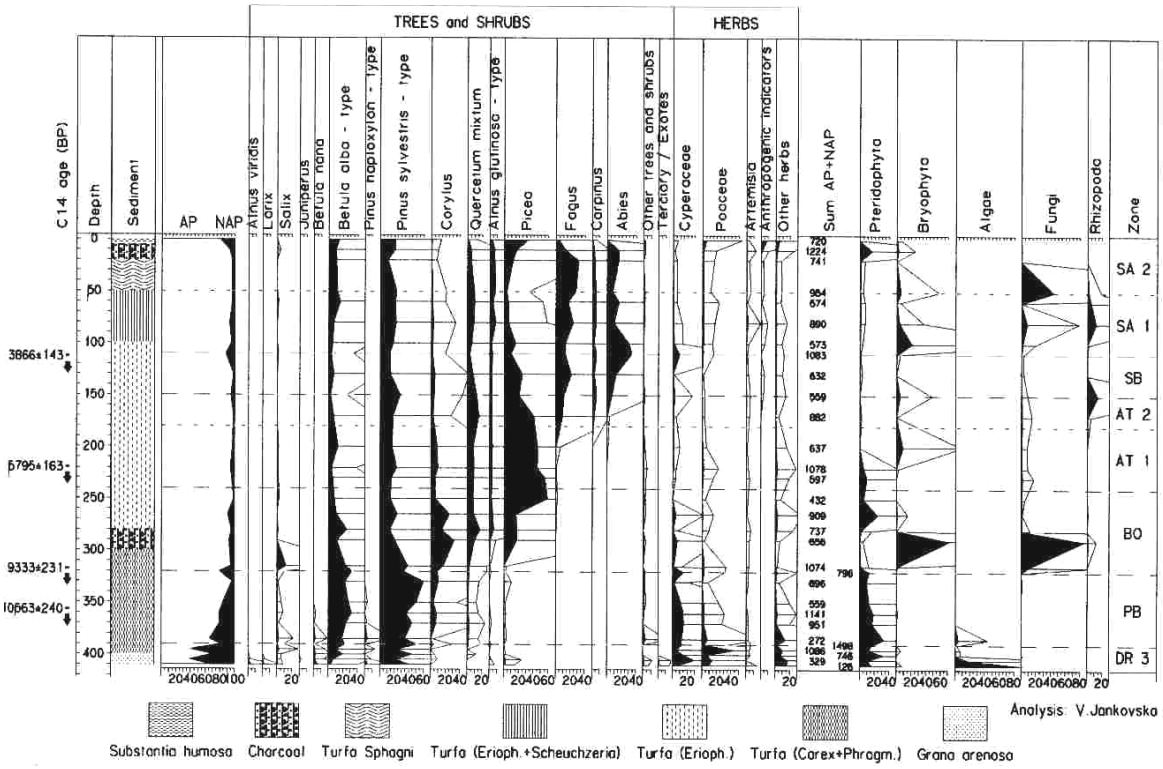

Fig. 3. Pollendiagram from the Vlčí rokle Gorge.

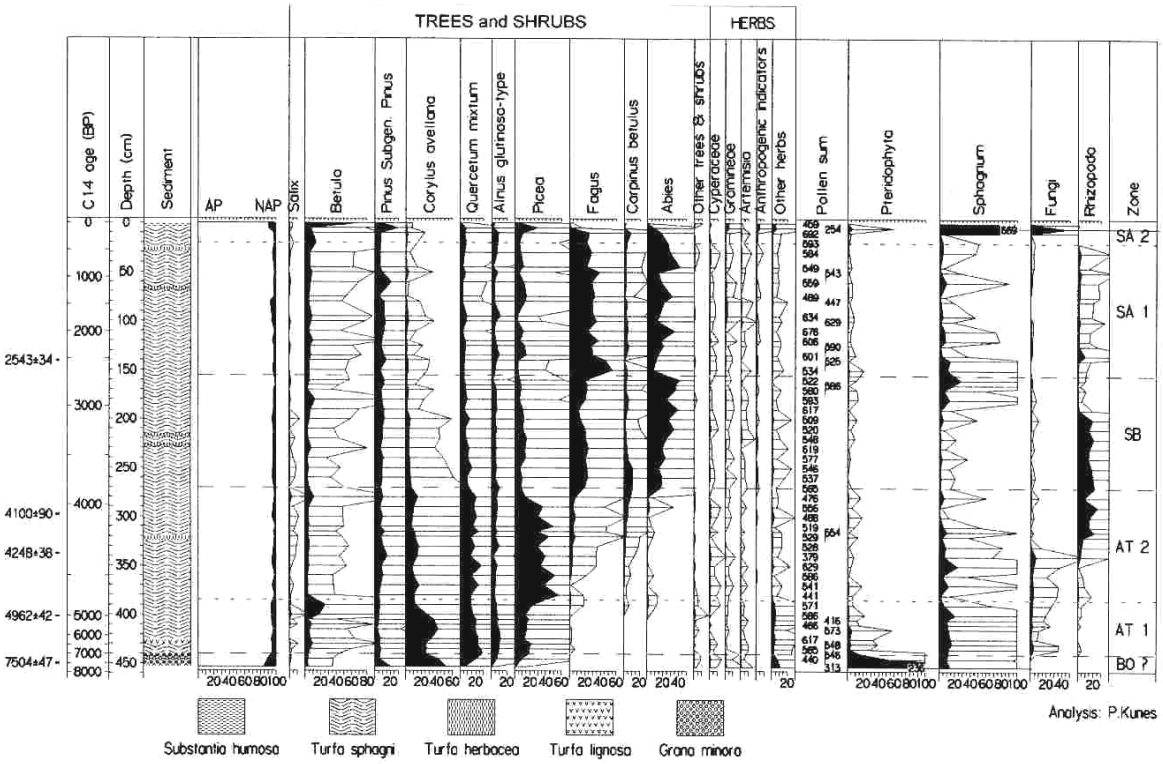

Fig. 4. Pollendiagram from the Teplické údolí (Čáp) Valley.

