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Geologic-floristic setting of the Mazovian Interglacial sites in Wilczyn and Lipnica in southern Podlasie (eastern Poland) and their palaeogeographic connections

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The paper presents the results of pollen and geological analyses from two interglacial lake at Wilczyn and Lipnica. Geological studies in the Podlasie region have shown that a genesis of some fossil lakes can partly be related to the neotectonic structures (Wilczyn). The genesis and the existence of the other ones was dependent mainly on a course of climate conditions (Lipnica). In the pollen diagrams local pollen zones typical for Mazovian Interglacial have been distinguished. The course of the interglacial plant succession with Holsteinian sea-level change has been compared. The change of water level and trophic conditions were discussed.

INTRODUCTION

Geomorphologic and geologic investigations carried out in the region of Biała Podlaska (Fig. 1) led to the discovery and an initial floristic analysis of sites with organogenic deposits, that is Wilczyn (S. Szymański, 1992, K. Bińka, 1994, 1995; K. Bińka, J. Nitychoruk, 1995*a*; K. Bińka *et al.*, 1996; L. Lindner, 1996) and Lipnica (J. Nitychoruk, 1994; K. Bińka, J. Nitychoruk, 1995*b*) in particular. The mentioned papers reveal that, in spite of a different lithologic development and varying thickness, the deposits represent the Mazovian Interglacial and are overlain by one till horizon from the Odranian (Wartanian?) Glaciation or its residuum. A possibility appeared to connect the geomorphologic-geologic setting of site Wilczyn (WL-1 on Figs. 1 and 2) with a nearby site of coeval deposits in the western part of Grabanów (see J. Nitychoruk, 1995; L. Lindner, 1996; L. Lindner, R. Wyrwicki, 1996).

Furthermore, the discovery of similar deposits north of Grabanów (see K. M. Krupiński, 1995) and in the eastern part of the town (see K. M. Krupiński, S. Skompski, 1995) enables a more detailed palynologic correlation of these deposits. It is worth noting that in all the mentioned sites, deposits representing the Mazovian Interglacial lie on glacial and glaciofluvial deposits of the Sanian 2 Glaciation. Glaciogenic series of the Sanian 1, Nidanian and Narevian Glaciations occur below the discussed series, together with fluvial or lacustrine deposits occurring above them, assigned to the Ferdynandovian, Malopolanian and Podlasian Interglacials (L. Lindner, 1988; J. Nitychoruk, 1994, 1996).

DESCRIPTION OF SITES

Wilczyn. The collected data show (see K. Bińka *et al.*, 1996) that the site is situated within a depression between Wilczyn and Grabanów (Fig. 2). The depression forms a surface lying about 5–10 m below the surrounding post-glacial plateau, in its near-surface part built of two tills with intercalations of sands, silts, gyttja, clays and gravels (often with glaciotectonic disturbances), occasionally covered by glaciofluvial sands with gravel and Scandinavian boulders. A few thin sheats of the younger till, together with overlying glaciofluvial sands (kame?) with gravel and boulders and sporadically with lag deposits in its lower part, have been discovered within the surface of the depression (strike of depression W–E). Narrow shelves of these sands or younger valley sands(?), overbuilt by silts and with substantial accumulation of gravel and small boulders in their lower part, occur on slopes of the depression. In the lowermost parts of the depression, cut with melioration ditches, vast areas built of organic muds and peats up to 2–3 m thick are present.

Carried out earthworks allow to state that in the zone of the mentioned depression and in the area of its direct surroundings the oldest Quaternary strata are represented by poorly sorted sand with fine gravel (layer 1 on Fig. 2), what has been discovered by a hand probe below the oldest till in the bottom of the depression in the western part of Grabanów. The sand was TL-dated in the Gdańsk University Laboratory, and the obtained result of > 49.9 ka (UG-1547) is probably the effect of the sample of the sandy material taked for analysis being too small. The older till covering the sand (layer 2 on Fig. 2) occurs in the northern part of the depression near Julków as well, what has also been discovered by hand probes. The till is characterized by a grey colour, large admixture of sand and a distinct presence of Scandinavian boulders. In the zone of the discussed depression the mentioned sands and the overlying till have not been drilled through to the depth of 1–4 m. Profiles of boreholes in the region of Biała Podlaska, Roskosz and Cicibór reveal that the till reaches up to a dozen or so metres (L. Lindner, 1988; S. Szymański, 1992; J. Nitychoruk, 1994). The obtained image of the geological structure shows that in the region of Wilczyn, similarly as in the site of Mazovian Interglacial deposits in Biała Podlaska (see K. M. Krupiński *et al.*, 1988), the till builds slopes of an ancient lake depression from this interglacial (Fig. 2) and therefore should represent the remains of the ice-sheet of the Sanian 2 Glaciation.

In the Grabanów site the till is covered by an almost 1 m thick layer of strongly ferruginous gravels with boulders (layer 3 on Fig. 2). These gravels, together with the overlying sands (layer 4 on Fig. 2) and occurring in the lower part of the depression Scandinavian boulders, up to 1.5 m in diameter, are the result of washing-out of the discussed till. Most probably the washing-out took place just after the deposition of till or during its melting out from dead-ice blocks connected with the retreat of the ice-sheet of the Sanian 2 Glaciation. In the western part of the outcrop (beyond the geological section presented on Fig. 2) the younger strata are presented by poorly sorted sands with intercalations of lake marl (according to L. Lindner, R. Wyrwicki, 1996). This deposit contains considerable amounts of shells of snails *Viviparus diluvianus* (Knuth) and *Lithoglyphus jahni* Urbański and represents a lacustrine deposit of the Mazovian Interglacial, glaciotectonically pushed out from an ancient depression between Grabanów and Wilczyn (see J. Nitychoruk, 1995; K. Bińka *et al.*, 1996; L. Lindner, 1996), where it occurs *in situ* (layer 5 on Fig. 2) and reaches over 30 m in thickness as well as contains a lens of sandy material.

The depression probably represented a part of a post-glacial lake from the Sanian 2 Glaciation, deepened during the Mazovian Interglacial in course of contemporary neotectonic processes (J. Nitychoruk, 1994, 1996). It had a parallel progress, is several kilometres wide and at least tens kilometres long, between Wilczyn and Grabanów in the west and Małaszewicze in the east (K. Bińka, 1994; K. Bińka, J. Nitychoruk, 1995*b*, 1996). The presence of snail shells of *Viviparus diluvianus* (Knuth) and *Lithoglyphus jahni* Urbański, as well as results of palynologic and macroflora analyses from the upper part of lake marl in the WL-1 section (Fig. 2), allow to connect functioning of the lake with the Mazovian Interglacial (K. Bińka, 1994; K. Bińka, J. Nitychoruk, 1995*b*). This age position of the discussed sediments is consistent with TL-dating at the Gdańsk University Laboratory at 396.5±59.5 ka (UG-1856).

The younger deposits from this lake are clays with recently discovered (L. Lindner, R. Wyrwicki, 1996) fragments of shells of the above mentioned snails (layer 6 on Fig. 2), which were accumulated already in the anaglacial part of the Odranian (Wartanian?) Glaciation. On the other hand the youngest

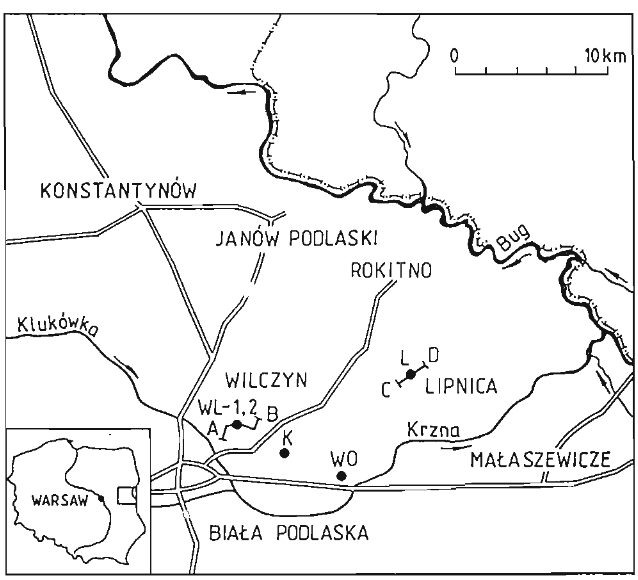


Fig. 1. Location sketch of the Wilczyn (WL-1, 2), Kaliłów (K), Woskrzenice (WO) and Lipnica (L) sites with geological sections A–B and C–D marked

Szkic lokalizacyjny stanowisk Wilczyn (WL-1, 2), Kaliłów (K), Woskrzenice (WO) i Lipnica (L) wraz z przekrojami geologicznymi A–B i C–D

