

## KOMOŘANY LAKE – A LOST ARCHIVE FOR PALAEOBOTANICAL, ARCHAEOLOGICAL AND HISTORICAL INFORMATION

VLASTA JANKOVSKÁ

Institute of Botany, Academy of Science of the Czech Republic, Lidická 25/27, 602 00 Brno, Czech Republic,  
e-mail: vlasta.jankovska@ibot.cas.cz



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**Abstract.** Komořany Lake was the largest lowland lake in the Czech Republic. The remains of its water surface were still visible in the 20th century, but the locality was destroyed by brown coal mining. The oldest preserved sediments were dated as the Late Glacial. The limnic sediments consisted mainly of algal gyttja covered by peat which contained information from the Late Glacial to the present. This information was used by archaeologists, geologists, geographers, and most of all by palaeobotanists. Palaeovegetation and the previous landscapes from the end of the Last Glacial Period until the present were reconstructed through pollen analysis.

The palaeoreconstruction of the lake environment was based on analysis of the pollen grains of water and swamp vegetation. It is important to emphasize that for the characterisation of the individual phases in the development of the lake environment coccal green algae, mostly from the genus *Pediastrum*, were used.

The landscapes and vegetation in the Late Glacial- the beginning of the Holocene was characterised by forest tundra (Podkrušnohorská pánev Basin) or tundra (Krušné hory Mts). Cold steppe and forest steppe dominated in the České středohoří Mts. Aforestation began in the Preboreal, and in the Boreal, the tree species of *Quercetum mixtum* (QM) were already present in the area. *Corylus* dominated in the Krušné hory Mts. In the Atlanticum (AT 1 - AT 2), the distribution of *Picea* and *Alnus* increased, but the trees of QM occupied a large area especially in the Podkrušnohorská pánev Basin. At the end of the Atlanticum and in the Subboreal (SB), *Fagus* and *Abies* expanded with a strong presence of *Picea*. The Early Subatlanticum (SA 1) and partly the Late Subatlanticum (SA 2) were characterized by the dominance of *Fagus*, *Abies*, and *Picea* in the Krušné hory Mts, and by QM in the Podkrušnohorská pánev Basin. The trees of QM, with the addition of *Carpinus*, dominated also in the České středohoří Mts, which, however, was already anthropogenically modified in SA 2. From the Middle Ages, the territory was largely changed by deforestation and modification of the forest composition.

The lake biotope gradually changed through the millennia. The original oligo-dystrophic environment with very cold water warmed up and gave way to richer mesotrophic and eutrophic vegetation. In the last phase of the infilling, even dystrophisation occurred, being caused by peat sedimentation at the edges of the lake in reed, magnocariceta and alder stands.

■ Komořany Lake; pollen-and-coccal green algae analyses; Late Glacial; Holocene; Palaeoreconstruction; the Czech Republic

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### Introduction

The sediments of natural water biotopes (lakes) as well as artificial forms (ponds, cisterns, etc.) – are important sources of palaeoinformation. They are used first of all in palynology and in various other palaeobotanical research. Scientists from other disciplines, such as archaeology, may also find much relevant information from limnic sediments.

At present, in the Czech Republic, unfortunately very few original lake biotopes are known which limits the possibilities of using the information preserved in their sediments. Lake biotopes have never been especially common in the Czech Republic, not even during their maximal occurrence in the Late Glacial and Early Holocene. Furthermore, if lakes appeared in the periglacial landscape, their biotopes were usually filled in during the Holocene climatic optimum at the latest. As a result, the sediments of former lakes can only be found by accident, often in the form of gyttja and other limnic sediments under peat layers. Many current

peat bogs have been formed on the sites of former lakes (Jankovská 1980, Pokorný and Jankovská 2000).

A sad example of a lake from which palaeoecological, archaeological, historical and other related information was to a large extent lost is the so-called Komořany Lake. Its former place is now occupied by artificial biotopes: the remains of open-cast brown coal mining pits, partly overgrown slag heaps, and various industrial buildings etc.