currence of *Corylus* pollen - also reported by other authors (Peichlová, 1979; Madeyska, 1989) from neighbouring areas.

Boreal (BO) - expansion of vegetation, spreading of *Corylus* in montane, light and moist conditions, *Ulmus, Quercus* and *Tilia* in lower stands, dominance of *Picea* and *Alnus glutinosa* in the gorges of the Teplické skály Mts.

Early Atlantic (AT 1) - forest cover (Fig. 3 and 4), mainly spruce, light-demanding species (*Corylus, Pinus* and *Betula*) restricted to extreme stands (on rock edges etc.), species of *Quercetum mixtum* in the surrounding areas.

Late Atlantic (AT 2) - *Fagus* spread in higher elevations, together with *Carpinus* (in analogy with neighbouring territories - Peichlová, 1979; Madeyska, 1989).

Subboreal (SB) - typical invasion tree is *Abies*, decline of spruce forest reduced to extrazonal stands in gorges, increasing curve of *Plantago lanceolata* may indicate the presence of man in lower parts of the landscape.

Early Subatlantic (SA 1) - climax communities with spruce, beech and fir, occurrence depends on exposure, hydrological and climatic conditions.

Late Subatlantic (SA 2) - very sporadic influence of man until the late Middle Ages, forest composition changes after complete discovery of this area in the nineteenth century.

Discussion and conclusions

Today's vegetation in the inner part of the Teplické skály Mts. consists of various stands depending on local geomorphological, hydrological and climatic conditions. There is a rather low floristic diversity due to acid and low-nutrient conditions, but some biotopes support very specific vegetation.

Clearly, the radiocarbon dates in the "Vlčí rokle" gorge do not correspond to the same zones in the "Teplické údolí (Čáp)" profile. Samples for dating in the "Vlčí rokle" were often pieces of wood taken directly from the trench by incorrect method, so they need not refer exactly to the layer analysed by the pollen analysis (this is indicated by the arrows).

Initial phases of peat-bog development depended on hydrological conditions. These could be represented by small waterholes, very cool and dystrophic, as indicated by planktonic algae, mainly *Pediastrum kawrayskyi* and *P.integrum* (residuals from the Pleistocene) (Fig. 3). Sometimes the bottom was influenced by water overflows and denudation of organic material. A similar situation may be evidenced at the base of the "Teplické údolí" profile with pioneer vegetation on sand, which is due to water influence (Fig. 4). Microclimate in sandstone areas is strongly determined by irradiation; therefore, it was not likely to change much during the Pleistocene and Late Glacial and only mosses and occasional genera of *Carex* and *Eriophorum* could occur in moist habitats. Plateau and rock edges were covered by birch, pine and juniper typical for the Late Glacial.

Earlier evidence of some tree species pollen here (Peichlová, 1979; Madeyska, 1989) does not mean that their Glacial refugees were located somewhere close to this area. *Corylus* is reported already between ^{14}C data 11,790 and 10,140 BP (Peichlová, 1979) from the Broumovská kotlina basin. *Corylus* really began to expand already in the Preboreal in this area until it finally prevailed in the Boreal period. An explanation of this interesting phenomenon will be discussed in further studies. With due reservation we may speculate about hazel spreading by early mesolithic human populations. A similar situation appears with *Carpinus* in the Late Atlantic. In the rest of Bohemia it normally appears no sooner than at the beginning of Early Subatlantic (SA 1). Additional evidence of earlier occurrence of *Carpinus* comes from southern Poland by Madeyska (1989), and becomes more frequent to the east (Ralska-Jasiewiczova, 1989) to the mountains and also to the Polish Uplands (Latałowa, 1989). Its early occurrence has been also recorded by Chaloupková (1995). It is likely that the migration patterns of both species here differed from the rest of the Bohemian basin and might have some connection to migration outside the Carpathian Mts. range.

The peculiarities in the Teplické skály Mts. can be identified by the pollen record as well. Sandstones are generally thought to provide good habitats for relict pine-woods. These trees could have persisted from the Preboreal on rocks due to low competition by other tree species there. Comparison of both pollen diagrams (Fig. 3 and 4) revealed differences in the proportion of pine pollen. In particular, in the "Teplické údolí" profile, we cannot expect any large pine-wood cover (after taking correction for the large pollen production of pine). Some differences between the profiles are obvious also in the pollen that is likely to be imported from outside into the gorges (excess in *Artemisia* or anthropogenic indicators, e.g. *Plantago lanceolata*). Pollen sedimentation and transport depending on relief will be provided in some further study.

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