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New data on interglacial sediments at Zakrucze near Małogoszcz, the Holy Cross Region

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Recent palynological examination of lake sediments from Zakrucze near Małogoszcz indicates possible correlation to the Mazovian Interglacial. These sediments fill a fluvial-karstic depression, incised in tills of the South-Polish Glaciations (Sanian 1 and Sanian 2). Lake sediments are located in extraglacial zone of the Middle-Polish Glaciations (Odranian and Wartanian), and are mantled with glaciofluvial series of the first of these glaciations and with younger fluvial-slope deposits.

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INTRODUCTION

During studies of the Pleistocene sequence in the western Holy Cross Mts. at the beginning of the seventies, lake sediments were found in numerous boreholes in the Zakrucze area near Małogoszcz under a sandy cover, 1.5–5 m thick (Fig. 1). Thanks to R. Jachimowicz (Office for Water Administration Projects, Warsaw), a new borehole to 7.2 m depth could be done at the most promising locality in 1973, to reach the very bottom of the series. 21 samples were collected from the core and a preliminary pollen analysis suggested the younger Eemian age of the series (L. Lindner, M. Ziembińska-Tworzydło, 1974). A statement in a final part of the paper of that time says that the diagram from Zakrucze is based on single and rarely collected samples, and therefore calls for a more detailed examination of sediments from the borehole that cuts the whole organic series (L. Lindner, M. Ziembińska-Tworzydło, 1974). Thus, in 1976 a new borehole was done with the corer of Dr. K. Więckowski and with his non-profitable participation. However, this time the lake sediments could not be cut through either due to technical reasons but the core reached already a depth of 11.2 m (ZA-76 at Figs. 1–3). The collected 219 samples at every 5 cm were subjected to a new pollen analysis by A. Rzętkowska-Orowiecka and are presented in this paper. They do not support the previous age determination of the sediments and refer them to the Mazovian Interglacial.

GEOLOGIC SETTING

The analyzed lake sediments are located in the southeastern part of the village Zakrucze, within a small depression to the east of a railway side-track to the cement plant at Małogoszcz. The depression was devoid of drainage in the seventies but later a drainage pattern developed. It occurred 2–3 m beneath a surface of alluvial fans, spreading at outlets of small incisions at the northeastern slope of the Przedbórz–Małogoszcz Range. At present, the depression is strongly transformed by sediment traps, constructed for the mentioned cement plant.

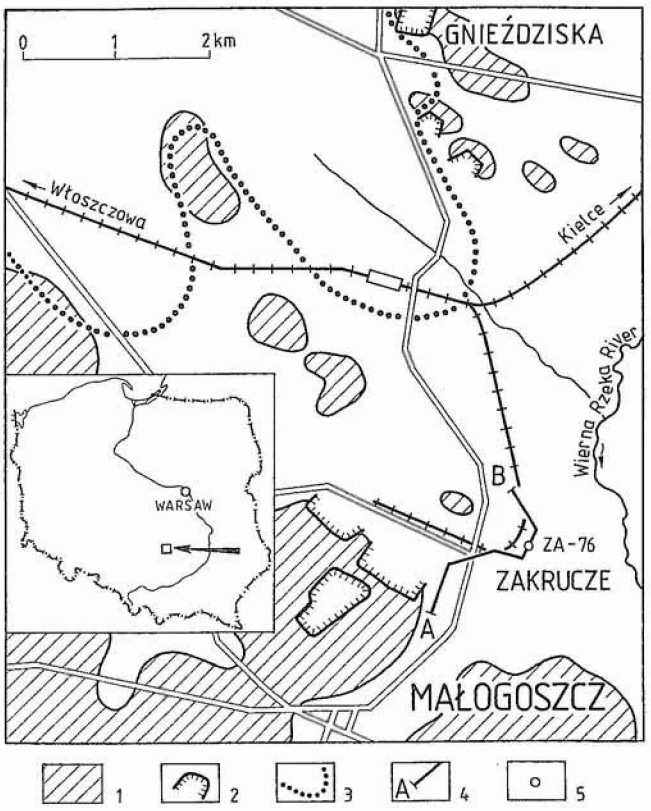

Fig. 1. Location-geological sketch of the Zakrucze area near Małogoszcz
1 — pre-Quaternary bedrock and its weathering waste after M. Hakenberg (1973) and P. Filonowicz, L. Lindner (1986); 2 — quarries; 3 — maximum (southern) ice-sheet extent during the Odranian Glaciation after L. Lindner (1977*a*); 4 — geologic section (*cf.* Fig. 2); 5 — location section ZA-76