### Study site (Text-fig.1)

The remains of the former Komořany Lake (50°30'N, 13°30'E, 230 m a.s.l.) could still be found in the last century at the north-eastern foot of Krušné hory Mts (Text-fig. 1). The sediments of this, the largest original lowland lake in the Czech Republic, (detritus gyttja, diatom and chlorococcal algal gyttja, peat) existed untouched until approximately the first third of the 20th century. They were then destroyed by brown coal surface mining. At present, neither the lake nor its sediments exist any more.



Text-fig. 1. Geographical position of the locality

### Review of previous scientific research activities at the study site

The importance of this locality is related, among other things, to the fact that it was here that the first attempt to synchronise palaeobotanical and archaeological finds was made (Rudolph 1926). The rescue research in the 1980s could only access the sediments from the peripheral parts of the lake which recorded the end of the Late Glacial and whole Holocene (Jankovská 1983, 1984, 1988, 2000). The most complete analytical pollen record of the Late Glacial Period was presented by Losert (1940). Fortunately, in his pollen research he used some sediment from the central part of the lake. In the 1950s, E. Neustupný was engaged in research on archaeological finds from sediments of Komořany Lake. He later published a synthesis of his research (Neustupný 1985). In order to make the dating and palaeoreconstruction of the environment more exact, he utilised the results of special pollen analyses (Jankovská 1988). A similar attempt was made by Pacltová et Žertová (1959). Diatom analyses were presented in the publications of Řeháková (1962, 1983, and 1986). Historical events related to Komořany Lake were evaluated by Schlesinger (1871) and later by Pokorný (1963). Hurník (1969) dealt with geological issues within the larger framework of palaeontology. Březák et Klápště (1983) reconstructed the geomorphology and hydrology of the former Komořany Lake and produced a map. Klápště (1985) made a palaeoreconstruction of the former long-distance roads through the territory in the Early Middle Ages and also compiled a distribution map of prehistoric and early medieval finds (Klápště 1988). Vencl (1970, 1994) published data concerning the Palaeolithic and the Mesolithic within the territory of the former Komořany Lake.

The information needed for palaeoreconstruction of the vegetation and character of the surrounding region, as well as the lake biotope, from the end of the Late Glacial until the present was obtained by pollen and palaeoalgologic analyses (Jankovská op. cit.). The palaeoreconstruction was produced for the territory of the Podkrušnohorská pánev Basin, Krušné hory Mts, and České středohoří Mts (Jankovská 1995).

At present, the profiles taken during rescue research in the 1980s and 1990s are being analysed by nearly every available method. The pollen analysis results of profiles processed in the 1980s and 1990s are being prepared for

publication. New profiles are at present being analyzed as part of an interdisciplinary research project with the support of the Grant Agency of the Czech Republic, No. 206/09/1564.

### Brief outline of the palaeoreconstruction of vegetation and landscape character

The landscape character and vegetation composition in the study region were different depending on the altitude gradient and other abiotic conditions.

**Late Glacial (DR1-DR3):** In the Krušné hory Mts communities of mountain tundra and forest tundra prevailed. In the České středohoří Mts forest steppe to cold herbs steppe dominated. In the Podkrušnohorská pánev Basin many wetland communities were present (lakes, swamps, willow stands, etc.).

**Preboreal (PB):** In the Krušné hory Mts birch forest tundra prevailed, probably with the occurrence of *Betula nana* and *Betula pubescens* ssp. *tortuosa* bushes. *Pinus sylvestris* and probably *P. mugo*, and *Populus tremula* were also present. The first climatically more demanding trees migrated into the area of the České středohoří Mts and likewise to the Podkrušnohorská pánev Basin, where wetlands prevailed.

**Boreal (BO):** In the Krušné hory Mts, the expansion of *Corylus* began, reached its maximum spreading at that time here. In the České středohoří Mts, the expansion of the trees of „*Quercetum mixtum*“ (QM), represented by *Quercus*, *Tilia*, *Ulmus*, *Corylus*, etc. began. In the Podkrušnohorská pánev Basin, infilling from the marginal parts of Komořany Lake began (*Phragmitetum*, *Magnocaricetum*, etc.). The spreading of *Alnus* also began.