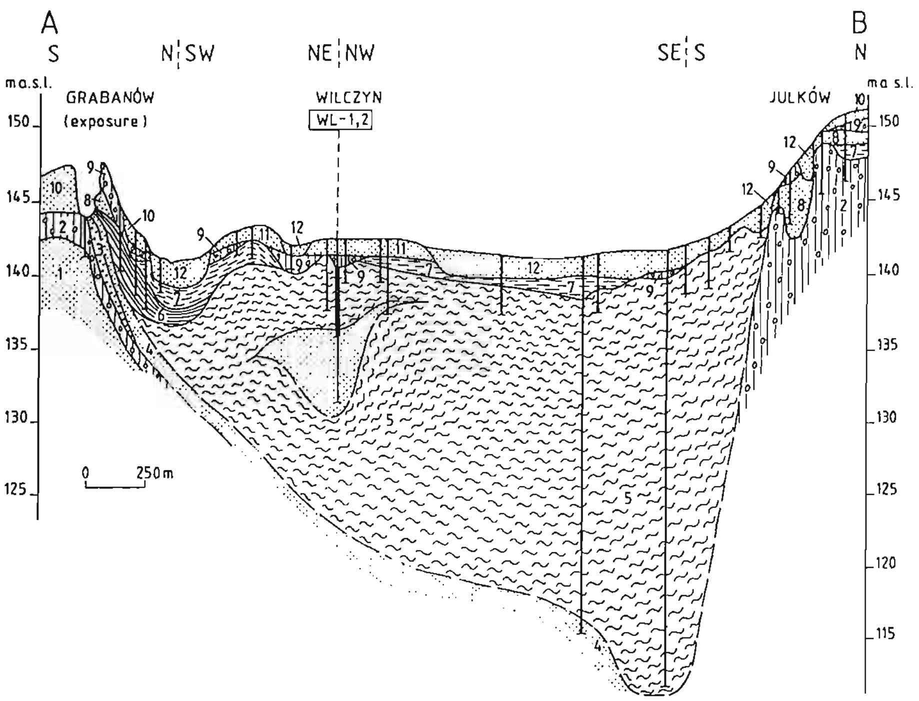


Fig. 2. Geological section through near-surface Quaternary deposits in the vicinity of Wilczyn with position of discussed site (WL-1, 2) of Mazovian Interglacial deposits

Sanian 1 Glaciation: 1 — poorly sorted sand with fine gravel, 2 — till, 3 — gravel with small boulders, 4 — poorly sorted sand; Mazovian Interglacial: 5 — lake marl with lenses of poorly sorted sand; Odranian (Wartanian?) Glaciation: 6 — clay, 7 — silt, 8 — fine-grained and poorly sorted sand with gravel and small boulders as well as intercalations of clay and till, 9 — till, 10 — sands with gravels and boulders and intercalations of silts and tills, 11 — poorly sorted sand with single grains of gravel and lag in the lower part; Eemian Interglacial, Vistulian Glaciation, Holocene: 12 — poorly sorted sands with gravel and boulder lag in the lower part, overbuilt by silts, slope deposits and humous muds passing occasionally into peaty muds

Przekrój geologiczny przez osady czwartorzędowe w stanowisku utworów interglacjalnych Wilczyn (WL-1, 2) z zaznaczonym miejscem poboru rdzeni

Zlodowacenie sanu 1: 1 — słabo wysortowane piaski ze żwirem, 2 — glina, 3 — żwir z małymi głazikami, 4 — źle wysortowany piasek; interglacjał mazowiecki: 5 — kreda jeziorna z soczewkami źle wysortowanego piasku; zlodowacenie odry (warty?): 6 — ił, 7 — mułki, 8 — drobnoziarnisty i słabo wysortowany piasek ze żwirem i małymi głazikami oraz przewarstwieniami iłu i gliny, 9 — glina zwałowa, 10 — piasek ze żwirem i głazikami oraz wkładkami mułku i gliny zwałowej, 11 — źle wysortowany piasek z pojedynczymi żwirkami i brukiem głazowym w spągu; interglacjał eemski, zlodowacenie wisły, holocen: 12 — źle wysortowane piaski ze żwirkami i brukiem w spągu zastąpione mułkami, utwory zboczowe i namuły humusowe przechodzące w namuły torfowe

lacustrine deposits are silts with fragments of the same shells, discovered by probes and boreholes (layer 7 on Fig. 2), as well as sands with clay intercalations (layer 8 on Fig. 2) visible in the Grabanów outcrop and TL-dated in the Gdańsk University Laboratory at 317±47.6 ka (UG-1855).

Observations carried out in the Grabanów outcrop as well as a variable upper surface of the mentioned lacustrine deposits, including the contact with overlying sheets of younger till in the area of the depression between Wilczyn and Grabanów (Fig. 2), show a glaciotectonically disturbed upper part of these deposits. In the area of the depression this disturbance, expressed for example by the tilt of layers to the north by 45°, affected not only interglacial but also older deposits, connected with the retreat of the ice-sheet of the Sanian 2 Glaciation. The disturbance was caused by the last in the area Scandinavian ice-sheet during the Odranian (S. Szymański, 1992) or Odranian = Wartanian? Glaciation (J. Nitychoruk, 1994; L. Lindner, 1996), the trace of which is the mentioned, occurring in sheets, brown, sandy younger till (layer 9 on Fig. 2), or its clayey-sandy residuum with boulders, up to 1.0–1.5 m thick, with xenoliths preserved in its lower part (glacier floats) of sands with gravel and small boulders and a large accumulation of shells of *Viviparus diluvianus* (Kunth). The xenoliths probably represent parts of beach deposits of an ancient lake from the Mazovian Interglacial, frozen on to the bed of the ice-sheet, what has been testified by TL-dating in the Gdańsk University Laboratory at 344.5±51.7 ka (UG-1854). For the till the TL-date comes to 186.0±27.9 ka (UG-1853), which most probably testifies against its Wartanian Glaciation age.

In the slope area of the depression between Wilczyn and Grabanów, as well as on the surface of the surrounding post-glacial plateau, poorly sorted glaciofluvial sands, up to 2–3 m thick, with gravel and small boulders (layer 10 on Fig. 2) occur above the till. They represent probably remains of older kame forms from the retreat of the last in the area Scandinavian glaciation (Odranian, Wartanian?). In the bottom of this depression the mentioned till is covered by poorly sorted sands up to 1.5 m thick with single grains of gravel and boulder lag in its lower part (layer 11 on Fig. 2). These sands

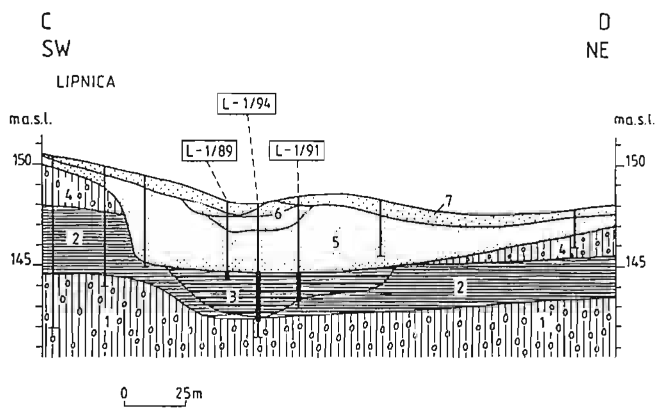


Fig. 3. Geologic section in Quaternary sediments at the Lipnica site
Sanian 2 Glaciation: 1 — sandy brown-grey till, 2 — grey-black clay and brown clay with silt; Mazovian Interglacial: 3 — lacustrine sediments — mostly peat and bituminous shales; Odranian Glaciation: 4 — brown till, 5 — fine-grained sand; Vistulian Glaciation, Holocene: 6 — sand and sandy silt, 7 — soil

Przekrój geologiczny przez osady czwartorzędowe w stanowisku Lipnica
Zlodowacenie sanu 2: 1 — glina zwałowa, piaszczysta, brązowo-szara, 2 — ił szaro-czarny i ił z mułkiem brązowy; interglacjał mazowiecki: 3 — osady jeziorne — głównie torf i łupki bitumiczne; zlodowacenie odry: 4 — glina zwałowa brązowa, 5 — piasek drobnoziarnisty; zlodowacenie wisły i holocen: 6 — piasek i mułek piaszczysty, 7 — gleba

represent probably remains of younger kame forms, connected with last stages of the retreat of the mentioned ice-sheet.

The age of the sands was determined by TL-dating in the Gdańsk University Laboratory at 250 ka (UG-1549), which is significantly against the TL-date for the older till (Wartanian?).

Younger Quaternary deposits of the area are represented by valley (fluvial?) poorly sorted sands with gravel and lag in its lower part, overbuilt by silts, slope deposits and humous muds passing occasionally into peaty muds (layer 12 on Fig. 2). These sediments represent probably the time interval from the Eemian Interglacial, through the Vistulian Glaciation to the Holocene.

Lipnica. In course of geological investigations carried out in the SE part of Podlasie by J. Nitychoruk, east of Lipnica, organogenic sediments occurring within a post-glacial plateau were drilled at the depth of 2.5 m. At some later time (1991) a 1.5 m core for pollen counts was taken to a depth of 4.5 m and next it was preliminary analyzed under a microscope (K. Bińka, J. Nitychoruk, 1995*a*). In 1994 organogenic deposits at Lipnica have been bored again and samples for pollen analysis have been collected.

