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**The vegetation changes of the Holocene based on a pollen analysis study for selected peat bogs of Oświęcim Basin**

*Summary*

The main objective of the present research was to show changes in the vegetation of the Oświęcim Basin in the longest possible time interval of the Holocene. As part of this main objective, the reconstruction of noticeable local environmental changes at the researched sites and in their immediate vicinity was also carried out. The work also attempts to determine the impact of settlement processes on changes in the valley's natural environment. The history of Holocene transformations of vegetation in the Oświęcim Basin has been the subject of few scientific studies, and its course could only be inferred based on interpolation of data from quite distant sites.

Sediments from two sites in the western part of the basin (Strumień and Orzesze bogs) and three in its central part (Zapadź, Goczałkowice and Rotuz bogs) were collected for research purposes. The research was carried out using the pollen analysis method, which was supplemented with a partial analysis of plant macroremains, lithological analysis, and the mineralogical composition of organic sediments was also determined. The age of the examined deposits was determined using the radiocarbon method (AMS and  $^{14}\text{C}$  technique), and the age-depth models constructed on their basis enabled the development of a calendar chronology, which is important for the correlation of pollen data of individual profiles from the Oświęcim Basin.

The pollen data obtained as a result of the analysis allowed for the separation of local pollen zones characterizing the main stages of vegetation development in the central and western parts of the Oświęcim Basin from the late Preboreal period to the present day. New pollen successions of the Oświęcim Basin are part of Poland's Holocene vegetation succession trend and represent the typical sequence of appearance and culmination of pollen from individual trees. They also documented many local features.

The Early Holocene stage was expressed by the Preboreal and Boreal dominance of pine forest communities of the central part of the basin (Zapadź and Goczałkowice bogs) and the successive increase in the share of pollen of thermophilic taxa (*Ulmus*, *Quercus*, *Corylus*

*avellana*) indicating the formation of mixed and deciduous forests in the Boreal period. The next stage of development of forest communities in the middle part of the basin covered the Atlantic period (Middle Holocene) and was characterized by the dominance of multi-species mixed forests and deciduous with spruce growing in importance (Z1-3 and Z2-3 *Picea-Pinus-Corylus*, Z1-4 and Z2-4 *Picea-Alnus*). In the sediments of the Zapadź bog correlated with the late Atlantic period, the first pollen grains of cereals (*Triticum* type, *Cerealia* type) were determined.

The pollen record of the early Subboreal period (Z1-5 and Z2-5 *Picea-Pinus-Corylus*) documents a slight decrease in the *Ulmus* pollen value, following the trend recorded in the pollen diagrams of many European sites from the turn of the Atlantic and Subboreal periods. As a result of the progressing climate and habitat changes in this period, there was also a clear reconstruction of stands, dominated by spruce (Z1-5 and Z2-5 *Picea-Pinus-Corylus*) and more and more numerous hornbeam, beech, and fir (Z1-6, Z2-6 and O1 *Abies-Picea*). In addition, from around 2202–1948 BC, a reduction in spruce was recorded with a growing role of fir, especially in the vicinity of the Zapadź bog (Z1-7 *Abies-Carpinus-Fagus*). Forest community transformations were natural, with little involvement of the anthropogenic factor. The share of cereal pollen in the Middle and Late Subboreal fragments of the profiles is still low, suggesting poor settlement of the basin area.

The last distinguished stages of vegetation development fell during the Subatlantic period. Changes in the forest landscape of the Oświęcim Basin at that time were a continuation of the changes initiated in the previous period, which document the development of multi-species mixed forests in the type of oak-hornbeam forest with the participation of e.g., hornbeam, beech, oak, lime and occasionally spruce, elm and maple (S-1 *Abies-Fagus-Carpinus*). The younger record of the Subatlantic period also indicates the dominance of this type of forest community with a temporary increase in the importance of linden in the vicinity of the Rotuz mire (R2-1 *Tilia-Abies-Fagus*). In 1156–1264 AD, the lime acreage was clearly reduced. After a decrease in the share of the *Tilia cordata* type pollen, a short-term increase in the value of *Betula alba*-type pollen was noted. The youngest fragment of the succession of the Rotuz 2 profile is characterized by a gradual increase in the share of *Pinus sylvestris* type (R2-2 *Fagus-Abies-Carpinus*).

In the Subatlantic of pollen spectra, lower values of the total pollen of trees and shrubs (AP) are observed than in older pollen successions of the Oświęcim Basin, as well as a slight increase in the frequency of pollen of cereals and plant species associated with human

activity. Despite this, it is lower than in sites from other areas of Poland. The development of settlement in the Oświęcim Basin was probably hindered due to the high degree of afforestation, which was documented by high values of AP in individual pollen spectra. Mentions of dense forests covering large basin areas also appear in archaeological studies on the Middle Ages (NID).

In addition, the area of the Oświęcim Basin in the Middle Ages and modern years was at risk of flooding, documented in the literature (e.g., Czaja, 2012). The results of lithological, mineralogical, and plant macroremains analyses carried out for the sediments of the Strumień bog document the record of flood episodes disturbing the peat sedimentation. Based on the obtained results and the chronology of the profile sediments, two flood episodes were found to run following the phases of increasing the fluvial activity of rivers presented in numerous studies of the Upper Vistula Valley (e.g., by Ralska-Jasiewiczowa and Starkel, 1988; Ralska-Jasiewiczowa, 1989; Starkel, 2006). In addition, these episodes represent events of a supra-regional nature. The older episode ran in a similar time frame correlated with the Migration Period (Lamentowicz et al., 2015; Pleskot et al., 2022), while the younger record is timely and consistent with the period of high humidity of the Subatlantic climate and increased frequency of floods from the area of Western and Central Europe.

Mineralogical analysis and clear fluctuations in organic matter content in the Strumień profile prove the occurrence of local flood events correlated with the early medieval period. The site's location near watercourses determines the risk of modern flood episodes negatively affecting peat accumulation.

The remaining profiles selected for this dissertation do not show macroscopically visible lithological features, which prove the fluvial activity of rivers and smaller watercourses of the basin. The pollen analysis results and plant macroremains composition suggest only groundwater fluctuations. The results of the mineralogical analysis of the organic sediments of the Zapadź site confirm the conclusions drawn based on paleobotanical research.

Preliminary results of the correlation of palaeobotanical, lithological, and mineralogical analyses provided promising conclusions, which will be extended to include other sites in the Oświęcim Basin area.