**Atlanticum (AT 1, AT 2):** In that Holocene climatic optimum, the greatest expansion of forest communities occurred. In the Krušné hory Mts, spruce stands with the first examples of *Fagus* prevailed, and at the end of this period, *Abies* also occurred here. In the České středohoří Mts, the trees of QM dominated. The presence of *Picea*, *Fagus*, and *Abies* is not excluded here. The remains of steppe communities survived in extreme biotopes and also where human activity was present. In the Podkrušnohorská pánev Basin, around Komořany Lake, large stands of *Alnus glutinosa* were spread. On the minerotrophic grounds, the trees of QM mainly *Quercus*, prevailed.

**Subboreal (SB):** In the Krušné hory Mts, all climax trees were already present (*Picea*, *Fagus*, and *Abies*) together with the trees of QM at the foothills. *Alnus* stands prevailed around the Komořany Lake and *Quercus*, *Ulmus*, *Tilia*, *Fraxinus*, and *Acer* were present in large numbers in all parts of the Podkrušnohorská pánev Basin. The original, mostly deciduous stands in the České středohoří Mts were gradually destroyed by human activities.

**Early Subatlanticum (SA1):** In the Krušné hory Mts *Picea*, *Abies* and *Fagus* prevailed. The lowlands at the foot of the Krušné hory Mts, similarly to the České středohoří Mts, were covered above all by forest communities of the trees of QM and *Carpinus*, which came to this region already in the Subboreal.

**Late Subatlanticum (SA2):** In the lowland regions of

Podkrušnohorská pánev Basin and also in the České středohoří Mts, large areas of original trees stands were deforested. Human activities also influenced on the extent and composition of the original stands in the Krušné hory Mts, especially since the Middle Ages (glassworks, etc.).

### Palaeoreconstruction of the development of Komořany Lake biotope

**Late Glacial (DR1 – DR3):** During the Late Glacial Period, the lake contained cold, clear water and very sporadic vegetation composed of water macrophytes. It seems that only *Myriophyllum* cf. *spicatum* and *M. alterniflorum* were present here. On the other hand, the algal communities were relatively rich. *Pediastrum kawraiskyi* indicates clear, cold, stenotherm water (oligotrophic or mesotrophic lakes). Some colonies of *P. boryanum* var. *longicorne* and *P. integrum* could also indicate the influence of a dystrophic environment. In some cases, it was complicated to distinguish *P. boryanum* var. *longicorne* from *P. alternans*. On the territory of the Czech Republic, *P. alternans* was found as a “fossil” for the first time in the Komořany Lake. This alga was described from an actual lake in Denmark (Nygaard 1949). The combination of *P. kawraiskyi* and *P. alternans* is a very good indicator for cold water environments in the past (Komárek et Jankovská 2001). It was also confirmed in eastern Poland (Lake Karasne – pollen slides K. Balaga) and lakes of the Leczynsk – Wladowsk region (I. Krajewska and M. Obremska, personal communication). Zawisza (personal communication) found *P. kawraiskyi* and *P. alternans* in Trzebiatow Lake.

**Preboreal (PB):** In the algal communities, *Pediastrum kawraiskyi*, *P. integrum*, and *P. alternans* dominated. Moreover, common plankton species were also represented (*P. boryanum*, *P. duplex* var. *rugulosum*, *Tetraedron minimum*, etc.). The initial expansion of water macrophytes (*Sparganium*, *Nymphaea*, *Typha*, and *Equisetum*) began. The spreading of *Pediastrum angulosum* was connected to these plant communities. The lake probably represented an oligo-dystrophic or slightly eutrophic environment.

**Boreal (BO):** The previous, mostly oligo-dystrophic to slightly eutrophic water environment turned into a mesotrophic, partly eutrophic environment. Algal species of cold waters (*P. kawraiskyi*, *P. alternans*) permanently occurred. There was probably a constant inflow of cold water from the Krušné hory Mts. *Coelastrum reticulatum* newly settled in Komořany Lake. This could be explained by high summer temperatures and better trophic conditions in the lake which were favourable for the occurrence of this alga.

**Early Atlanticum (AT 1):** The presence of *Pediastrum kawraiskyi* gradually ended, and the occurrence of the trophically more demanding *Coelastrum reticulatum*, which also requires higher temperatures, increased. Water vegetation (*Trapa natans*, *Nymphaea*, *Potamogeton*, *Sparganium*, *Myriophyllum spicatum*, *M. verticillatum*, etc.) expanded. Among water macrophytes, *P. angulosum* proliferated. *P. duplex* var. *duplex* and var. *gracillinum* occurred in the pelagic environment of the open water table in the central part of the lake. *P. duplex* var. *rugulosum* was common. The

decomposition of rich plant biomass caused higher eutrophication.