The plateau in the analyzed site reaches the height of 150–155 m a.s.l., and the organogenic sediments occur in a small (3 m deep) depression and have a considerably small extension between 50 and 75 m. These sediments are represented by peats and bituminous shales (layer 3 on Fig. 3), reaching 2–3 m in thickness and lying in a depression within greyish-black clays, passing upwards into brown clays and silts (layer 2 on Fig. 2). About 5.5 m below ground level lies a brownish-grey sandy till (layer 1 on Fig. 2), underlying the organogenic sediments, while above them lies a thin (2–3 m) till, brown in the lower sandy part (layer 4 on Fig. 2). The cover of organogenic sediments is represented by sands and sandy silts (layers 5 and 6 on Fig. 2), there is, however, a notable lack of tills or their residua. The origin of the depression, in which peats started to accumulate during the Mazovian Interglacial, was connected with the retreat of the ice-sheet of the Sanian 2 Glaciation. The interglacial lake represents one of the phases after the disappearance of a larger depression, in which ice-dam clays were accumulated in the terminal part of the glaciation.

The character of sediments of the Lipnica Basin, outlined in present-day morphology in form of a small depression, is similar in the investigated area to the occurrence of the Eemian Interglacial deposits. These sediments are represented largely by peats, therefore in the future the pressure of the overlying sediments (typically 1–2 m of the Vistulian) will cause its squeezing and the creation of a small depression.

The age determination of the discussed sediments as the Mazovian Interglacial is connected with the problem of the lack of a cover of glacial deposits or their residua from the Middle-Polish Glaciations. Most probably the occurrence of these deposits in a source area of an immense depression, within which glacial waters were discharged, was responsible for the removal of the glacial coverage. Remains of the fluvioglacial accumulation are represented by fine-grained sands overlying organogenic deposits. The thin layer of sands and sandy silts occurring in the present-day depression originated from nearby heights during the Vistulian Glaciation, as well as during the Holocene in a temporary basin.

PALAEOBOTANIC ANALYSIS

In 1990 L. Lindner, S. Szymański, and J. Semil discovered lake sediments at Wilczyn. In June 1991 L. Lindner and J. Nitychoruk together with collaborators bored at this site and the core was taken to a depth of 5 m (WL-1) for pollen analysis.

In 1992 at Woskrzenice (K. Bińka, J. Nitychoruk, 1995*b*) a 10 m profile of deposits has been taken using a Ejkekamp sampler. In 1993 the sediments at Wilczyn have been bored again and the samples for macrofossil analysis have been collected (WL-2 profile). Then at Kaliłów under a 3 m mineral cover K. Bińka and J. Nitychoruk (1996) discovered lacustrine sediments similar to those present at Woskrzenice what proved that these three sites represent one fossil lake.

The new discovered sediments at Lipnica demonstrate the quite another character. Lying on the plateau some distance from Wilczyn the shallow lake basin reacted more sensitively to climate change. For this the Lipnica site seems to be very useful as a water level and climate indicator.

Up to the present the palynologic studies from Woskrzenice and Kaliłów and the preliminary report from Wilczyn have been published. The present study of Wilczyn and Lipnica cores completes the picture of the interglacial climate changes obtained from pollen analysis of the previously examined profiles at Woskrzenice and Kaliłów that formed together with Wilczyn the same lake basin. This has allowed the plant succession of Mazovian Interglacial to be reconstructed and the change of climate conditions to be assessed. For this reason the evolution of Lipnica and Wilczyn lakes is presented together against a background of Mazovian plant succession in the Podlasie Lowland based on the previously analyzed at Woskrzenice and Kaliłów.

The Wilczyn core (WL-1) represents deposits forming near the former lake shore in comparison with those at Kaliłów and Woskrzenice. It has been divided into four L PAZ (*Carpinus-Abies-Artemisia-Chenopodiaceae*, Fig. 4) and WL-2 into 2 L MAZ (Fig. 5).

The 3 m core from Lipnica (1994) contains four L PAZ distinguished on the basis of the dominant terrestrial taxa (*Picea-Alnus-Carpinus-Abies*, Fig. 6).

The course of pollen zones is as follows (the pollen zones present in Wilczyn core are marked by WL, Lipnica — L, Woskrzenice — WO and Kaliłów — K).

Cyperaceae-Gramineae **L PAZ (1)** (WO). The pollen zone is limited to a 5 cm layer of organic muds in the Woskrzenice profile. Its characteristic feature is the almost exclusively presence of grass and sedge pollen grains. It leads to an assumption that this layer was accumulated in the moss-tundra zone. The pollen spectra of this type often appear in mineral deposits, e.g. Carpathians region.

Juniperus-Hippophaë **L PAZ (2)** (WO, K). Pollen grains of shrubs, dwarf shrubs and NAP prevailed in the zone. The birch pollen representation reaches up to 30% (including *Betula nana* t.), however, its really presence in 1 cm^3 is very low (up to 35,000). This can mean that the pollen zone *Juniperus-Hippophaë* was formed out of a forest zone although in shrubs and herbaceous communities the occurrence of other birch species is possible, however, not attaining tree stature. A distinguished feature in the pollen spectrum is appearance of numerous plants that nowadays grow outside the Arctic zone (K. Bińka, 1995; K. Bińka, J. Nitychoruk, 1996) and Arctic-Alpine plants (e.g. *Saxifraga oppositifolia* t., *S. stellaris* t., *Selaginella selaginoides*, *Betula nana*, probably *Thalictrum alpinum*, *Salix polaris* t., *S. herbacea* t. and *Polygonum viviparum*). In what way was the coexistence possible? The tundra communities of that time (such diagnose was made for the *Juniperus-Hippophaë* zone) located inward the land were different from present-day tundra zone in northern Europe due to an influence of the continent, therefore a simple correlation is not possible. Important for climate diagnose is appearance many of pollen types connected with the marine climate — *Selaginella*, *Saxifraga* sp., *Sparganium affine*, *Hippophaë* (*pro parte* — *H. rhamnoides* ssp. *rhamnoides*?) not occurring in the post-interglacial sequence at Wilczyn. This indicates that the marine influence around that time may be connected with sea transgression. Such event has been noted in the Schleswig–Holstein during the Elsterian Lateglacial (W. Hinsch, 1993).

Unlike the previous zone plants indicating development of rushes (*Typha latifolia, Parnasia, Equisetum* and *Sparganium*) and plants inhabiting deeper parts of the lake (*Batrachium, Myriophyllum spicatum, Potamogeton* and *Ceratophyllum*) grew in the shallow lake.

A distinctive feature of the *Juniperus-Hippophaë* zone is the statement in the pollen spectrum of secondary pollen grains. They got to the lake with the mineral matter from eroded older rocks (glacial tills especially). The rebedded pollen grains have not been degraded during this transportation. It proves that during this translocation the cyclic drying of sporomorphs didn't happen which are firstly responsible for the destruction. It is also indirectly the evidence of the moist climate conditions dominating throughout the zone.

Pinus-Betula **L PAZ** (3) (WO, K). The zone beginns the interglacial succession. The pollen frequency in the deposits decidedly rises up to 80 000–100 000 pollen grains in 1 cm^3. The zone has been divided into two subzones:

a — *Betula* — with maximum birch representation (up to 75%),

b — *Pinus* — a sudden and pronounced rise in pine to 45% on an average. The melting-out of dead-ice blocks on which it was situated caused the deepening of the lake. It was marked by scarce occurrences of local plants. The calcareous gyttja is in large part without mineral matter (silt and mud) which was characteristic feature of previous zone.

Picea-Alnus **L PAZ** (4) (K, WO, L). The farther rise of temperature caused the expansion (except spruce) of more demanding trees — oak, ash and elm. Because of the diversity of pollen curves 3 subzones have been distinguished:

a — *Larix-Pinus*. A large part of pollen spectra is made of pine and birch, however, *Picea* and *Alnus* percentages rise systematically. The more thermophilous trees occur sparsely.

b — *Alnus-Fraxinus*. It has been distinguished because of the presence of plants attached to the marine climate — ash, elm, ivy and mistletoe.

c — *Larix-Pinus*. In the subzone there is again a small culmination of pine and larch.

Such succession means the change in the characteristics of climate in this subzones:

— in the directions of increasing continentality of climate (the subzone **a** and **c**),

— with distinctly marked marine features (subzone **b**).

In general the subzones of the *Picea-Alnus* are better outlined in Wilczyn–Woskrzenice lake basin than at Lipnica site.