Szkic sytuacyjno-geologiczny okolic Zakrucza koło Małogoszcza
1 — skały przedczwartorzędowe oraz ich pokrywy zwietrzelinowe według M. Hakenberga (1973) oraz P. Filonowicza, L. Lindnera (1986); 2 — kamieniołomy; 3 — maksymalny (południowy) zasięg lądolodu w czasie zlodowacenia odry według L. Lindnera (1977*a*); 4 — linia przekroju geologicznego (por. fig. 2); 5 — lokalizacja profilu ZA-76

Detailed geologic studies in this area (M. Hakenberg, 1973, 1974; P. Filonowicz, L. Lindner, 1986, 1987; L. Lindner, 1976, 1977*a, b*, 1980, 1995*a*), numerous boreholes and geophysical data in this part of the Wierna River drainage basin, supplemented with new palynological examination of the section Zakrucze, introduce new data to a stratigraphy of the Quaternary sequence in the western Holy Cross Region. They are particularly important as pioneer sheets of the *Detailed Geological Map of the Holy Cross Region*, in scale of 1 : 25 000, have been started in this very area recently.

Collected data suggest therefore, that the Quaternary bedrock between Małogoszcz and Zakrucze is composed of the Upper Jurassic limestones (layer 1 at Fig. 2). The Quaternary sequence starts with a clayey-debris weathering waste of these limestones which have moved downslope (layer 2 at Fig. 2), and with interfingering ice-dam lacustrine silts (layer 3 at Fig. 2). These sediments as well as the overlying till (layer 4 at Fig. 2), even over 20 m thick, should be connected with the Sanian 1 Glaciation. The till was interpreted previously as an evidence of the oldest ice-sheet advance during the South-Polish Glaciation (M. Hakenberg, 1973, 1974; P. Filonowicz, L. Lindner, 1986, 1987) or the Cracow Glaciation (L. Lindner, M. Ziembińska-Tworzydło, 1974; L. Lindner, 1977*a, b*).

The overlying vari-grained sand (layer 5 at Fig. 2), about 5 m thick, seems to represent probably a fluvial series of the Ferdynandowian Interglacial or a glaciofluvial deposition, connected with ice-sheet advance during the following glaciation. The latter is well indicated by the overlying till (layer 6 at Fig. 2). Basing on the present stratigraphical schemes of the Quaternary of Poland, it should represent the Sanian 2 = Wilgian Glaciation (*cf.* M. D. Baraniecka, 1990; L. Lindner *et al.*, 1995).

These Quaternary sediments are partly or even completely eroded. At Zakrucze, this erosion and the younger fluvial deposition are indicated by a gravel (layer 7 at Fig. 2) and an overlying sand (layer 8 at Fig. 2). These sediments fill an incision which is a fragment of a valley system of the pre-Wierna River. There is a buried depression at their surface, filled with lake sediments that have been previously connected with the Eemian Interglacial (L. Lindner, M. Ziembińska-Tworzydło, 1974). Palaeogeomorphology of these lake sediments corresponds to a certain degree with location of a drainage-less depression at a land surface. This fact, as well as similar depressions at land surface to the northeast, at prolongation of a tectonic dislocation in the Upper Jurassic limestones (*cf.* M. Hakenberg, 1973, 1974), seems to support a previous conclusion that the depression is a good example of a covered karst. The later concentrated along tectonic dislocations in limestones and have been reflected, not only since the Eemian Interglacial, as considered previously (*cf.* L. Lindner, M. Ziembińska-Tworzydło, 1974), but already just before the Mazovian Interglacial — as suggested in the present paper.

Lake sediments of the Mazovian Interglacial near Zakrucze that fill an older karst depression, are represented by clayey silt with pieces (inserts?) of bituminous shales (layer 9 at Fig. 2), peat with pieces of wood in the lower part (layer 10 at Fig. 2) as well as by silt, clayey at the bottom (layer 11 at Fig. 2) and even spreading outside the limits of a buried valley-like depression.