**Late Atlanticum (AT 2):** *Pediastrum kawraiskyi*, *P. alternans*, and *P. integrum* no longer occurred. *Coelastrum reticulatum* also gradually disappeared. Rich water vegetation was represented by *Nymphaea*, *Nuphar*, *Trapa natans*, *Potamogeton*, *Sparganium*, and *Myriophyllum*, and algal communities exhibited great diversity. Sporadic algal taxa of the last cold water environment mixed with numerous taxa of the warmer, eutrophic environment.

**Subboreal (SB):** *Pediastrum angulosum* had always been relatively abundant. This was connected with the occurrence of macrophytic water vegetation. On the other hand, the occurrence of the pelagic taxa of *Pediastrum* (especially, *P. duplex* var. *rugulosum*) decreased.

**Early Subatlanticum (SA 1):** The abundant *Pediastrum angulosum* was characteristic as this taxon grew among rich water macrophytes. Planktonic *P. duplex* occurred only sporadically because of the overgrowth of the lake. In this period reeds and magnocariceta expanded from the littoral to the central part of the lake. In addition, alder also expanded. Increased humification and formation of peaty sediment changed the environment of the locality. *Pediastrum boryanum* var. *longicorne* occurred, being an indicator of dystrophic conditions on the marginal parts of the lake. Zygospores of filamentous algae (Conjugatophyceae) of the *Mougeotia-Spirogyra-Zygnema* types indicate small, shallow pools at the lake margin and inside *Alnus* stands.

**Late Subatlanticum (SA 2):** The lake was overgrown by water and swamp vegetation. The water surface of the original lake was divided into smaller water biotopes. The results of pollen analyses confirmed the existence of vegetation in shallow water bodies (*Alisma plantago-aquatica*, *Sparganium*, *Typha latifolia*, *T. angustifolia*, *Phragmites*, and Cyperaceae). The area of the original lake was colonized by people in the Middle Ages and was exploited as meadows and fields. During the last century, the locality of the original Komořany Lake was completely destroyed by brown coal mining.

Throughout the existence of Komořany Lake, the Late Palaeolithic, Mesolithic, Neolithic, Eneolithic, and Medieval age people occupied the landscape around the lake. It is more than probable that *Trapa natans* (water nut) was used for human consumption in the Mesolithic.

### Conclusions

The sediments from the former Komořany Lake were the single most important sources of information about the history of the landscape between the Krušné hory Mts and the České středohoří Mts. Above all, they preserved data concerning vegetation changes for more than 10,000 years. These data can also be used for investigation of fauna and many other aspects of natural development. We have produced a palaeoreconstruction of the whole landscape during the various time periods in the Late Glacial and the Holocene. This paper briefly summarizes the results of pollen and palaeoalgalogical analyses, used in the palaeoreconstruction of the vegetation, landscapes and lake biotopes.

We are planning to continue analytical work on the material obtained during rescue excavations from the last remains of the sediments of Komořany Lake. At the same time, we are analyzing diatoms and the other objects with new, modern methods. The identification of coccal green algae, especially the genus *Pediastrum* and *Botryococcus*, has become more precise. The newly discovered overwhelming quantity of *Pediastrum kawraiskyi* as well as the frequent occurrence of *P. alternans* is noteworthy. Both taxa can be seen as glacial relicts in Central Europe. At the same time, *Trapa natans* grew in large numbers in Komořany Lake from the Boreal until the end of the Atlanticum. It is possible that its fruits (water nuts) were consumed by people in the Late Palaeolithic and in the Mesolithic. It is also probable that people used the nuts of *Corylus* as a supplementary food, especially during the Boreal. This bush reached its maximum distribution during the Boreal in the Krušné hory Mts.

At present, we can only note the irreplaceable loss of the "natural archive" in Komořany Lake. We are processing the last samples of sediments sampled during rescue excavations in the 1970s and 80s.

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