A distinguishing mark is the presence of *Hedera helix*. This species is considered under the marine one. In the Holocene in Poland, the maximum influence of marine conditions and the occurrence of *Hedera* fall on so-called Atlantic period. It relates in part to the extent of the Baltic (the Littorina transgression) which in Mazovian Interglacial reached farther to the south than nowadays due the marine transgression. Then *Alnus-Fraxinus* subzone may be (if any) the sign of the above mentioned processes. The next subzone (**c** — *Larix-Pinus*) marks a short period of increase in continentality that might have caused a some limitations of the Holsteinian Sea

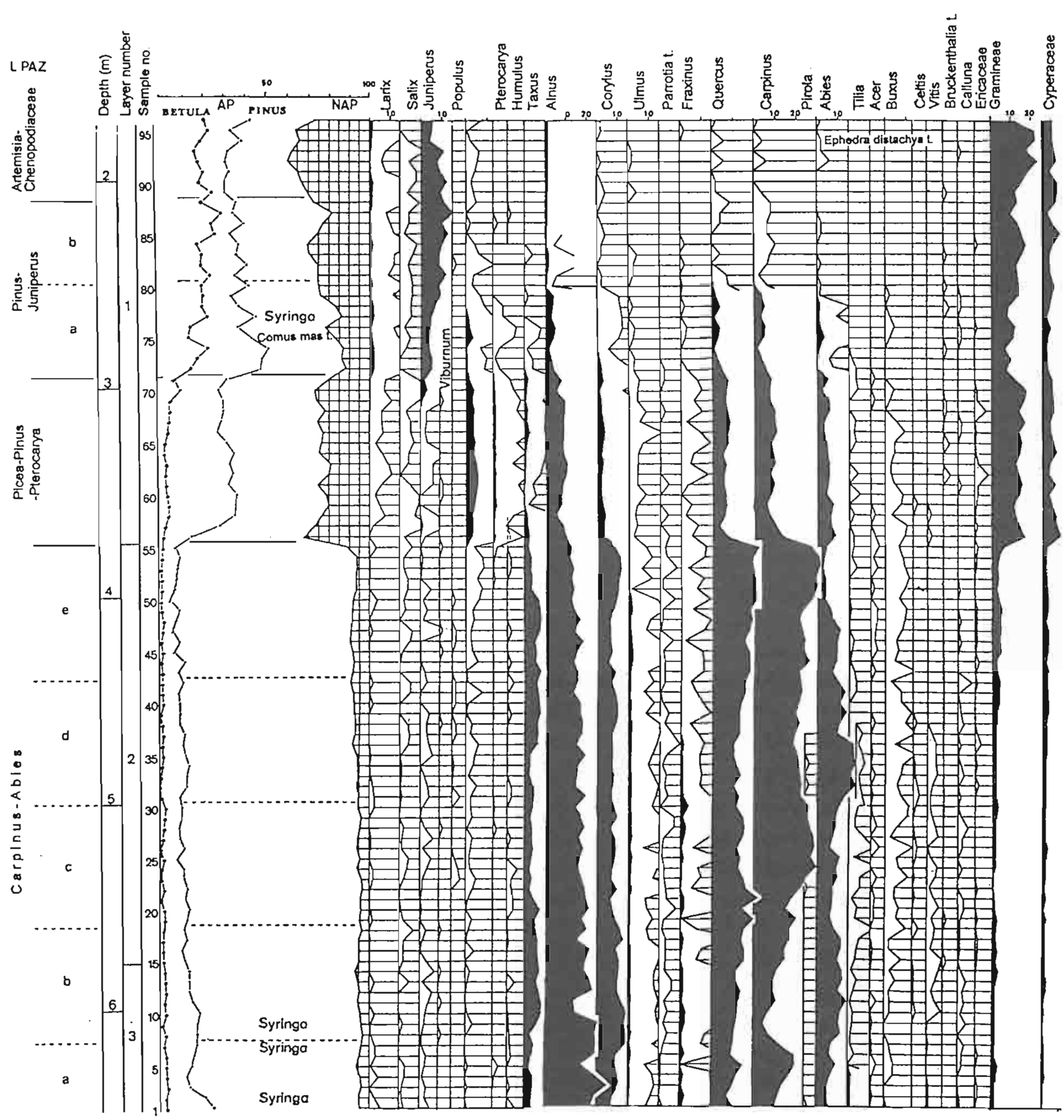


Fig. 4. Pollen diagram from Wilczyn (WL-1)

Leyer number: 1 — lake marl with macroremains and with the increasing content of mud and silt to the top, 2 — lake marl, 3 — sand and mud with organic matter

area. In the pollen diagram at Granzin (K. Erd, 1969) this presumable short lasting transgression episode was not noted probably because of an insufficient sampling of a core. It concerns also the Holsteinian site at Billbrook (G. Linke, R. Hallik, 1993). W. Schwarzenholz (1969) who analyzed diatoms from Granzin found mostly limnic taxons around that time. In *Picea-Alnus* zone the accumulation type is different at analyzed sites. At Wilczyn–Woskrzenice basin the lake marl (WO) and the lake marl with varied admixture of sand (K) without macrofossils were accumulated. At Lipnica the analyzed interval was formed by: a sand with admixture of organic material (5.2–5.6 m), a decomposed peat (5.0–5.2 m) and a bituminous shales (4.55–5.0 m). The above sequence of sediments indicates a constant rise of water level at Lipnica and a good water conditions at Wilczyn–Woskrzenice lake basin.

Taxus **L PAZ (5)** (K, WO, L). The succeeding very strong change of climate features. After a short time (subzone **c** of

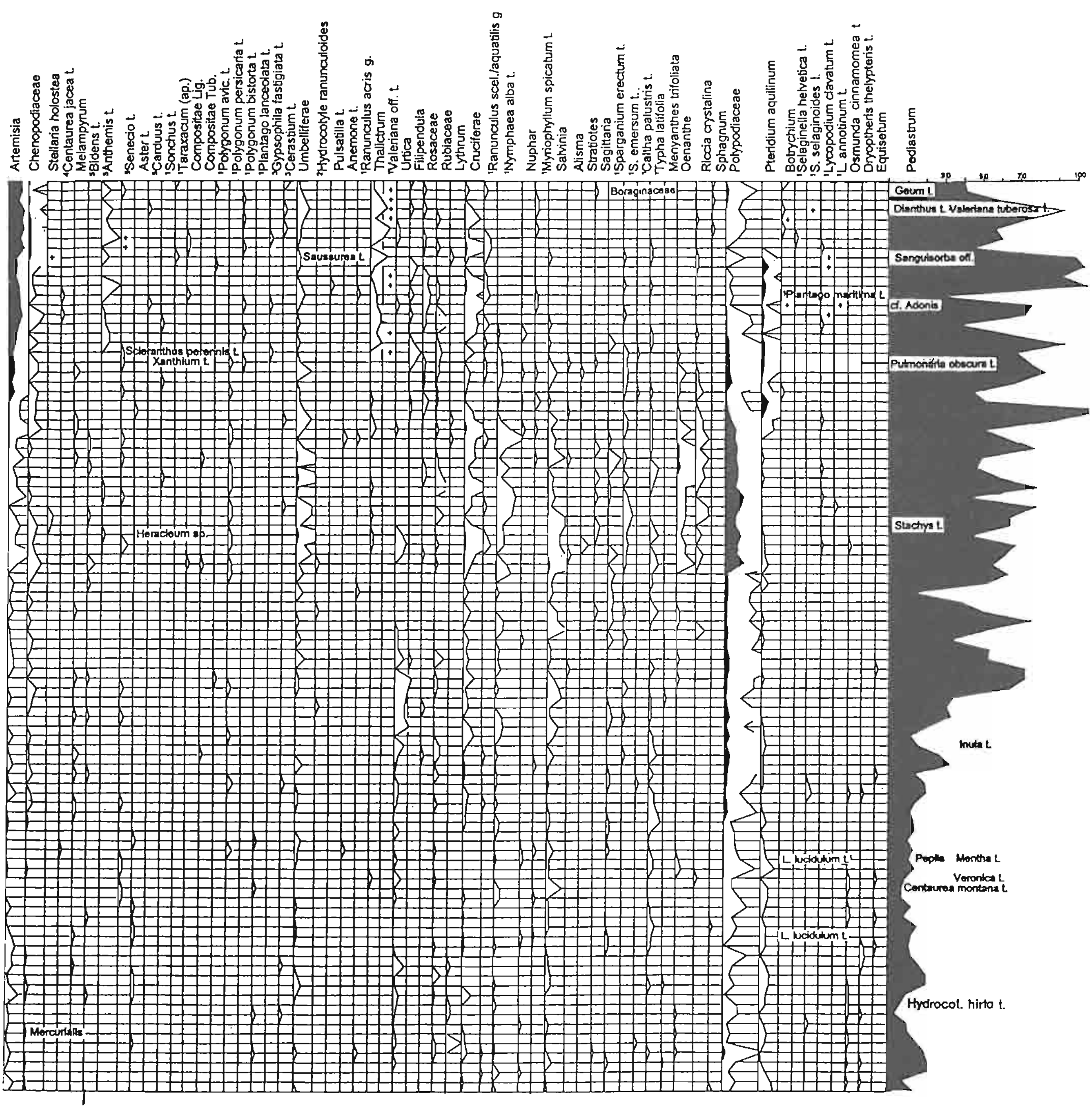


Diagram pyłkowy z Wilczyna (WL-1)

Numery warstw: 1 — kreda jeziorna z makroszczątkami przechodząca ku stropowi w węglanowy osad ilasto-mułkowy, 2 — kreda jeziorna, 3 — piasek z mułkiem i substancją organiczną

Picea-Alnus) intense marine climate conditions occurred. This among others, may be concluded from the maximum percentage of yew and from *Hedera* having the greatest distribution in the pollen diagram. The occurrence of the last taxon in this climate background does not prove the essential temperature rises as it results from the demand of *Hedera* in Poland. Under the strong influence of the marine conditions the high temperature demands of ivy decrease substantially (J. Iversen, 1944). In the *Taxus* zone several pollens of *Ilex* (*I. aquifolium* probably — oz.) have been found, what confirms the above mentioned change of climate. All these lead us to the conclusion that during the *Taxus* period the transgression of the Holsteinian Sea to the south taked place. It is confirmed by geological data. In the Erd's profile (Granzin) the *Taxus* zone is marked by transgressive sediments with marine diatoms (up to 60%). In Billbrook (W. Hinsch, 1993; G. Linke, R. Hallik, 1993) the transgression was noted in so-called *Picea* phase. The small marine ingression was recorded at that time in Lithuania and Latvia (O. Kondratiene, W. Gudelis, 1983).

