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DEVELOPMENT OF THE KLETNO PEAT-BOG AND POSTGLACIAL AND HOLOCENE TRANSFORMATIONS OF THE BIAŁOWIEŻA PRIMEVAL FOREST VEGETATION IN THE LIGHT OF POLLEN ANALYSIS

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A b s t r a c t. In this paper the introductory results of research on history of the plant cover in Białowieża National Park are described. Development of plant communities (at the SE area of BNP) since Younger Dryas up to modern time are shown on the basis of pollen analysis. Sporomorphs of telmatophytes and aquatics are the basis to show the successional changes of the local plant communities: the stage of an open water lake, its overgrowing and creation of a peat-bog further existing.

K e y w o r d s: palinology, the Post-glacial, the Holocene, Białowieża Forest

INTRODUCTION

The Białowieża Primeval Forest is one of the best preserved natural forest complexes in the European Lowland. It covers an area of app. 1,250 km^2, out of which only 41% is located in Poland. Its uniqueness is based on the simultaneous occurrence of components of both deciduous and coniferous forests in the tree stands [5]. A considerable area of the Polish Białowieża Primeval Forest is taken up by dry-ground forests (oak and hornbeam forests with linden and maple trees) which occur in he most fertile stands. Habitants located higher and less abundant in water are grown by mixed coniferous forests including pine, oak and spruce whereas the most humid sites are occupied by alder.

Previous research on the history of vegetation in this area was conducted by Paszewski and Poznański [8], Dąbrowski [4], Borowik-Dąbrowska and Dąbrowski [2], Charzewski [3], and Mitchell and Cole [7].

In 1999, a co-operation involving palaeoecological research in the Białowieża Primeval Forest, was established between a research team led by Prof. Tobolski from the Department of Biogeography and Palaeoecology, the Adam Mickiewicz University in Poznań and Prof. Faliński from the Białowieża Geobotanical Station of the Warsaw University. The article presents results of palaeoecological research of the Kletno peat-bog.

METHODS

The core analyzed was taken from the peatbog in the southeastern part of the Park located in the forest section 373 (Fig. 1). In the peat-bog surroundings, there developed various forest communities that make mixed coniferous forests and al-

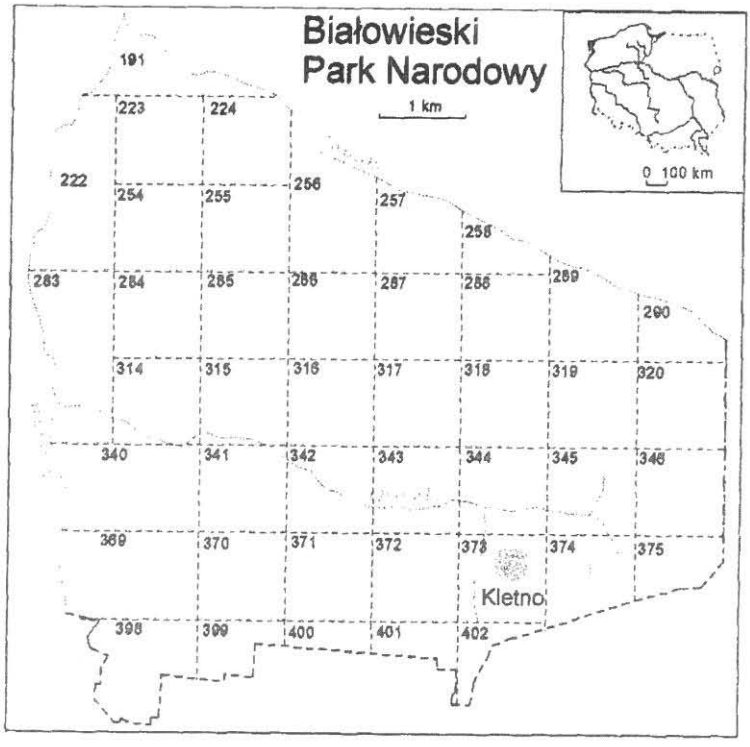

Fig. 1. Location of core "Kletno"

der carrs. The Kletno profile comprises 315 cm of biogenic sediments underlain by mineral deposits. Despite low deposit thickness, there is a record on the history of vegetation from the early part of the late glacial period (younger Dryas) to modern times.

The samples used in palinological research underwent laboratory preparation relevant to a particular sediment type by applying 10% KOH and Erdtmans acetolysis [1]. Making allowance for the presence of mineral material, bottom specimens from the depth of 315-265 cm were additionally exposed to the activity of 40% cold HF.

