Acta Agrophysica, 2002, 67, 197-206

DEVELOPMENT OF THE DZIEDZINKA RAISED BOG (THE BIAŁOWIESKI NATIONAL PARK) ON THE BASIS OF PALYNOLOGICAL AND PLANT MACROFOSSILS ANALYSIS

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A b s t r a c t. The Holocen history of the Dziedzinka raised bog is presented on the basis of regional vegetation development and mire development. Geological survey, palynological analysis and plant macrofossil analysis are the main sources for the palaeoecological reconstruction.

K e y w o r d s. palaeoecology, palaeolimnology, pollen analysis, macrofossils, lake terrestrialization, peatland geology, Białowieża National Park

INTRODUCTION

The raised bog Dziedzinka (9.5 ha area) is situated in the spring area of the Orłówka stream (a left tributary of the Narewka) in 373 forest divide of the Białowieża National Park (Fig. 1). The raised bog is covered with a *Sphagnum* lawn with pine in the central part (*Sphagnetum medio rubelli pinetosum* and *Vaccinio uliginosi pinetum typicum*) and with spruce distributed along the edges of the bog [4]. Succession of pine and spruce at this site was the subject of research (Faliński's *op. cit*). An analysis of development of the raised bog and a description of the origin and development of the local plant communities and regional vegetation during the Holocene is the aim of this study.

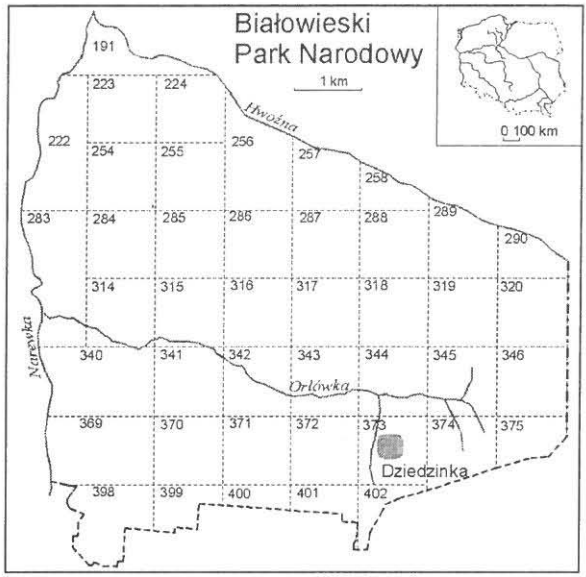

Fig. 1. Localization of the Dziedzinka raised bog

METHODS

A geological survey was conducted on the bog. Two longitudal and altitudal transects crossing the center of the bog were pointed out (Fig. 2). The components of the sediment were described according to Troels-Smith system [6]. One core (S-20) was taken for palynological and macrofossil analysis. The Dziedzinka S-20 drilling was located in the central part of the peatbog in the place of a high thickness of biogenic sediments. The core was taken up to a depth of 124 cm thus reaching, a mineral substratum in the bottom.

Samples for palinological research (1 cm^3 in volume) were prepared by applying a standard laboratory methodology; they were cooked in 10% KOH and exposed to Erdtman acetolyse [2]. Mineral components were removed by using additionally cold 40% HF. Two *Lycopodium* tablets containing spores of *Lycopodium clavatum* were added to each test specimen in order to calculate the absolute concentration values of sporomorphs [5].