An occurrence of the bituminous shales at Lipnica and the lake marl without macrofossils in Wilczyn–Woskrzenice basin confirms inferences made about climate conditions for this zone. It is noteworthy that the Lipnica lake at the *Taxus* phase in comparison with the whole profile had the greatest extent. A macroremains and a local pollen rain at analyzed fossil lakes were very scarce so inferences about the former local vegetation cover are difficult. The palynologic evidence (rise of *Sphagnum* in Lipnica core) shows only that around the margins of the site existed a *Sphagnum* — peat bog. The pollen spectra from the last two samples of *Taxus* zone at Lipnica contain less — preserved pollen grains what can prove that at the end of *Taxus* L PAZ the lake disappeared and a destruction of sporomorphs had taken a place.

Pinus-Larix **L PAZ (6)** (L, WO, K). The pollen zone has been distinguished in the three sections. The last two sites, however, have got more reliable pollen record. The *Pinus-Larix* zone marks the relatively high rise in *Pinus* and *Larix* curves and the small increase in NAP.

The zone has been divided into 4 subzones:

a — *Picea-Alnus-Taxus.* Alder and spruce retreated from the forest communities and simultaneously *Carpinus* spread reaching 2%.

b — *Carpinus-Quercus.* The increase of oak and hornbeam pollen marks this subzone, probably due to the small temperature rise. However, there is not any response of other indicator plants.

c — *Pinus-Betula.* The pine-birch dominated association prevailed at this time. A decreasing temperature caused the limitation of deciduous trees.

d — *Carpinus.* A succeeding small rise of the temperature enable a development of plant communities resembling those in *Carpinus-Quercus*. The one exception is the occurrence of *Abies* curve.

The progress of the climate continentality favours a development of pine. A more demanding species from the previous zone preferring the marine climate falls gradually. It leads to an assumption that the Holsteinian Sea area might have decreased due to marine regression. This process is noted in Lithuania and Latvia where the two Holsteinian transgressions are divided by the regression deposits. The pollen profile at Granzin didn't note a regression of the Holsteinian Sea and the marine diatoms appear constantly. However, it seems that this pollen diagram (like at Breetze — L. Benda, K. D. Meyer, 1973; Dockenhuden, Hummelsbüttel — G. Linke, R. Hallik, 1993) has got stratigraphic hiatuses in comparison with other's from adjacent area (H. Müller, 1974) in which *Pinus-Betula* zone was noted like at the Woskrzenice, Kaliłów and Lipnica.

The change of the climate and in consequence the lowering of water level in Wilczyn–Woskrzenice basin has not been reflected in the sediment character and the lowering of water level can be inferred from the palynologic evidence. At Lipnica, however, the pollen zone consists of two peat samples only. The increasing continentality of climate caused a disappearance of the lake and a *Sphagnum* peat was accumulated. A content of macroremains in analyzed two samples is different. The lower one is composed of *Sphagnum* with numerous *Carex, Lycopus, Menyanthes trifoliata, Bidens tripartitus, Heleocharis* sp., *Typha* sp., *Thalictrum* sp., whereas in the pollen spectrum occurred *Rhynchospora, Drosera* and *Utricularia*. The diverse species composition reflects the quickly changing climate conditions in this 10 cm interval or may be the effect of spatial plant distribution.

The upper sample also consists of *Sphagnum* peat with the *Pinus* scales and needles and numerous *Carex* nuts and *Andromeda polifolia*. In this sample also 4 seeds of the extinct species — *Aracites interglacialis* have been found. The palaeobotanic evidence in the upper zone indicates the existence of communities similar to the present-day *Vaccinio uliginosi-Pinetum* ones.

Carpinus-Abies **L PAZ (7)** (WL, WO, L, K). Phase of climatic optimum in which the occurrence of indicator plants (e.g. *Buxus, Vitis, Celtis, Parrotia* t., *Salvinia, Viscum* and thermophilic fir, hornbeam and oak) were most abundant. The pollen zone is marked by heterogeneity and constant fluctuations of *Abies, Carpinus* and *Quercus* curves and for this reason it has been divided into 6 pollen subzones:

a — *Carpinus-Corylus.* Pollen data in this subzone indicate an extension of more demanding (climatically and edaphically) trees such as hornbeam, oak, fir and hazel. It shows also some diversity.

b — *Abies.* A change of climatic conditions especially increasing humidity resulted in rapid expansion of fir and the decline of the *Carpinus* curve. Good moisture conditions favour also yew which curve rises to a certain degree.

c — *Quercus-Carpinus.* From the beginning of the subzone there is a dominance of oak after which culmination of hornbeam is observed. The boundary with next phase is not sharp.

d — *Abies.* Renewed expansion of fir, however, this time with admixture of oak and hornbeam.

e — *Quercus-Carpinus.* Succeeding simultaneous development of oak-hornbeam communities with deepest retreat of fir.

f — *Abies.* Subzone has only been noted in Kaliłów. Small culmination of fir finishing climatic optimum.

Expansion of fir at a considerable distance from its present-day distribution, and its following maxima are a feature of the Mazovian Interglacial. *Abies* belongs to trees with submaritime area of distribution. Occurrence of *Abies* [suboz], *Quercus* [(oz)] and [oz], *Carpinus* [suboz], *Corylus* [(oz)], *Viscum* [(oz)] and *Buxus* [oz] in climatic optimum as well as above mentioned indicator plants harmonize with the greatest transgression of Holsteinian Sea in the whole Mazovian Interglacial. It seems that this process was stronger than in the *Taxus* zone because of a more favourable temperature conditions. It is confirmed by geologic evidences from Lithuania and Latvia and Russia (O. Kondratiene, W. Gudelis, 1983) and England (P. A. Ventris, 1996) where the transgression deposits of this time are often noted. Also in Germany the initial phase of transgression (subzone **a** of *Carpinus-Abies* L PAZ in pollen diagrams from Woskrzenice and Kaliłów) connected with maximum extent of the Holsteinian Sea is noted at several sites (Pritzwalk, Dockenhuden, Granzin, Hummelsbüttel, Breetze). In the first three profiles in the

