

Relationship between the Late Glacial and Holocene vegetation and the animal component of their ecosystems

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The main goal of pollen and macrofossil analyses of Late Glacial and Holocene sediments is the palaeoecological reconstruction of vegetation cover in the area under study. Vegetation, the most conspicuous component of every landscape, and its composition is the result of the interaction of different components of the biotic and abiotic environments. Therefore, the knowledge of vegetation conditions also allows us to reconstruct other components of the natural environment for a given time period. Likewise, faunal assemblages are closely related to certain types of vegetation.

The results of palaeoecological analyses from north-west Bohemia (the Krušné hory Mts. and Podkrušnohorská pánev Basin and the western part of the České středohoří Mts.), southern Bohemia (Třeboňská pánev Basin), and Slovakia (West Carpathians – Intermontane Basins below the High Tatras Mts.) will be used as examples of floral – faunal interactions for specific periods of the Late Glacial and Holocene – Pre-Alleröd, Boreal, Late Atlantic (see Figs. 1, 2, 3).

Late Glacial:

Pre-Alleröd (DR1, BÖ, DR2) – 12 000 – 10 000 BC; See Fig. 1.

The Krušné hory Mts. had a character of tundra and forest-tundra along ridges with small clusters of birch, pine, juniper, and willow stands. In the Podkrušnohorská pánev Basin, the so-called Komořanské Jezero Lake was located between the foothills of the Krušné hory Mts. and the České středohoří Mts. Aquatic and riparian vegetation were sporadic, but in the surrounding area, there were willow stands and pine-birch forest-tundra (Jankovská 1988a).

At those times, the Třeboňská pánev Basin was dominated by forest-tundra communities, numerous mossy stands, moist meadows, and initial peat bog communities. Small lakes were characteristic features of the landscape. Dense tree stands, predominantly of willows, were located along the Lužnice River (Jankovská 1980).

In the intermontane basins of the western Carpathians, below the High Tatras Mts., the vegetation cover was formed by forest-tundra communities. *Larix* accompanied by *Pinus cembra* and *P. sylvestris* were notable elements of expanding forest communities at the end of the last glacial period (Würm). These stands of trees were probably more widespread along streams where the sporadic occurrence of other tree species, e.g., *Picea*, may have existed as well. Higher slopes and ridges of the neighbouring hills were covered by tundra vegetation.

On the basis of palaeoecological reconstruction, vegetation cover, and geomorphological character of the landscape at that time, the occurrence of boreal fauna, e.g., the presence of *Rangifer tarandus*, *Lepus timidus*, *Canis lupus*, *Alopex lagopus*, *Lagopus lagopus*, *L. mutus*, *Nyctea scandiaca*, *Lammus* sp. div., etc., is suggested in all three areas under study. There were also animal species

which are missing in the Sub-Arctic region of today, e.g., *Equus* sp. (Musil 1992, p. 160: "The species diversity of mammals from the end of the Pleistocene is substantially higher than that at any time of the Holocene"). Lakes supported ichthyofauna and ornithofauna, although their compositions should be reconstructed by specialists. Furthermore, the vegetation conditions outlined for the three areas being compared indicate differences in their fauna. For example, the higher occurrence of *Nucifraga caryocatactes* can be presumed in the Carpathian basins in connection with *Pinus cembra* stands. In contrast with *Herzycium*, tree stands of the intramontane Carpathian basins were predominantly conifers.

Human populations of hunters and gatherers associated with the types of landscapes described for the Late Palaeolithic are interpreted, for example, by archaeological finds from the surroundings of Komořanské Jezero Lake (Vencl 1970, 1994). Nevertheless, evidence of the existence of Late Palaeolithic settlements from the Třeboňská pánev Basin is missing, although there are numerous Late Palaeolithic sites in the neighbouring Austrian Waldviertel Mts. ("Plateaulehmpaläolithikum", Beneš 1978). In the intramontane basins below the High Tatras Mts., Late Palaeolithic settlements are associated with the "Swiderien" (Bárta 1980, 1987) culture, which is analogous to "Magdalenien". These settlements are associated with a human population of reindeer hunters.

Holocene

Boreal (BO) – 6 800 – 5 000 BC. See Fig. 2.

According to the results of pollen analyses, *Corylus* stands were predominant in the Krušné hory Mts. during the Boreal period. This shrub began to spread into open birch and pine stands as early as the end of the Preboreal. The coincidence of favourable conditions (higher temperature, higher humidity, and especially favourable light conditions) led to a large hazel expansion. Mixed oak stands expanded at lower altitudes and in the Podkrušnohorská pánev Basin. Expansion of aquatic vegetation occurred in Komořanské Jezero Lake. Above all, *Trapa natans* (waternut) grew abundantly there.