The results of palynological analysis were presented in the form of a percentage pollen diagram (Fig. 3). The total of tree pollen (AP) and herbaceous plants (NAP) made the calculation basis and composed 100%. The participation of *Cyperaceae*, aquatic and moorland vegetations as well as spores and undetermined and rebedded sporomorphs was, however, calculated in relation to this sum and increased by a value

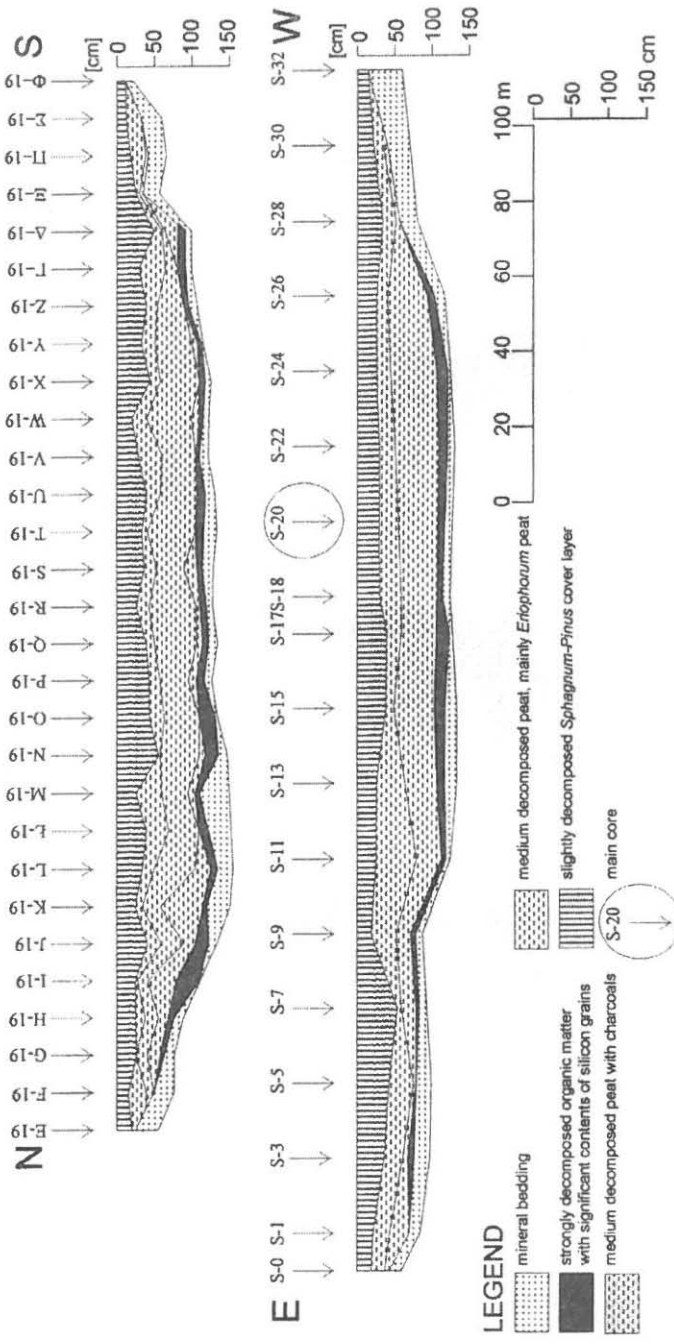

Fig. 2. Geological cross-section through the Dziedzinka raised bog

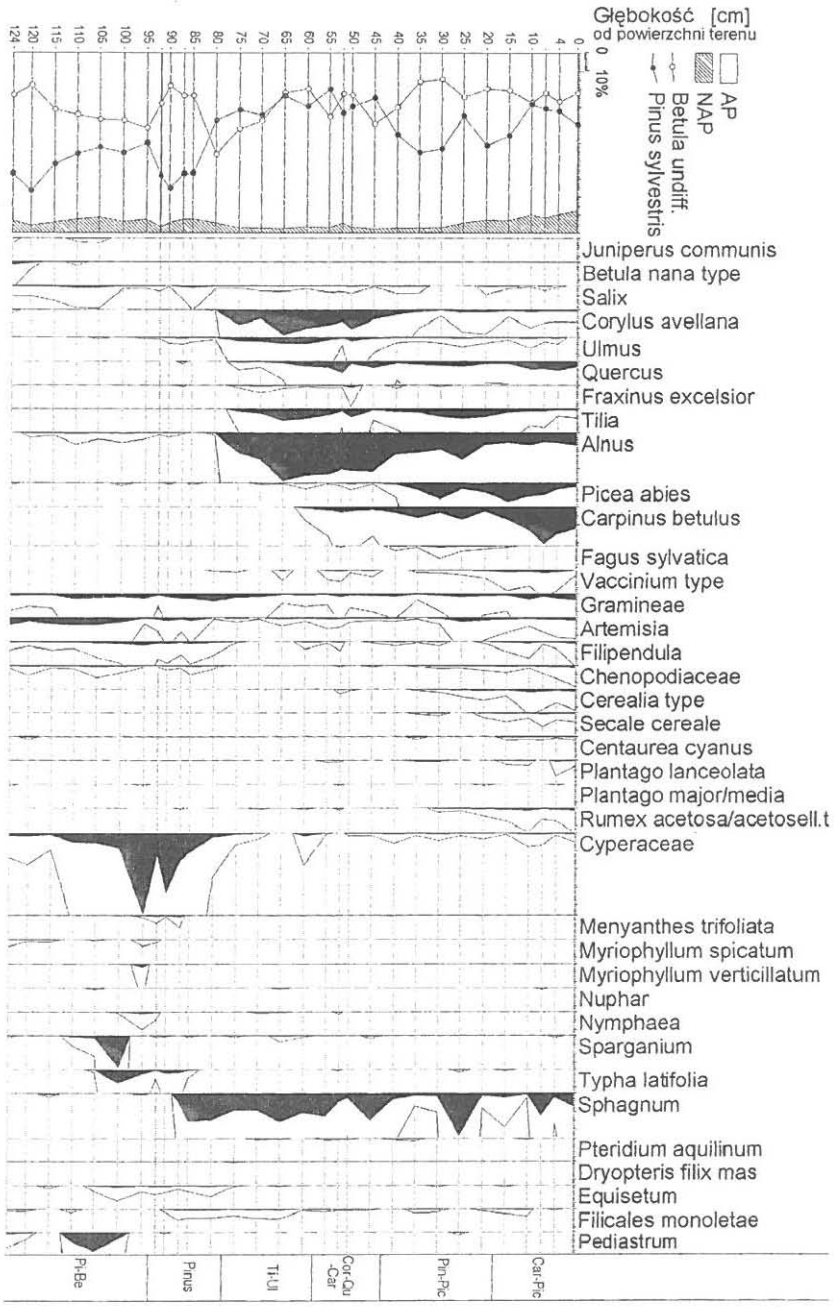

Fig. 3. Dziedzinka, Pollen diagram, (selected curves)

of a given taxon [2]. Samples taken at every 5 cm were analysed. Considering a very low rate of sedimentation, they shall have to be more concentrated in the future.

After subsampling for palynological analysis, the rest of the samples were used for a macrofossil analysis. Samples were cut into 1-5 cm long sections, and the sample volume was determined (ranging between 9-49 cm^3). Some more compacted samples were heated for 5 min. in 10% potassium hydroxide (KOH). All samples were sieved with running water over 250 and 120 μm. The residues were examined under a stereomicroscope (magnifications between 10-100×). For the determination of the macroremains some key atlases and reference collection were used.

RESULTS

Geology

A preliminary geological survey conducted during field work showed a vast basin with a flat bottom of a mineral ground in the bed (Fig. 2). A stratum of organic sediments with a significant content of mineral substance (20-50%) in a form of well rounded silicon grains is the bottom layer. In the core, S-20 thickness of this layer amounted to 30 cm (depth 94-124 cm). A laboratory analysis revealed quite a large number of water and marsh plant macrofossils. Stratum of moderately humified peat was overlying it. It contained charcoal particles with addition of a mineral material (depth 60-94 cm). Underground parts of vascular plants, probably *Eriophorum angustifolium* were the main component of the peat. There were no fruits or seeds only some single branches of *Sphagnum* from Section *cuspidata* were found (depth 75-80 cm). The dominating plant component of the sediment at a depth of 0-60 cm was *Eriophorum vaginatum* at the bottom and *Sphagnum* and *Pinus silvestris* in the top layer.