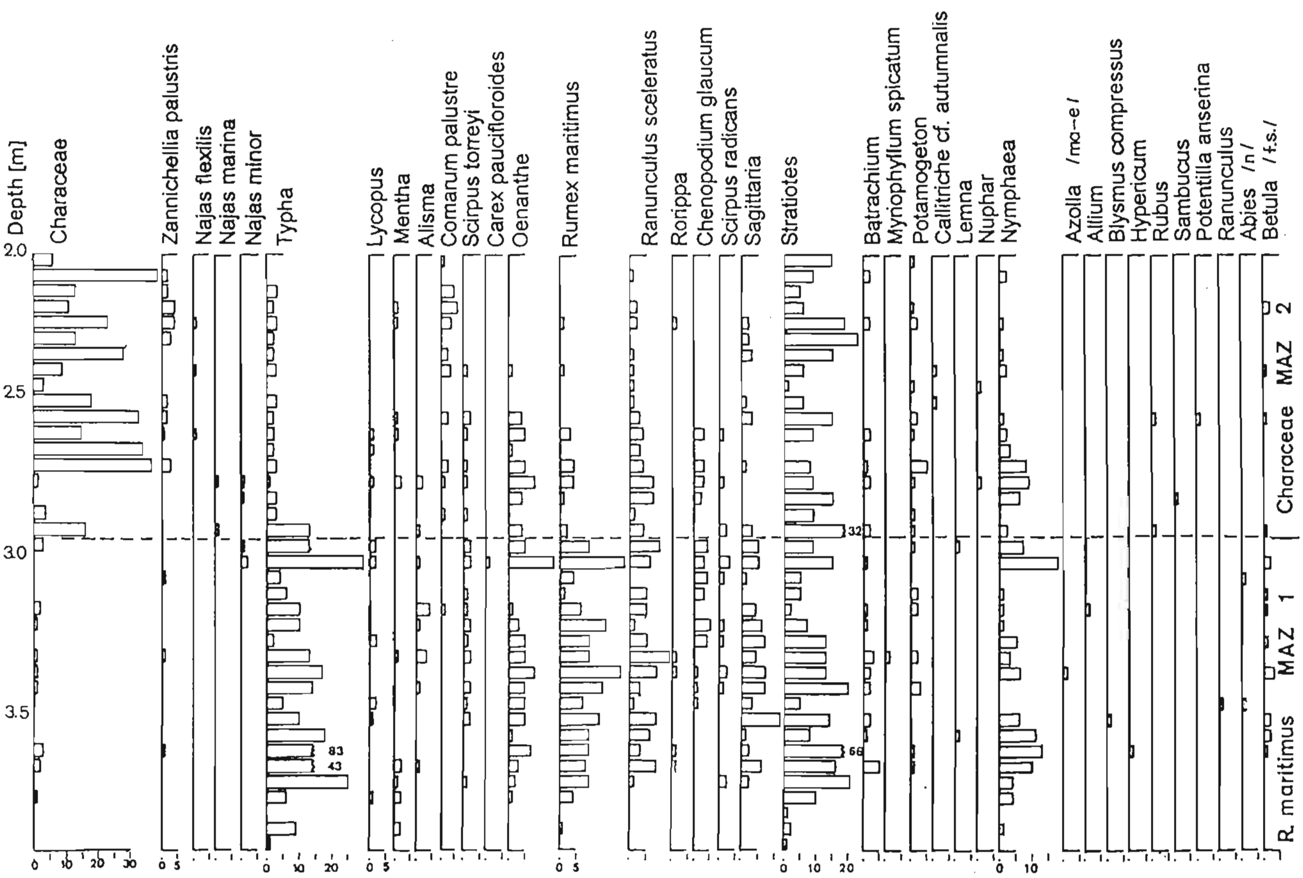


Fig. 5. Macroremain diagram from Wilczyn core (WL-2)
Lithology like in WL-1

Diagram makroszczątkowy profilu Wilczyn (WL-2)
Litologia jak w profilu WL-1

course of *Carpinus-Abies* L PAZ the marine influence decreased and the marine and brackish associations of diatoms and molluscs were replaced by limnic and brackish ones (G. Linke, R. Hallik, 1993; L. Benda, 1993; W. Hinsch, 1993; K. Erd, 1969, 1973).

A degree of climate humidity of *Carpinus-Abies* L PAZ was smaller than in 5 L PAZ (the lack of maritime *Hedera* and the small admixture of *Taxus*). Cyclic moisture change in *Carpinus-Abies* zone favoured fir on the one hand and by smaller precipitation oak and hornbeam on the other. Curve of *Vitis* shows a collapse at the end of subzone **d**, simultaneously with *Ulmus* and partly *Fraxinus* ones. This is probably connected with a reduction of Alno-Padion community. It is consistent with postulated climate for this subzone, especially some decline of precipitation, which fall on decrease in *Abies*. At this time in the lake at Kaliłów and Woskrzenice calcareous gyttja was accumulated. At Wilczyn the profile begins with sands and next as a result of lake transgression gyttja was deposited. In subzone **d**, however, calcareous gyttja changed its character. Towards a top of the zone the sediment gets more unconsolided with increasing in the number of macrofossils. Then in small numbers appear (section WL-2): *Rumex maritimus*, *Oenanthe*, *Callitriche* cf. *autumnalis*, *Mentha*, *Azolla*, *Lythrum*, *Lemna*, *Salvinia*, *Scirpus* cf. *radicans*, *S. torreyi*, *Cyperus fuscus*, *Potamogeton*, *Najas marina*, *Chenopodium glaucum*, *Carex paucifloroides* and *Blysmus compressus*. Some plants indicate existence of areas (broad zone of lake shore) drying in late summer. A confirmation of the lowering of the water level is the rise of *Pediastrum* curve in the Wilczyn section in this subzone. This curve rises from the beginning of *Carpinus-Abies* L PAZ as is shown in pollen diagram. I think it is due to good climatic conditions that caused small rise in the eutrofication level. The lowering of the water level because of decreasing humidity and the consequential increase of eutrophication is perceptible from the end of subzone **d** and lasted to the next pollen zone. The evolution of climate at the end of *Carpinus-Abies* L PAZ particularly the reduction of humidity results *pro parte* from a sea-level change. As it has been discussed above at the end of climatic optimum the influence of the Holsteinian Sea on the vegetation in Poland gradually decreased due to moving of the sea shores towards the north at some places.

At Lipnica the shallow lake existed around that time with the cyclic oscillations of water level leading to the disappearance of water. Thus the macroremains composition is fortuitous and doesn't indicate the domination any of the plant community — *Lemna, Ranunculus sceleratus*, numerous *Carex* nuts, *Potamogeton, Menyanthes trifoliata, Taraxacum, Abies, Taxus, Alnus, Betula* and *Vitis*. The bad state of preservation of pollen grains confirms the ephemeral character of the lake at this site. The *Carpinus-Abies* pollen zone is the last pollen zone found at Lipnica.

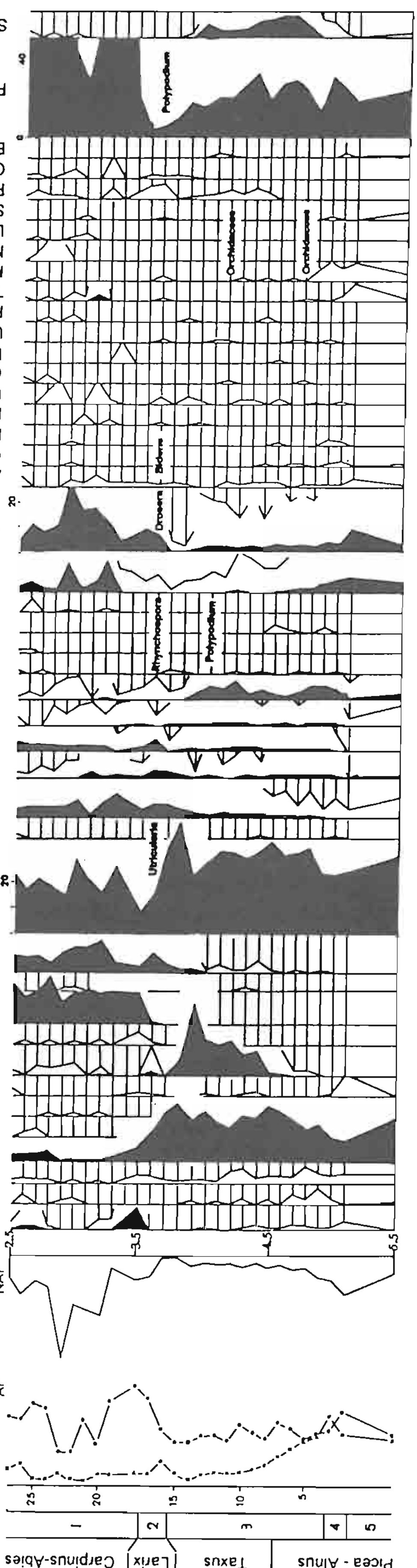
Picea-Pinus-Pterocarya **L PAZ (8)** (WL, K). A sudden collapse of most pollen curves especially at Wilczyn marks the lower boundary and probably the stratigraphical hiatus. The upper boundary runs across further pronounced rise in *Betula, Pinus, Juniperus* and *Larix* with simultaneous drop in *Quercus, Abies* and *Carpinus*. In pollen zone 8 the climate conditions got worse what is expressed in the decline of hornbeam, oak, fir, ash, elm and linden. *Pinus, Larix* and *Bruckenthalia* prove increasing continentality of the climate. Abundant non-arboreal pollens consisting mostly of *Gramineae* and *Cyperaceae* are local in origin. Lake marl occurring in this zone is formed by shallower deposits with snail shells and plant macrofossils in comparison with L PAZ 7. In the lake occur numerous plant species showing various zones:

1. The rushes (*Typha* and *Typha latifolia* — pollen and fruits, *Sparganium erectum* t., *S. emersum/minimum* t. and *Mentha* sp. — seeds).

2. The plants of Lemnetalia and Potamogetonetalia (*Salvinia* — abundant microspore, *Lemna* — fruits and pollen grains, *Nymphaea alba* t. — pollen and seeds, *Azolla* — megaspores, *Potamogeton* — fruits, *Myriophyllum spicatum* — fruits, *Hippuris* — fruits, *Callitriche* cf. *autumnalis* — fruits, *Najas marina* — fruits, *Sagittaria* — fruits, *Batrachium*).