The predominance of pine stands mixed with birch was characteristic for Třeboňská pánev Basin in the Boreal. The tree species of mixed oak stands (*Quercetum mixtum* – QM), as well as spruce and alder, penetrated the landscape only slowly, predominantly along streams. The landscape was easily accessible evidenced by dominantly open pine stands, and the areas of the present large peat bog complexes were still forest-free in the BO. Small lakes surviving from the Late Glacial were gradually overgrown. In the BO, *Trapa natans* grew in Třeboň region.

The intermontane basins below the High Tatras Mts. were covered by spruce stands in the BO. The main species of Late Glacial stands – *Larix*, *Pinus cembra*, and *P. sylvestris* – were pushed up to higher elevations and towards the peat bogs (Jankovská 1988b).

With regard to the previous Late Glacial period, a considerable vegetation change occurred in all types of the landscapes under comparison. In the Krušné hory Mts., the elements of boreal fauna could still survive as open hazel stands at higher altitudes. In the adjacent České středohoří Mts., the elements of "steppe-like" fauna survived. Komořanské Jezero Lake was a convenient biotope for ichthyofauna and water-ornithofauna. Reforestation of the area was accompanied by the spreading of forest fauna (e.g., *Bison bonasus*, *Bos primigenius*, *Ursus arctos*, *Cervus elaphus*, *Capreolus capreolus*, *Lynx lynx*, *Felis silvestris*, *Sciurus vulgaris*, *Martes martes*, and others) and the decline of open landscape fauna. In the Treboňská pánev Basin, the disappearance of the main elements of the tundra and forest-tundra fauna and the gradual expansion of forest fauna is interpreted for the BO. The number of biotopes for ichthyofauna and water-ornithofauna decreased due to the overgrowth of the last remains of small lakes. Since the end of the BO, only running water could be presumed to have existed in the Treboň region; stagnant waters could have existed only exceptionally (e.g., oxbow lakes in the alluvium of the Lužnice River). The intermontane basins below the High Tatras Mts. had a spruce taiga character. Only areas of some peat bogs remained forest-free. The occurrence of elk (*Alces alces*) and the penetration of forest fauna is interpreted for the region below the High Tatras Mts. The discovery of gnawed spruce cone spindles from peat in the locality Sivárňa document the past occurrence of squirrels (*Sciurus vulgaris*).

In the BO, all the three types of landscape are significantly different from each other. Each of them was suitable for human populations in a different way. The area around Komořanské Jezero Lake was favourable for Mesolithic settlement (Vencl 1970, 1994) with sources of fish, birds, and game. The occurrence of water nut (*Trapa natans*) may also have been a food source for Mesolithic people (Vuerola and Aalto 1982, Jankovská 1988). In the Krušné hory Mts., hazel-nuts may have been attractive to Mesolithic populations that passed through, as documented by the finds of stone tools.

Treboňská pánev Basin was also favourable for Mesolithic people in the BO. Until recently, only a few stone tools had been found in this region.

The intermontane basins below the High Tatras Mts. would have been difficult to pass through because of the dominant water-logged spruce stands. This region was therefore inconvenient for settlement. Nevertheless, the finds of stone tools of Mesolithic age in sediments of the peat bog of Sivárňa (Jankovská 1984) in the northern part of the Spišská kotlina Basin document that prehistoric people frequented this locality. The reason for their presence might be mineral water springs in the surroundings and / or the source of ochre from fired limonite which existed at this locality. Moreover, *Pinus cembra* (stone pine), producing edible seeds, probably still grew there in the Mesolithic age.

Late Atlantic (AT2) – 4 000 – 2 500 BC. See Fig. 3.

The Krušné hory Mts. were covered by spruce stands along ridges and higher slopes. In AT2, beech began to expand rapidly there, and fir newly entered the area. Mixed oak stands (*Quercetum mixtum* – QM) predominated in the Podkrušnohorská pánev Basin, and the surroundings of Komořanské Jezero Lake was covered by alder stands and reeds.

In the Treboňská pánev Basin, *Quercetum mixtum* expanded in AT2. Water-logged spruce stands, alder stands, and large peat bog areas covered by communities

of *Sphagnetalia medii* extended across the region. Pine and oak stands predominated on sandy substrates, and Beech and fir had also entered the area.