Local pollen collection zones

The diagrams were initially divided into 6 local pollen assemblage zones (L PAZ) – biostratigraphic units which were named after taxa characteristic of them. Their boundaries can undergo changes once subsequent tests have been included into research. At the present stage of research it is difficult to determine unmistakably whether separation of zones overlapped the natural boundaries of vegetation changes or only places of sedimentation gaps.

Considering the fact that the area occupied by the mid-forest peatbog was only small, the pollen diagram from the Dziedzinka gives information on the local history of the peatbog vegetation cover and forests that surround it [1].

Table 1. The Dziedzinka peatbog: description of local pollen assemblage zones (LPAZ)

Name of local pollen assemblage zones (L PAZ)	Depth (cm)	Description of pollen spectra
Pinus-Betula	94-124	High values of *Pinus* (app. 49.9%) and *Betula* (app. 27.6%), considerable contribution of NAP with the max. values of *Artemisia* (4%) and *Filipendula* (1.2%). Culmination of *Salix* (max. 75.4%) in the zone roof. Boundary – on decrease of *Betula* curve and an increase of *Pinus*.
Pinus	77-94	Max. values of *Pinus* (max. 62 and app. 56.4%), a continuous curve of *Ulmus* ocurs. Boundary – an increase in the contribution of *Corylus* and *Alnus*.
Alnus-Corylus	67-77	A considerable contribution of *Alnus* and *Corylus*, continuous curves of *Tilia*, *Quercus* and *Fraxinus* occur and the contribution of *Ulmus* increases. The Boundary – an increase of *Corylus*, *Alnus* an *Tilia*.
Tilia-Ulmus	57-67	Max. values of *Tilia* (6.5%) and *Ulmus* (3.7%), a continuous curve of *Carpinus* occurrs. Boundary – a decrease fall of *Tilia* and *Ulmus* and an increase of *Carpinus* above 1%.
Quercus-Carpinus	37-57	Max. of *Quercus* (6.6%), a continuous and high contribution of *Alnus* (app. 19.5), min. of *Pinus* (25.1 and app. 29.6%). Boundary – an increase of *Picea*.
Pinus-Picea-Carpinus	13-37	A high contribution of *Pinus* (app. 49.2%). *Picea* (max. 10.2%) and *Tilia* (max. 5.2%) reach culmination. Boundary – the fall of *Picea* and the increase of *Carpinus* and *Quercus*.
Carpinus-Quercus	0-13	*Carpinus* (max. 20.4 and app. 15.4%) and *Quercus* (max. 5.2 app. 4.5%) reach the max. values, equalized curves of *Pinus* (app. 31.7%) and *Betula* (app. 25.2%). A continuous presence points to human farming (*Cerealia, Secale, Plantago lanceolata*).

Rapid changes in the percentage of taxa, e.g., marshland plants, that reached a two-digit value (a rapid growth of *Sparganium typ* and *Typha latifolia*) can point to very strong water oscillations in this area as well as intervals in sedimentation (hiatus). Additionally, a sudden occurrence of *Corylus* and *Alnus* points to a sedimentation gap. This may, however, result from a palinological record of little precision in the profile analysed that is conditioned by a very low sediment accumulation rate. A mathematical calculation shows that app. 1 cm of sediment was created within a period of 100 years.

Regional vegetation development (history of forests)

The diagram from the Dziedzinka peatbog reflects most probably the Holocene history of vegetation from the Pre-boreal period to modern times. The pollen zone of *Pinus-Betula* is characterized by the development of Pre-boreal forest assemblages dominated by pine and birch. A considerable contribution of light-demanding trees such as birch and a relatively frequent occurrence of heliophytic plants including *Artemisia*, *Filipendula*, *Gramineae*, and *Chenopodiaceae* evinced still a rather small density of this tree stand.