These sediments are overlain with sand and gravel (layer 12 at Fig. 2), being remains of glaciofluvial deposition (outwash terrace?) in front of the older (Odranian) ice-sheet of the Middle-Polish Glaciations. This ice-sheet advanced as far as 2–4 km to the northwest of Zakrucze (Fig. 1). It deposited there a separate (third in this region) till and fragments of kame terraces (*cf.* A. Żołnierz, 1971; L. Lindner, 1977*a, b*) on the slopes, composed of the Upper Jurassic limestones. These glaciofluvial sediments were, during deglaciation and the Lubawian Interglacial, cut by relatively narrow valleys, running down the northeastern slopes of the Przedbórz–Małogoszcz Range and later filled with sand and fine gravel (layer 13 at Fig. 2). During the Late Pleistocene i.e. from the Wartanian to the Vistulian Glaciation, most of these incisions were completely filled with sand, silt inserts and limestone debris (layer 14 at Fig. 2). These sediments outcrop at the two-step supra-inundation terrace (2nd terrace), which is an equivalent of a similar valley series in the drainage basin of the middle Nida River (*cf.* M. Hakenberg, L. Lindner, 1971). They inter-

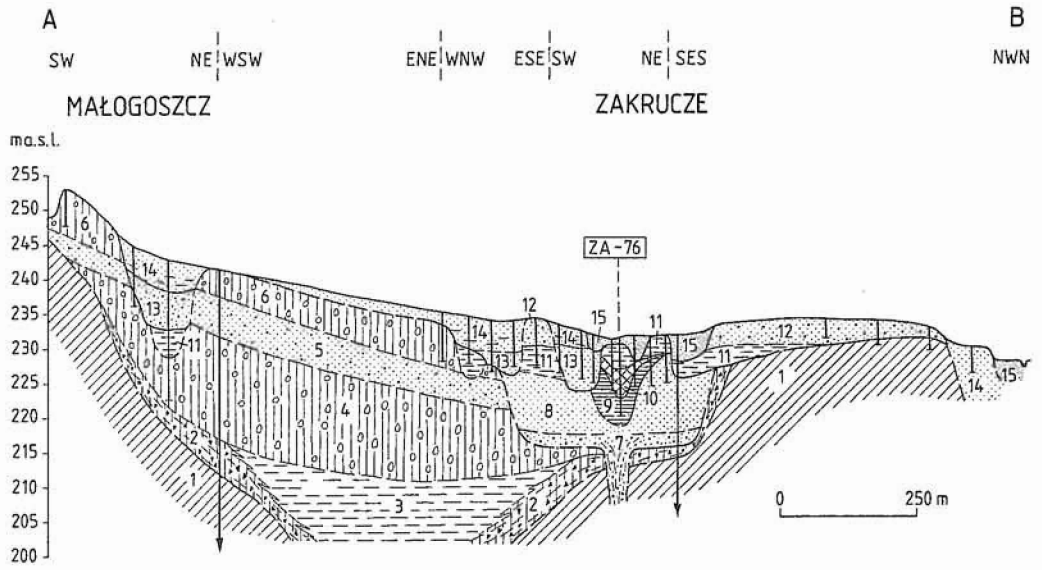

Fig. 2. Geologic section A–B across Quaternary sediments in the Zakrucze area after L. Lindner and M. Ziembińska-Tworzydło (1974), slightly modified
1 — Upper Jurassic limestones; **Sanian 1 Glaciation**: 2 — clayey-debris weathering waste of limestones, 3 — grey-yellow ice-dam silt, 4 — sandy, grey- and yellow-brown till; **Ferdynandowian? Interglacial**: 5 — vari-grained, yellow-brown sand with gravel of local and Scandinavian rocks, locally clayey (fluvial?); **Sanian 2 Glaciation**: 6 — sandy, brown-grey till, 7 — gravel of local and Scandinavian rocks (fluvial?), deformed by karst phenomena, 8 — medium- and coarse-grained (fluvial?) sand, deformed by karst phenomena; **Mazovian Interglacial**: 9 — clayey, black lake silt, with pieces of bituminous shale in the bottom, 10 — peat, with pieces of wood in the bottom, above slightly sandy, passing into a peaty mud in the top, 11 — grey-green and grey-yellow łake silt, clayey in the bottom; **Odranian Glaciation**: 12 — vari- and coarse-grained, yellow-grey glaciofluvial sand with gravel of local and Scandinavian rocks; **Lubawian? Interglacial**: 13 — vari-grained, yellow-brown fluvial? sand with fine gravel of local and Scandinavian rocks; **Wartanian? Glaciation–Vistulian Glaciation**: 14 — fine- and medium-grained grey-yellow sand with inserts of silt and limestone debris (fluvial and of alluvial fans); **Holocene**: 15 — fine- to coarse-grained sand with admixture of gravel (fluvial and deluvial)