Water-logged and other types of spruce stands dominated continuously in the intermontane basins below the High Tatras Mts. Beech and fir began to expand on slopes of the adjacent hills (Spišská Magura Mts., Levočské vrchy Mts.).

The fauna of all three areas under study was dominated by elements of forest fauna. Some elements of open landscape fauna (steppe-like fauna) might have survived in AT2 only as relicts above the upper forest limit in the mountains (boreal fauna) or in open oak stands (e.g., České středohoří Mts.). In AT2 all the three landscapes under study could also have been favourable biotopes (peat bogs, birch-stands) for elk (*Alces alces*).

From all the three regions under comparison, the Podkrušnohorská pánev Basin with Komořanské Jezero Lake was most suitable as a settlement area for humans. It was inhabited by the Stroked Pottery Culture (Neustupný 1985). In AT2 the Treboňská pánev Basin was a forested and nearly inaccessible landscape, with a great number of wetlands including peat bogs, alder stands, and water-logged spruce stands. Nevertheless, the Lengyel Culture penetrated into it along the Lužnice River (Beneš 1978). The intermontane basins below the High Tatras Mts. were not favourable for permanent settlement. However, archaeological finds have confirmed the existence of roads and temporary settlements.

Palaeobotanical research may also help in the investigation of entomofauna as demonstrated, for example, in the solution of the problem of the original "food plant" for the butterfly *Eupithecia gelidata* (Spitzer et al. 1991) in the Treboňská pánev Basin. In contrast, the occurrence of the butterfly *Neptis rivularis* in this area indicates the presence of the shrub *Spirea salicifolia* which has not been demonstrated palaeobotanically before now.

This paper is not intended to be a detailed study of the problems of the floral – faunal relationships in the Late Glacial and Holocene periods. Its purpose is only to draw botanists' and zoologists' (palaeobotanists' and zoogeographers') attentions to some possibilities of joint interpretations of palaeobotanical data.

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Key to figs. 1, 2, 3. (following pages)

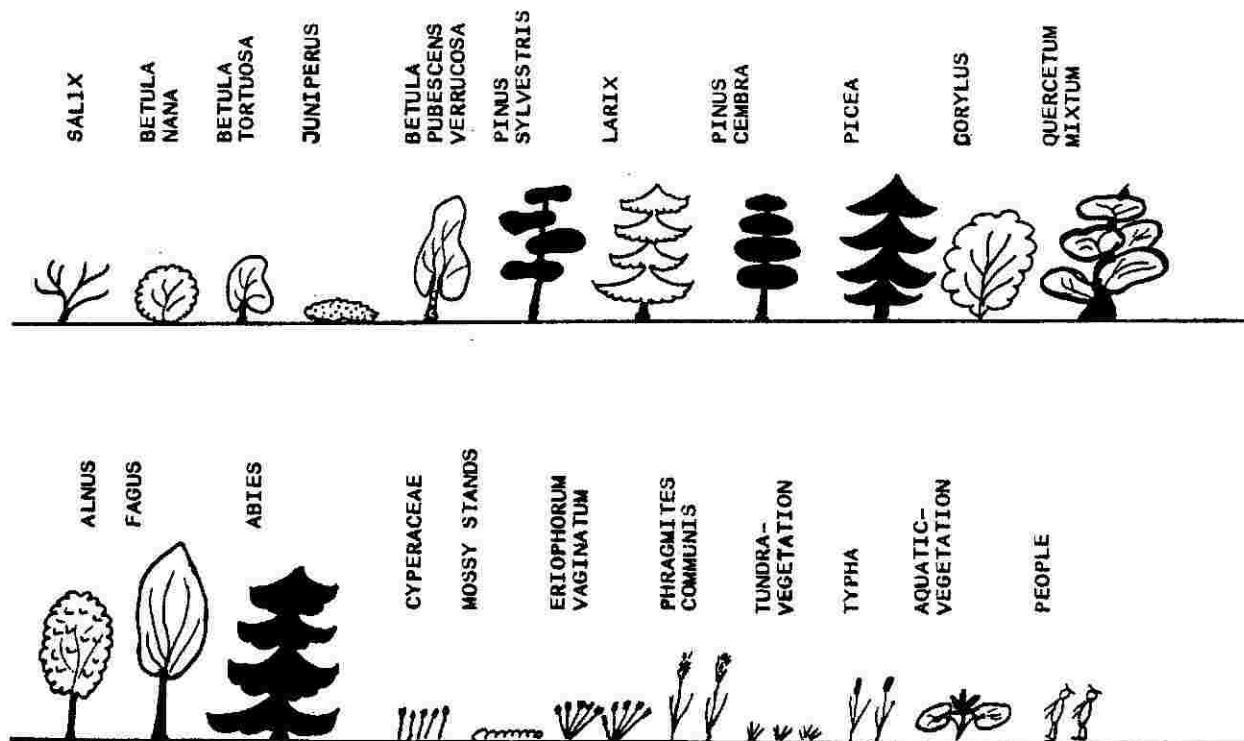
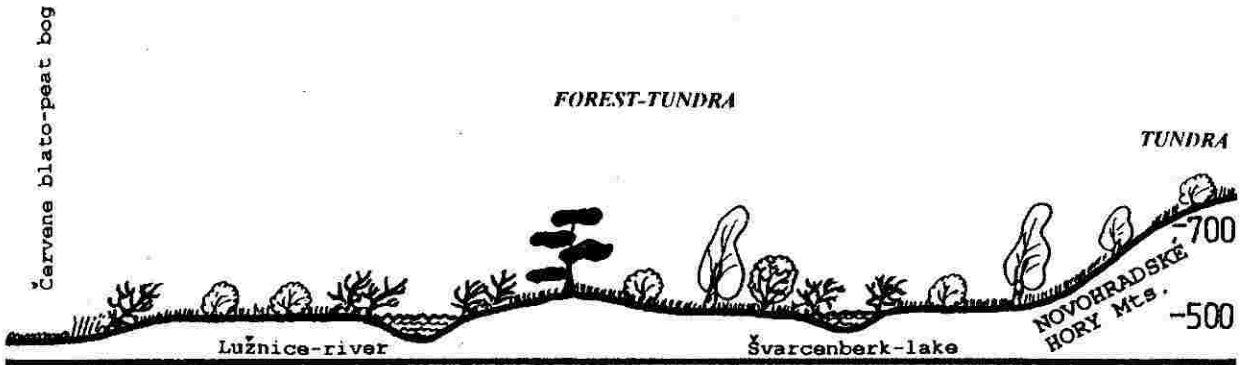