An interesting feature is the appearance of numerous plants (Wilczyn core — Fig. 4) indicating the habitats occurring in the late summer in the emerging lakes or rivers' shores. Such communities occur often on the Vistula in the Mazovia region. This area is occupied by annual plants from *Bidention tripartitae* and *pro parte Nanocyperion flavescentis*. From July to late autumn as the lake (or river) shores slowly dry on the eutrophic and a little salt ground appear noted also in analyzed section *Rumex maritimus, Chenopodium* cf. *glaucum, Ranunculus sceleratus, Cyperus fuscus, Rorippa palustris, Bidens* t., *Polygonum nodosum* (fruits) and *P. persicaria* t. Among plants growing outside these communities *Taraxacum* and *Leontodon autumnalis* (fruits) attracted attention. Occurring in great number at Wilczyn *Scirpus* cf. *radicans* is recorded nowadays in *Nanocyperion. Riccia crystallina* appeared also in the communities above mentioned. This liverwort having big spores (60–70 μ) with characteristic reticuloid pattern grows on wet, light and loamy places all over Europe and in Asia, Africa and North America (I. Rejment-Grochowska, 1966, 1971). *Riccia* is a good indicator plant for its way of reproduction. Spores maturing in thallus don't undergo translocation typical for most plants. *Sporangia* with spores are placed from under of thallus. Maturing in autumn they get directly to the sediment. In pollen zone 8, 9 and 10 the relatively high *Gramineae* and *Cyperaceae* pollen curves attracted the attention. The occurrence of the last-mentioned may explain the appearance such species as *Scirpus torreyi, S.* cf. *radicans* and *Carex* sp. Among *Gramineae* the pollen grains of *Phragmites* haven't been noted. It may be probable that the grass curve was formed by genii related to moist habitat e.g. *Glyceria, Leersia* and occurring in *Bidention tripartitae — Eragrostis pilosa.*

Pinus-Juniperus **L PAZ (9)** (WL, K). Two subzones have been distinguished. Subzone **a** is characterized by quick expansion of birch-pine forests at simultaneous rise of open communities with grasses, motherworts and partly juniper. The main elements of AP from the previous pollen zone (*Carpinus, Alnus, Quercus, Corylus*) still occur. Among indicator plants *Buxus* appear rarely and in the lake *Azolla* and *Salvinia*. In the subzone **b**, forest communities occupied *Pinus* (*P. cembra* t. also) and *Betula* especially at the end of the zone. The thermophilic components of AP from subzone **a** have been eliminated. In both sections numerous NAP pollen types have been noted — *Pulmonaria obscura* t., *Melampyrum, Gypsophila fastigiata* t., *Xanthium, Bupleurum falcatum* t., *Polygonum bistorta*(?), *Knautia*, cf. *Adonis, Plantago maior* t., *P. maritima* t., *Compositae* (several pollen types — *Taraxacum* fruits also), *Thalictrum* (*pro parte T. minus/alpinum*), *Valeriana officinalis, Hyoscyamus* sp. (seeds), *Hypericum* (seeds) and *Filipendula*. I seem that the latest genus which occurrence is limited practically to this and next zone represents *F. hexapetala*. Steppe could move farther to the north than nowadays under more continental climate conditions. The factor that limits this type of vegetation is in most cases the maritime climate. This reason causes reduction of competition ability of steppe plants (H. Walter, H. Straka, 1970). Disappearance of more thermophilic plants and increasing climate continentality (*Pinus cembra, Bruckenthalia, Larix, Juniperus* and steppe plants) resulting from decreasing temperature proves a deterioration of the climate conditions. *Pteridium aquilinum* occurring in 9 PAZ demonstrates that former communities of this zone still represent the forest boreal zone. Nowadays bracken grows as far as 63°N. Considerable content of heliophytes leads us to presume that the communities resemble also forest-steppe ones. In the section Wilczyn (9 PAZ) pollen grains similar to those of *Polygonum bistorta* have been noted. They vary from typical form with such factors as smaller size and greater thickness of exine at the polar area. Similar grains appear in *P. amplexicaule* (P. van Leeuwen *et al.*, 1988) growing nowadays in China and Afganistan. Theirs occurrence seems improbable at Wilczyn. Pollen grains like above mentioned were noted by B. Menke (1976) in Early Quaternary sediments. J. N. Ananova (1958) is of the opinion that tertiary *P. bistorta* pollen resembling those described above occur in small amount in reference slide. It seems, however, unaccountable why at Wilczyn only non-typical pollens are found, just as in some Vistulian pollen data from Podlasie region. It is thought that underdeveloped grains in reference pollen slides result from the use of unmatured anthers. Lake sediments in zone 9 change gradually theirs character. The amount of plant macrofossils and snail shells decline (Fig. 5), especially in subzone **b**. Simultaneously there is a rise in mud content both at Wilczyn and at Kaliłów. Indeed in subzone **a** the plants were noted indicating periodic emergence of lake shores (*Ranunculus sceleratus, Rumex maritimus, Riccia, Chenopodium glaucum*) neverthe-



less they occur rarely. In zone 9 the *Characeae* family appeared in abundance. Nowadays it chiefly inhabits oligothrophic and mezotrophic lakes with limited flow. Its appearance proves rather stable water level just as *Zannichellia palustris, Najas marina, N. minor* and *N. flexilis* (Fig. 5). Shallow places and rushes inhabited *Stratiotes* (fruits), *Callitriche* cf. *autumnalis* (fruits), *Hydrocharis* (seeds), *Sparganium* (fruits), *Mentha* (seeds), *Azolla* (megaspores) and *Lemna* (fruits). The existence of the stable lake means a higher water level than in the previous zone.

Artemisia-Chenopodiaceae **L PAZ (10)** has been noted at Wilczyn only.

The lower zone boundary is marked by:

— a sudden rise in *Chenopodiaceae, Artemisia* and *Gramineae*,

— a decline of the *Pteridium* curve,

— the pollen frequency falls rapidly.

Among arboreal pollen *Larix, Betula* and *Pinus* (also *P. cembra*) are still present. Juniper prevailed in shrub communities. Theirs pollen curves run quietly in comparison with previous zone, but the frequency of pollen grains is very low what proves the post-interglacial floristic relations. The rise of clay and mud content indicates a reduction of the vegetation cover. Non-arboreal plants such as *Artemisia, Gramineae* and *Chenopodiaceae* predominated in former vegetation cover. *Thalictrum minus/alpinum, Rumex acetosa/acetosella, Botrychium, Saussurea* t. (*Serratula* sp.?), *Bupleurum falcatum* t., *Helianthemum, Allium* (seeds), *Leontodon autumnalis* (fruits), *Hyoscyamus* (seeds), *Potentilla anserina* (seeds), *Plantago maritima* t., *Senetio* t., *Sonchus* t., *Geum, Dianthus, Taraxacum* (fruits), *Cruciferae, Cerastium/Stellaria, Ephedra distachya* t. and *Selaginella helvetica* (nowadays occurring in sub-Mediteranean Mesobromnion communities) have a smaller content in the pollen spectra. Most of these plants although having wider habitat tolerance invaded probably into the open plant associations like steppe ones. Pollen grains of *Valeriana tuberosa* noted in zone 10 can indicate steppe conditions. This species occurs in South Europe and reaches northwards 47°30'N in France and 52°N in Russia (Flora Europea). Then it may be assumed that communities in *Artemisia-Chenopodiaceae* zone were something like steppe ones, probably with small patches of trees existing in the areas with high water level (e.g. along rivers).

In this pollen zone plants indicating the marine feature of climate have not been noted.

Fig. 6. Pollen diagram from Lipnica (L-1/94)

Leyer number: 1 — decomposed peat with admixture of mineral matter, 2 — *Sphagnum*-peat, 3 — bituminous shales, 4 — decomposed peat, 5 — sand with admixture of organic matter

Diagram pyłkowy z Lipnicy (L-1/94)

Numer warstwy: 1 — silnie rozłożony torf z domieszką materiału mineralnego, 2 — torf sfagnowy, 3 — łupki bitumiczne, 4 — torf rozłożony, 5 — piasek z domieszką materiału organicznego

In zone 10 and *Characeae* MAZ 2 followed the disappearance of a macroremains of the water plants. *Chara, Zannichellia palustris, Stratiotes* and *Myriophyllum spicatum, Potamogeton, Najas marina, Hippuris, Azolla*(?), *Callitriche* cf. *autumnalis* occur only rarely.

THE CHANGE OF WATER LEVEL AND TROPHIC CONDITIONS

In the bottom levels of the Wilczyn–Woskrzenice lake basin the lack of macroremains permits only the observations of the water level change on the grounds of the evolution of climate, the sediments and the pollen diagrams. The zones *Cyperaceae-Gramineae* and *Juniperus-Hippophaë* represent the shallow lake of glacial origin gradually enlarging in depth due to the rise of temperature and because of the melting-out of dead-ice blocks. Loamy silts in the lake were accumulated. Next zones are formed differently in analyzed sections. At Woskrzenice from the beginning of interglacial to the end of climatic optimum a calcareous gyttja settled what indicates a higher water level. The local plants abundantly present (pollen) in the first two zones declined. Then it is hard to say how the water level changed. Pollen diagrams from the Wilczyn and Kaliłów sections provide more information. At the last-mentioned some fall of the water level is suggested for *Pinus-Betula, Picea-Alnus* (partly) and *Pinus-Larix* zones when in Kaliłów section gyttja with the admixture of sand was deposited. The rise of water level followed in *Taxus* L PAZ. It must be remembered that *Taxus* zone is characterized by a marine climate what would likely have positive bearing on the water conditions. As has been noted above it is associated with the Holsteinian Sea ingression. Next after a short period of lowering of water level (*Pinus-Larix* L PAZ) in both profiles in *Carpinus-Abies* L PAZ was also accumulated calcareous gyttja what proves good water conditions. The sediments of the hornbeam-fir zone have the greatest transgressive distribution in the whole interglacial. It means that the lake occupied the largest area at this time. The first signs of the water level lowering in the climatic optimum are observed at the end of the subzone **d** at Wilczyn. This lowering is characterized by the cyclic occurrence of plants from *Bidention tripartitae* and lasts to the end of 8 L PAZ. Stratigraphic hiatuses are unquestionable at that time. Some renewed rise of water level followed in 9 and 10 L PAZ where the genera indicating a higher water level and sensitive to of water such as *Zannichellia* and *Najas* appeared.