RESULTS

The percentage diagrams (Figs 2 and 3) show results of the palinological analysis. The total of tree pollen (AP) and herbaceous plants (NAP) = 100% made the calculation basis. The participation of *Cyperaceae*, water and peat vegetation as well as spores was calculated in relation to this sum.

The diagram distinguishes 9 local pollen zones (L PAZ) biostratigraphic units of specific combinations of taxa (Fig. 2). They were marked as Kl (Kletno) with the numeration beginning from the profile bottom (Kl 1 – Kl 9 LPAZ) and were named after the taxa characteristic for them. The oldest zone, i.e. Kl 1 represents the late glacial period and the others (Kl 2 – Kl 9) correspond to the Holocene.

Regional transformations of plant communities surrounding the Kletno peat-bog are presented in Figure 2.

Kletno 1(315-294 cm) *Salix-Juniperus*

Sediments of Kl 1 PAZ were accumulated in the period of the Early Dryas period. It is characterized by a high diversification of palinotaxa and considerable percentage of herbaceous plants (above 30% on average). The seeds of *Artemisia, Chenopodiaceae, Cyperaceae* and *Poaceae* are most numerous. The light-demanding species such as *Dryas octopetala, Saxifraga oppositifolia* type, *Scleranthus perennis*, *Linnea borealis* and *Selaginella selaginoides* are less numerous but still indicative for the cool period. Such a contribution of palinotaxa suggests that low-stocked plant cover prevailed at that time. Its features corresponded to a park tundra with the occurrence of scrubs of *Juniperus*, *Hippophaë rhamnoides*, *Salix* and *Ephedra*.

In all spectra from this zone there appear rebedded exotic sporomorphs (*Rebedded* max. 2.1%) which presence was most probably caused by an inflow of