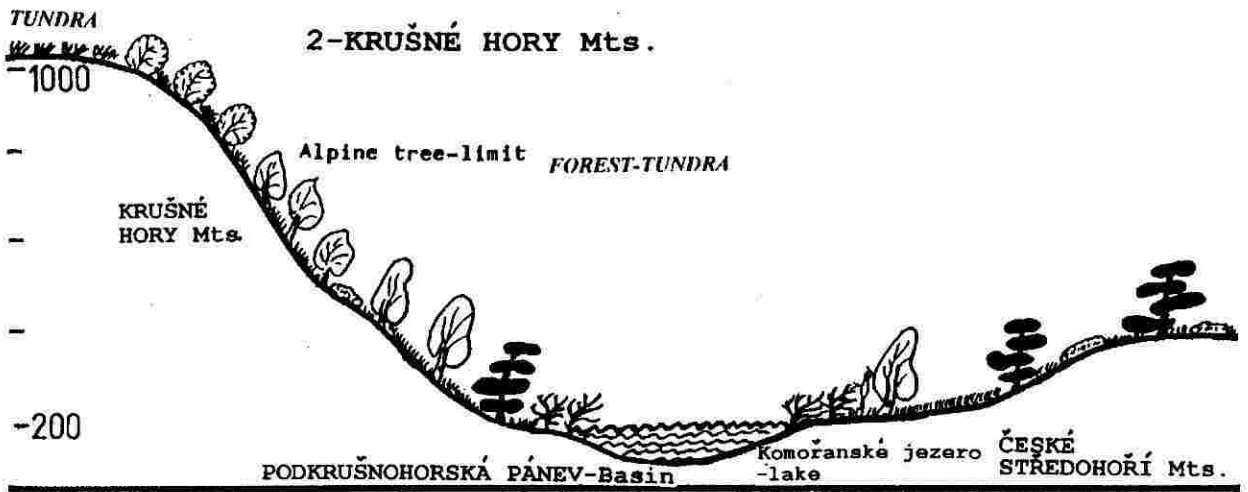
Fig. 1

PRE - ALLERÖD
 (DR1 - BO - DR2)
 ca 12000 - 10000 BC

1-TŘEBOŇSKÁ PÁNEV-Basin



2-KRUŠNÉ HORY Mts.



3-INTERMONTANĚ BASINS (W-CARPATHIANS)