The changes of water level at Lipnica were more distinct and sharply limited in deposits in comparison with those of the Wilczyn–Woskrzenice Basin. Since the *Picea-Alnus* L PAZ the rise of water level continued with a culmination in *Taxus* zone when bituminous shales were accumulated. In *Pinus-Larix* L PAZ that is poorly represented in core the lake disappeared and the peat-bog developed. The palynologic and macroremains evidence in *Carpinus-Abies* zone is indicative of existence of shallow lake with cyclic disappearance of water level. The above course of water level change is coincident with those of Wilczyn–Woskrzenice Basin except for *Carpinus-Abies* L PAZ.

For the lack of analyses of a more sensitive eutrophy indicator (e.g. *Cladocera, Diatomae*) conclusions were drawn from the fluctuations of *Pediastrum* and *Tetraedron* curves as well the observations of eutrophy demands of selected taxa. In the Wilczyn–Woskrzenice lake basin there were only noted *Pediastrum kawraiskyi, Sparganium affine, Utricularia* sp. and *Najas* sp. from the taxa having a predilection for oligo- and mezotrophic conditions. This last genus, however, is also noted nowadays in the eutrophic lakes. We think as it has been discussed above the worse trophic conditions occur in tundra period, in *Pinus-Larix* L PAZ and at the end and after the interglacial (1, 2, 9**b**, 10 L PAZ). It is based on the low curve of alga, a low production of the organic matter and the appearance of indicator plants. The rise of eutrophy (in this case marked by the increase of *Pediastrum* and *Tetraedron* curves) due to good climate conditions occurs in *Carpinus-Abies* L PAZ. The rise of eutrophy due to the lowering of water level begins at the end of climatic optimum and lasts in 8 and 9**a** L PAZ. In this period, apart from the luxuriant development of phytoplankton the intense growth of local vegetation followed.

FINAL REMARKS

The two analyzed lake basins, Wilczyn–Woskrzenice and Lipnica, undeniably differ in their origin as well as in their interglacial and post-interglacial development. The origin of the first basin has a melt-out — neotectonic character. Recent drillings carried out in the area have shown that the analyzed ancient lake contains a package of sediments reaching the depth of 37 m and extending for about 30 km in a narrow parallel belt (1–2 km wide) through Wilczyn, Kaliłów, Woskrzenice, Lachówka to Małaszewicze. After a gradual deepening in the beginning of the interglacial the sediments do not reveal any rapid changes in the water level, except for the period after the climatic optimum.

A different type of lake basin has been recognized within the glacial plateau in Lipnica. The water regime of the lake was dependent mainly on climatic conditions. In general the most convenient period for the existence of a stabile basin with a higher water level was the yew period (*Taxus* zone) with marine features of the climate (large precipitation). The other zones record facts pointing to the existence of a temporary basin (presence of stratigraphic hiatuses) or peat-bog communities.

The course of the climate change and plant succession in the Podlasie region around the Mazovian Interglacial may be correlated with the Holsteinian sea-level change. The first sign of this process is observed in *Juniperus-Hippophaë* L PAZ what can be connected with the Elsterian Lateglacial transgression. The rise of temperature and the slight lowered area without the heavy ice-cover enable the short invasion of waters. The next transgresion taked place probably in the subzone **b** *Picea-Alnus* L PAZ or surely in *Taxus* L PAZ. The *Pinus-Larix* L PAZ marks the sea regression followed by the greatest transgression of the Holsteinian Sea in *Carpinus-Abies* L PAZ due to the best temperature conditions in comparison with the whole interglacial. In a further course of interglacial and in the post-interglacial sequence mark the influences of continental climate without the marine plant indicators. This is connected with the regression of Holsteinian Sea.

The above presented observations concerning the pre- and post-interglacial evolution of climate and sea-level change can be apply in general outline to another stratigraphic units. The „open'' plant associations after the glaciation and before the interglacial were abundant in marine species. The first treeless post-interglacial sequences resembled the continental „steppe'' ones.

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SYTUACJA GEOLOGICZNO-FLORYSTYCZNA STANOWISKA INTERGLACJAŁU MAZOWIECKIEGO W WILCZYNIE I LIPNICY NA POŁUDNIOWYM PODLASIU (WSCHODNIA POLSKA) ORAZ ICH NAWIĄZANIA PALEOGEOGRAFICZNE

Streszczenie

W 1990 r. w trakcie prac geologicznych w rejonie Białej Podlaskiej L. Lindner, J. Semil i S. Szymański stwierdzili interglacjalne osady jeziorne w Wilczynie (fig. 1 i 2). Kompleksowe badania prowadzone przez zespół badawczy pod kierunkiem L. Lindnera pozwoliły na udokumentowanie tych osadów w kopalnym zbiorniku jeziornym rozciągającym się wąskim, kilkukilometrowym pasem na długości kilkudziesięciu kilometrów od Wilczyna do Małaszewicz i spoczywającego na osadach zlodowacenia sanu 2. Wymienione osady jeziorne są tu reprezentowane przez miąższe warstwy kredy jeziornej i gytii (do 35 m) i przykryte młodszymi osadami czwartorzędowymi (piaski, mułki i namuły torfowe), które były akumulowane od interglacjału eemskiego do dziś.

Na zboczach zbiornika stwierdzono szczątkowo zachowane osady kemowe z okresu zlodowacenia odry (warty) datowane na ok. 250 ka.

Osady zlodowacenia sanu 2, wraz z utworami plażowymi wymienionego zbiornika jeziornego, przebadano także w odkrywce w Grabanowie. Glina zwałowa tego zlodowacenia wraz z jej rezyduami przykryta jest tam przez silnie węglanowe mułki ilaste ze ślimakami, datowanymi metodą termoluminescencyjną na 317±47,6 ka. Osady te są zdeformowane glacitektonicznie i przykryte młodszą gliną zwałową (odry lub warty) z porwakami osadów jeziornych.

Analiza pyłkowa profilu z Wilczyna na tle wcześniej analizowanych rdzeni (Woskrzenice, Kaliłów) pozwala na umiejscowienie inicjalnego stadium wymienionego jeziora w późnym glacjale zlodowacenia sanu 2. Akumulacja jeziorna trwała w nim przez cały interglacjał mazowiecki do pointerglacjalnego okresu stepowego, poprzedzającego zlodowacenie odry (warty). Przez długi interglacjał jezioro cechowało się dużą głębokością.

Zupełnie odmienny typ rozwoju reprezentuje odkryty w 1991 r. przez J. Nitychoruka zbiornik jeziorny w niedalekiej Lipnicy (fig. 1 i 3). Stanowi on obecnie niewielkie, bagienne obniżenie w wysoczyźnie wypełnione torfami i łupkami bitumicznymi. Przykryte są one ok. 2-metrową warstwą osadów mineralnych, związanych ze zlodowaceniem odry (warty?) i z warunkami ekstraglacjalnymi zlodowacenia wisły. Możliwość trwania zbiornika jeziornego w Lipnicy w interglacjale mazowieckim nie wiąże się z procesami wytopiskowymi (Wilczyn), lecz przede wszystkim z korzystnymi warunkami klimatycznymi (oceanizacja). Analiza pyłkowa dowiodła, że zbiornik w poziomie *Picea-Alnus* i *Taxus*, gdy trwała akumulacja łupków, miał największą głębokość, co dowodzi postępującej oceanizacji. Potwierdza to przypuszczenia wysnute z analizy palinologicznej rdzeni z Wilczyna, Kaliłowa i Woskrzenic, że okresem o korzystnych stosunkach wodnych jest poziom cisowy. Profil w Lipnicy charakteryzuje się licznymi lukami stratygraficznymi, co się wiąże z jego genezą (np. brak poziomu *Pinus-Larix*). Ostatnim okresem tam zarejestrowanym jest poziom *Carpinus-Abies*, zapisany w facjach torfowych.

Analiza obydwu zbiorników jeziornych pozwoliła na wnioski natury ogólniejszej. Wiadomo bowiem, że przedinterglacjalne i interglacjalne ocieplenie klimatu spowodowały transgresje morskie.

Z analizy diagramów pyłkowych wynika, że — być może — pierwszy ślad tych transgresji można korelować z poziomem *Juniperus-Hippophaë*, w którym jest obserwowany udział gatunków przywiązanych do klimatu oceanicznego. Transgresja ta notowana jest w północnych Niemczech. Kolejna, niewielka ingresja (udokumentowana geologicznie w obszarach przymorskich) pojawia się w okresie cisowym (Granzin, Billbrook, obszar Litwy, Rosji i Łotwy). Pierwsze jej ślady są już widoczne w jednym z podpoziomów fazy *Picea-Alnus*. Następnie po regresji w poziomie *Pinus-Larix* dochodzi do największej transgresji w interglacjale holsztyńskim (mazowieckim), w okresie jodłowo-grabowym (Pritzwalk, Dockenhuden, Hummelsbüttel i in.). Spowodowane to było najkorzystniejszymi warunkami temperaturowymi w całej sekwencji interglacjalnej (optimum klimatyczne).