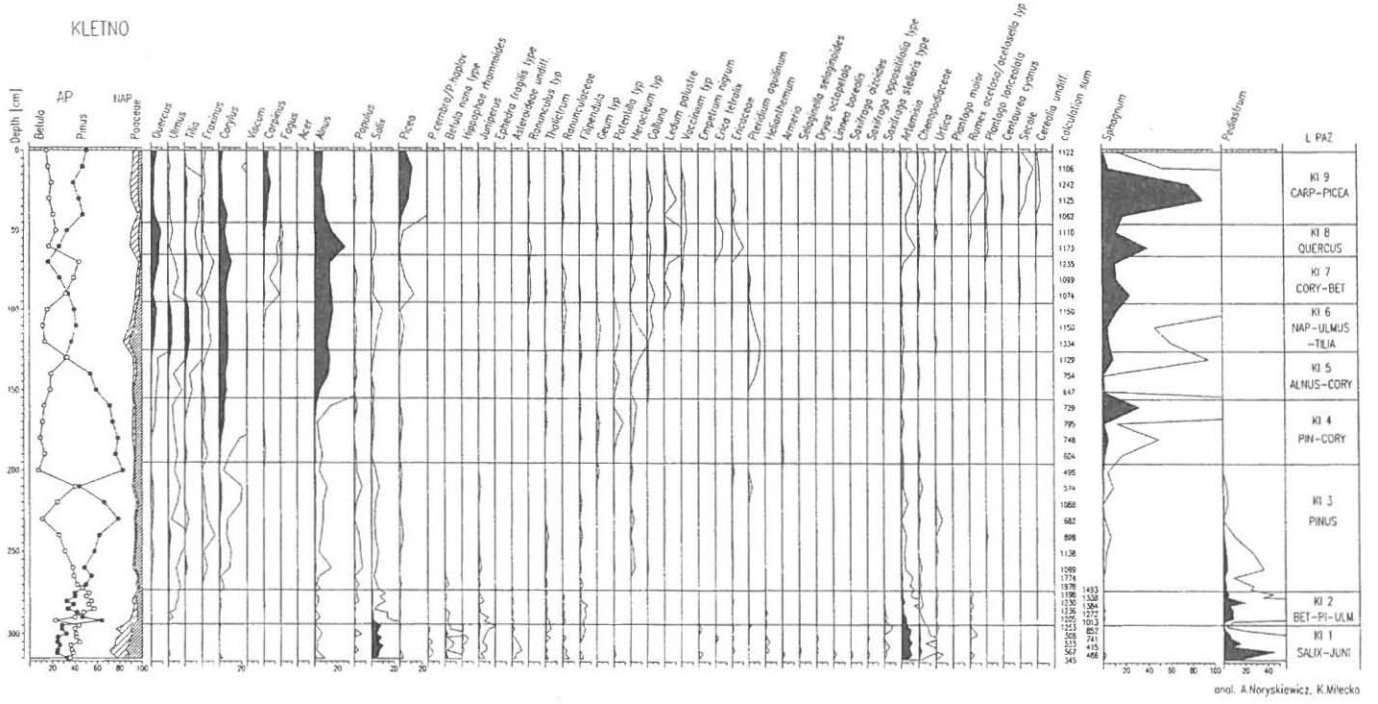

Fig. 2. Simplified percentage pollen diagram of peat-bog Kletno, curves of some trees, shrubs and herbs

mineral material to the allochthonous reservoir. Low density of the vegetation cover activated erosion processes in the reservoir environs which was probably one of the reasons for a very low pollen grain concentration in the sediment.

Kletno 2(294-273 cm) *Betula-Pinus-Ulmus*

This zone corresponds to the early Pre-boreal period. It was the time of the development of forest communities in which birch trees dominated and were accompanied by pine trees. A crossing of percentage curves of pine (*Pinus*) and birch (*Betula*) can be observed on the boundary of two zones, which is characteristic for the Holocene threshold. Such a phenomenon is perceived as a feature commonly met in the period described in the territory of the entire Europe [6]. From a depth of 287 cm, there appeared a continuous percentage curve of *Ulmus*, which indicated a regular occurrence of elm in the tree layer. Slightly later a new, mesocratic species, namely hazel (*Corylus avellana*) was found. Its single grains were observed in the spectra. A distinctive decrease in the percentage occurrence of NAP, especially heliophytes, points to a higher density of the tree stand. Together with an improvement in climatic conditions in the beginning of the Holocene, concentration of pollen grains in the sediment rapidly increased (from 968210 to 277530 grains cm^{-3}) which suggests that the area was covered by forest communities.

Kletno 3(273-195 cm) *Pinus*

A pre-dominant, but not stable content of *Pinus* pollen grains was found. There was also a starting point for the curves of mesophilous trees like *Quercus, Tilia* and *Fraxinus excelsior*. The percentage content of sporomorphs of *Ulmus* and *Corylus* slowly increased. A total curve of herbs NAP was rather low. A change of the forest communities was observed in this L PAZ *Pinus* became. The pine predominant forest expanded and increased its density, worsening conditions for light demanding plants. First of all, *Betula*, was limited in its area and also herbs of open communities like *Poaceae*, *Artemisia*, *Chenopodiaceae* and *Rumex*.

Kletno 4(195-155 cm) *Pinus-Corylus*

The highest percentage content of *Pinus* pollen grains (up to 80%) was observed in this L PAZ. *Corylus* curve reaches 5%. Low and uncontinuous curves of *Quercus, Tilia* and *Fraxinus* were also present. The content of pollen grains of *Ulmus* was low but stable. NAP did not exceed 8%. Such elements of pollen spectrum reflected the most important role of pine in the forest of a relatively high

density. It was also noticed that the initiation of changes in the forest communities took place. Immigration of *Ulmus* and the presence of *Corylus* reflected that process.

Kletno 5 L PAZ (155-125 cm) ***Alnus-Corylus***

The proportion of *Pinus* pollen grain was decreasing. Pollen grain of Alnus were most frequent. A slight growth of the proportion of mesophilous trees such as *Quercus, Ulmus, Tilia* and *Fraxinus* was found. This L PAZ reflected changes in the forest communities on mineral soils and on wet ground. Higher frequencies of deciduous trees were related to the development of mixed, deciduous forest in the end of the Boreal period and at the beginning of the Atlantic period. It was mainly possible due to better climatic conditions and higher mean annual temperature. The second thousand of years of the Holocene were also a period of intensive development of the *Alnus* communities. Alder was the most important species on the wet areas from that time until modern times.