Pine is unquestionably a domineering forest component in the *Pinus* zone which is accompanied by birch. Besides, the components of the thermophilous mixed forest occurred as an addition in the better habitats (small but continuous percentage curve of *Ulmus*).

From the *Alnus-Corylus* zone, there appeared a visible reconstruction of tree stands. New, thermophilous species entered the forests together with an improvement in the climatic conditions. Hazel spread in the undergrowth and oak, linden and ash-tee appeared in the tree layer next to previously occurring elm. Assemblages of water-logged forests with alder were of great importance. The spreading of hornbeam in the surroundings of the Dziedzinka was correlated with a decrease in the quantity of *Ulmus*. The presence of hornbeam in the study area was manifested by 4 culminations (52 cm – 3.1%, 35 cm – 5.9%, 25 cm – 6.9%, 7 cm – 20.4%) out of which the youngest was most vividly marked. Spruce was the last species to spread near the Dziedzinka. Its curve refracted in the middle of the *Quercus-Carpinus* zone and at that time nearly all percentage curves of deciduous trees increased (*Carpinus, Tilia, Alnus*, and *Quercus* and *Ulmus* to a lesser extent). It was most probably related to the local change of hydrological relations since a rapid increase in the quantity of *Sphagnum* spores with an absolute maximum (23.4%) was observed. A slight maximum of the beech curve (0.7%) in the spectrum from a depth of 30 cm was noted. The species do not occur today in the Białowieża Primeval Forest. The fact that pollen of beech which spreads relatively difficult was found, suggest that single specimens of this taxon reached the forest during the expansion of spruce to the primeval forest. The worsening climatic conditions inhibited the expansion of beech. If vegetation remains of this tree are not found, such reasoning is only a probability.

In the youngest zone of *Carpinus-Quercus* forest assemblages reminded modern ones. Oak and hornbeam deciduous forests including lime and pine as well as spruce coniferous forests were dominant in the most fertile habitats. Pine coniferous forests developed in dry stands while alder carrs and spruce-tees grew in humid sites.

Local vegetation development and water level oscillations

The occurrence of aquatic and rush vegetation (from the bottom at 124 cm to the depth at 87 cm) in the pollen diagram showed that sediments under research developed in water environment. A succession of overgrowing reservoir was recorded in the pollen spectra of this segment of the profile. It underwent subsequent stages with aquatic vegetation dipped (*Myriophyllum spicatum*, *Potamogeton*) and *Pediastrum* (absolute max. 38.4%), with floating-leaved vegetation (*Nymphaea* 0.4%), followed by rush vegetation (*Typha latifolia* max. 7.4%, *Sparganium* type max. 17.3%), and with representatives of *Cyperaceae* in the final stage which reached the absolute max. in the profile (45%) in the sediment bottom. Peat sedentation began already at a depth of 84 cm which was evidenced by numerous spores of *Sphagnum* as well as the character of the sediment.

Mire development based on macrofossils analysis

The Dziedzinka mire is a result of shallowing of a lake overgrown by Potamogeton communities (13 fruits of *Potamogeton natans* and 7 *Potamogeton* cf. *obtusifolius* at the depth 95-100 cm). The presence of *Potamogeton* fruits was revealed in all samples from a depth of 90-124 cm but there were not found at the level of 85-90. Macrofossil analysis confirmed results of the palynological study at this point. Endocarps of *Cyperaceae*, saying exactly *Carex* were found abundantly at a depth of 95-100 cm, about 100 fruits, mostly without utricles, were found. Species were described as probably Carex vesicaria with an admixture of 10 endocarps of *C. nigra*. Overall, further seeds were recognized as: *Menyanthes trifoliata, Myriophyllum verticillatum, Typha latifolia* and *Batrachium aquatile*. Macrofossils of the above plants proved the existence of a shallow lake overgrown mostly by *Potamogeton* in this place.