Kletno 6, 7, 8 L PAZ (125-45 cm) ***Nap-Ulmus-Tilia, Corylus-Betula, Quercus***

A low percentage of *Pinus* pollen grain was noticed. Pollen grain of deciduous trees, the main components of a mixed deciduous forest were predominant. The content of pollen grain of NAP changed. At the depth of 120 cm, NAP reached low culmination of 15%. A fundamental element of that curve is *Poaceae*. These L PAZes reflected domination of the mixed deciduous forest on mineral soils. *Corylus avellana, Frangula alnus, Sambucus nigra* and *Viburnum opulus* were the elements of a lower layer of this forest. There was also *Pinus* present in the areas with less fertile soil. *Juniperus, Calluna vulgaris, Ledum palustre* and some herbs were present in that kind of forest. *Alnus*, *Fraxinus*, *Populus* and *Salix* trees occupied wet areas along rivers and around lakes.

A high importance of deciduous forest with a minor presence of *Pinus* was observed during the Atlantic and Subboreal periods. We should notice however that the diagram presented doesn't contain a full sequence of sediments and a description of the detailed chronology was impossible at that stage of the research.

Kletno 9 L PAZ (35-0 cm) ***Carpinus-Picea***

In the upper part of the core, a relatively high content of pollen grain of *Carpinus betulus* and *Picea abies* was found. Other forest elements appeared with lower frequency than in the previous L PAZes. NAP curve reached 12% of the

content of pollen grain. Forests of the earliest stage of succession mirrored in the pollen diagram from the Kletno had features of a deciduous forest, combining species appearing during the climatic optimum, i.e., *Quercus*, *Tilia*, later immigrants like *Carpinus betulus* and some coniferous species, mainly due to a growing role of *Picea abies*.

Changes of local plant communities are shown in Fig. 3.

The deepest part of the sediments reflected a stage of on existing lake. Sporomorphs of aquatic plants like *Myriophyllum spicatum*, *M. verticillatum*, *M. alternifolium*, *Potamogeton* sp. and *Nymphaea alba* were found together with *Pediastrum*, an element of the water plankton. The lake had an eutrophic or mesotrophic character, as can be seen from the pollen grain of *Nymphaea* and the dominance of *Pediastrum* boryanum and *P. duplex*. These species appeared most often in water rich in nutrients.

A continuous curve of *Typha latyfolia* indicated an improvement of climatic conditions, especially higher annual temperature at the beginning of the Holocene. That species needs mean July temperature at the level of 14-15° [9]. At the depth of 230-260 cm, in *Pinus* L PAZ, curves of water plants diminished. Instead we can observe sporomorphs of *Sparganium*, *Typha latifolia*, *Polypodiaceae*, *Myriophyllum verticillatum* and *Menyanthes trifoliata*. Such a local pollen spectrum means that accumulation of sediments took place in the lake which was shallowed to a high degree and the process was going on.

The beginning of *Utricularia*, *Menyanthes trifoliata* curve and then a growing content of *Sphagnum* spores mirrored the phase of open water disappearence stage in the lake. *Sphagnum* spores were present in older sediment layers, too. They reflected the existence of small peatbogs around the lake and the process of organic sediment accumulation of terrestrial origin. Probably, pollen tetrads of *Typha latifolia* also reflected that phenomenon as it prefered the presence of organic material in the ground. Typha disappeared from the surrounding of the lake together with its complete overgrowing. Absence of algae *Pediastrum*, *Diatomae* and *Cladocera* in the sediments in the pollen diagram mirrored the beginning of the stage of peatbog development. Sporomorphs of telmatophytes were still present: *Cyperaceae*, *Carex* type and *Polypodiaceae*. *Sphagnum* was the most important element of peatbog plant communities up to the present time.

Specification of the accumulation rate of the sediments and detailed description of the peat-bog history is impossible at that stage of the research. First of all, it resulted from an uncontinuous accumulation mirrored in the diagram. Changes in the plant cover were incomplete in the regional and local view, either. Pollen

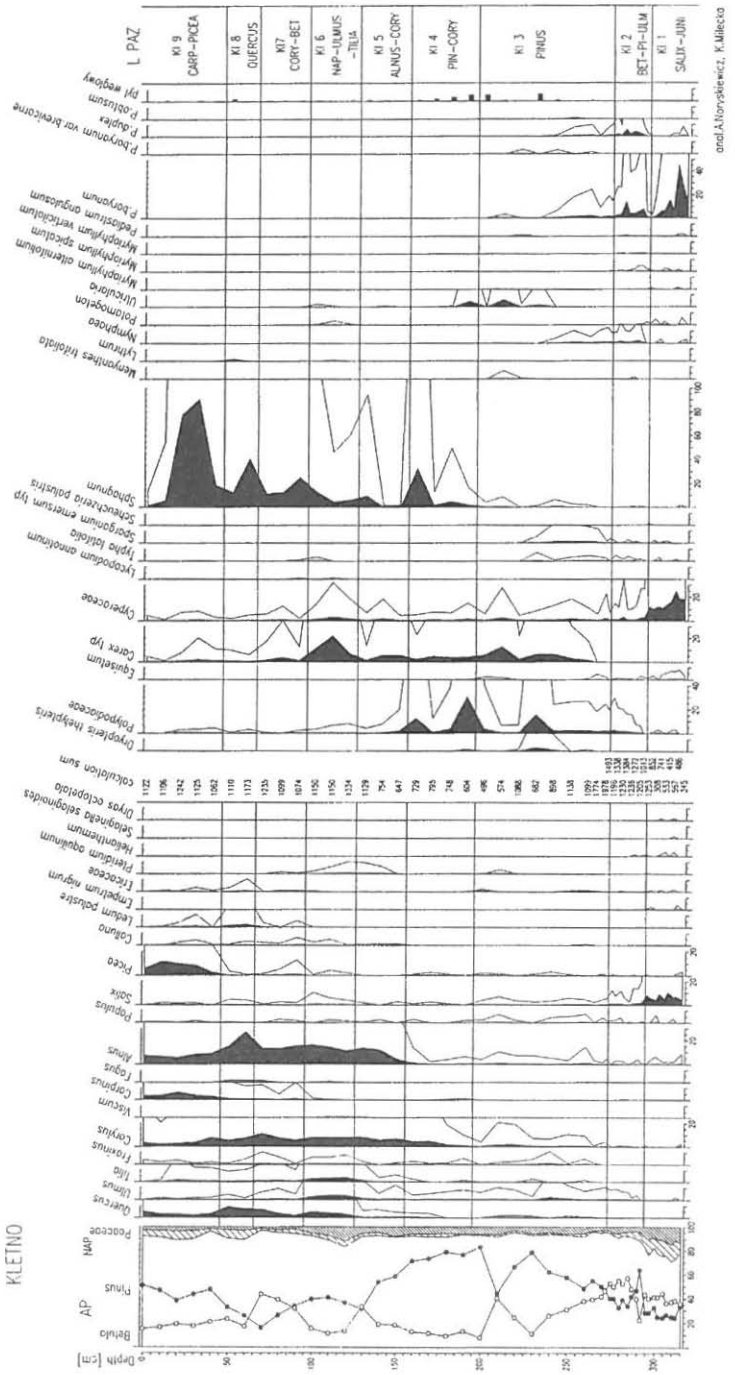

Fig. 3. Simplified percentage pollen diagram of peatbog Kletno, curves of some trees, herbs, telmatophytes and aquatics

analysis of the complete core of sediments should be done to make comparison and description possible.

Analysis of plant macroremains of the core the Kletno would be of great help as well as it will give creates a possibility of a detailed identification of a lot of species which is difficult or impossible during pollen analysis.

CONCLUSIONS

Lake sediments make the deepest part of the core. Detritous gyttja is overlayed by peat. The old lake was eutrophic/mesotrophic which has been proved by the presence of *Pediastrum* sporomorphs of *Sparganium, Typha latifolia, Polypodiaceae* and *Menyantes trifoliata* indicated a final, shallowing stage of the lake and the disappearing of the open water area. The absence of *Pediastrum, Diatomae* and *Cladocera* showed an ovegrowing of the lake at the time of peatbog development.

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ROZWÓJ TORFOWISKA KLETNO ORAZ POSTGLACJALNE I HOLOCEŃSKIE PRZEMIANY ROŚLINNOŚCI PUSZCZY BIAŁOWIESKIEJ W ŚWIETLE ANALIZY PYŁKOWEJ

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S t r e s z c z e n i e. W artykule omówione zostały wstępne wyniki badań nad historią szaty roślinnej Puszczy Białowieskiej. Na podstawie analizy pyłkowej osadów z torfowiska Kletno (południowo-wschodnia część Białowieskiego Parku Narodowego) przedstawiono rozwój szaty roślinnej od młodszego dryasu po czasy współczesne. Na podstawie składu sporomorf roślin wodnych i szuwarowych scharakteryzowano sukcesję lokalnych zbiorowisk roślinnych od stadium jeziora, poprzez zarastanie i zanik otwartego lustra wody, aż do powstania i dalszego funkcjonowania torfowiska.

S ł o w a k l u c z o w e: palinologia, późny glacjał, holocen, Puszcza Białowieska