A less numerous representation of *Carex* macroremains at the bottom of this layer or their absence in the lowest part, showed an initial phase of the lake with an open water surface. The lake was gradually overgrown by *Carex* and the open water surface disappeared completely (the layer above 90 cm). The next layer (60-90 cm), initially containing a lot of *Carex* and *Menyantes* macroremains, then turned into *Eriophorum* peat. This was an initial stage of peat bog development. The peat was not strongly decomposed, yet. There were no overhead plant parts, but numerous parts of charcoal were found. It showed that numerous fires took place at the site in the past together with clear water level fluctuations.

This stage was probably prolonged in time. Palynological analysis was not helpful at that point because of possible hiatuses in this layer. Charcoal were found in the overlying stratum, for instance at a depth of 40-45 cm, too. Above the depth of 60 cm, *Eriophorum vaginatum* was found in the form of leaf sheaths macroremains. Together with *Eripohorum vaginatum*, *Pinus* bark, *Menyantes* seeds and sporogonium operculum of *Sphagnum* sp. occured. At a depth of 50-55 cm, seeds of *Andromeda* and single leaves of *Caliergonella cuspidata* were found.

At the bottom layer, at a depth of 50-60 cm and 40-45 cm, the content of *Eriophorum vaginatum* macroremains amounted to 70-80%. Between these layers, macroremains of *Sphagnum* sp. (mainly from sectio *Cuspidata*) dominated again, like in the layer of 25-32 cm (in the core S-20) in which *Sphagnum* sp. reached 80-90% of the sample volume. The main additional components were *Pinus* macroremains. The next layer (20-25 cm) consisted of *Pinus* bark and branches in 70%. The remains of *Pinus* needles were very rare. The upper 20 cm layer of the sediment consisted mostly of *Sphagnum* sp. and *Pinus* bark.

SUMMARY

Palygenological analysis showed that the Dziedzinka raised bog developed as a result of a land formation process of an open water surface covered first by communities of *Potamogeton* sp. and later by *Carex* sp. From the depth of 90 cm, aquatic vegetation dissapeared and moorland Eriophorum sp., *Sphagnum* sp. and *Pinus* dominated.

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ROZWÓJ TORFOWISKA DZIEDZINKA (BIAŁOWIESKI PARK NARODOWY) W ŚWIETLE ANALIZY PALINOLOGICZNEJ I MAKROSZCZĄTKOWEJ

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S t r e s z c z e n i e. Na torfowisku wysokim Dziedzinka, położonym w oddziale 373 Białowieskiego Parku Narodowego przeprowadzono rozpoznanie geologiczne. Wytyczno dwa transekty, jeden o przebiegu południkowym, drugi o przebiegu równoleżnikowym, wzdłuż których wykonano łącznie 47 sondowań świdrem typu Instrof. Osady opisano metodą Troel-Smitha. Jeden rdzeń o długości 124 cm poddano analizie laboratoryjnej. Pobrano próby do analizy palinologicznej (co 5 cm) a pozostały materiał zbadano na zawartość szczątków makroskopowych. Analiza palinologiczna wykazała, że torfowisko wysokie rozwinęło się w wyniku procesu lądowienia wolnej powierzchni wodnej, zarastającej stopniowo najpierw przez zbiorowiska zdominowane przez rdestnice *Potamogeton* sp. a potem przez turzyce *Carex* sp. Od głębokości 90 cm zanika roślinność wodna a zaczyna dominować torfowiskowa, reprezentowana głównie przez wełniankę pochwową *Eriophorum vaginatum* i mchy torfowce *Sphagnum* sp. Znaczny udział posiada miejscami sosna.

S ł o w a k l u c z o w e: torfowiska, paleolimnologia, makrofity, Białowieski Park Narodowy