Przekrój geologiczny A–B przez osady czwartorzędowe w rejonie Zakrucza według L. Lindnera i M. Ziembińskiej-Tworzydło (1974), nieco zmieniony
1 — wapienie górnojurajskie; **zlodowacenie sanu 1**: 2 — gliniasto-gruzowa zwietrzelina wapieni, 3 — mułek szarożółty (zastoiskowy), 4 — glina zwałowa, piaszczysta, szaro- i żółtobrązowa; **interglacjał ferdynandowski?**: 5 — piasek różnoziarnisty, żółtobrązowy, ze żwirem skał lokalnych i skandynawskich, miejscami gliniasty (rzeczny?); **zlodowacenie sanu 2**: 6 — glina zwałowa, piaszczysta, brązowoszara, 7 — żwir z materiału lokalnego i skandynawskiego (rzeczny?), zaburzony w wyniku zjawisk krasowych, 8 — piasek średnio- i gruboziarnisty (rzeczny?) zaburzony w wyniku zjawisk krasowych; **interglacjał mazowiecki**: 9 — mułek ilasty, czarny, w spągu z okruchami łupku bitumicznego (jeziorny), 10 — torf, w spągu z kawałkami drewna, wyżej nieco piaszczysty, w stropie przechodzący w namuł torfowy, 11 — mułek szarozielony i szarożółty, w spągu ilasty (jeziorny); **zlodowacenie odry**: 12 — piasek różno- i gruboziarnisty, żółtoszary, ze żwirem skał lokalnych i skandynawskich (glacifluwialny); **interglacjał lubawski?**: 13 — piasek różnoziarnisty, żółtobrązowy, z drobnym żwirkiem skał lokalnych i skandynawskich (rzeczny?); **zlodowacenie warty?–zlodowacenie wisły**: 14 — piasek drobno- i średnioziarnisty, szarożółty, z wkładkami mułku oraz gruzu wapiennego (rzeczny i stożków napływowych); **holocen**: 15 — piasek od drobno- do gruboziarnistego, z domieszką żwiru (rzeczny i deluwialny)

finger in many places with alluvial fans, deposited in a periglacial environment during these glaciations (L. Lindner, 1976, 1995*b*). Sand with admixture of gravel (layer 15 at Fig. 2) is the youngest Quaternary deluvial and fluvial deposit, the latter being the youngest, Holocene alluvial series (of the 1st terrace) in the drainage basin of the middle Nida River (*cf.* M. Hakenberg, L. Lindner, 1973).

RESULTS OF POLLEN ANALYSIS

Pollen analysis of 30 silt and peat samples from the section Zakrucze ZA-76 (depth 11.2–1.5 m) is presented in this paper. Basing on individual pollen spectra, a percentage diagram (Fig. 3) was subdivided into 9 local pollen zones, correlated to 4 periods of vegetation development during the Mazovian Interglacial *sensu* W. Szafer (1953).

PERIOD I

Local pollen **zone Z-1** (*Pinus-Betula*) was distinguished in a bottom part of the section (samples 219–210). It indicates a mixed forest predominated by birch, with considerable participation of spruce and increasing role of alder. In a tree assemblage there is admixture of *Fraxinus, Ulmus, Tilia, Quercus* and *Corylus*. Among bushes, *Juniperus* and *Viburnum* occur. *Polypodiaceae* and *Humulus* are numerous. There is relatively a high diversity of herbs in this zone, however, only the curve of *Gramineae* reaches several percentage in the diagram. Total content of herbs in the spectra of samples does not exceed 9% what indicates occurrence of compact forest communities in that time.

Local pollen **zone Z-2** (*Picea-Alnus*) reflects abundant occurrence of alder (samples 210–201). The curve of this species reaches a maximum value of 43% in this part of the diagram. Tree communities contain also *Picea, Pinus, Betula, Fraxinus, Quercus* and *Corylus. Carpinus* and *Taxus* appear

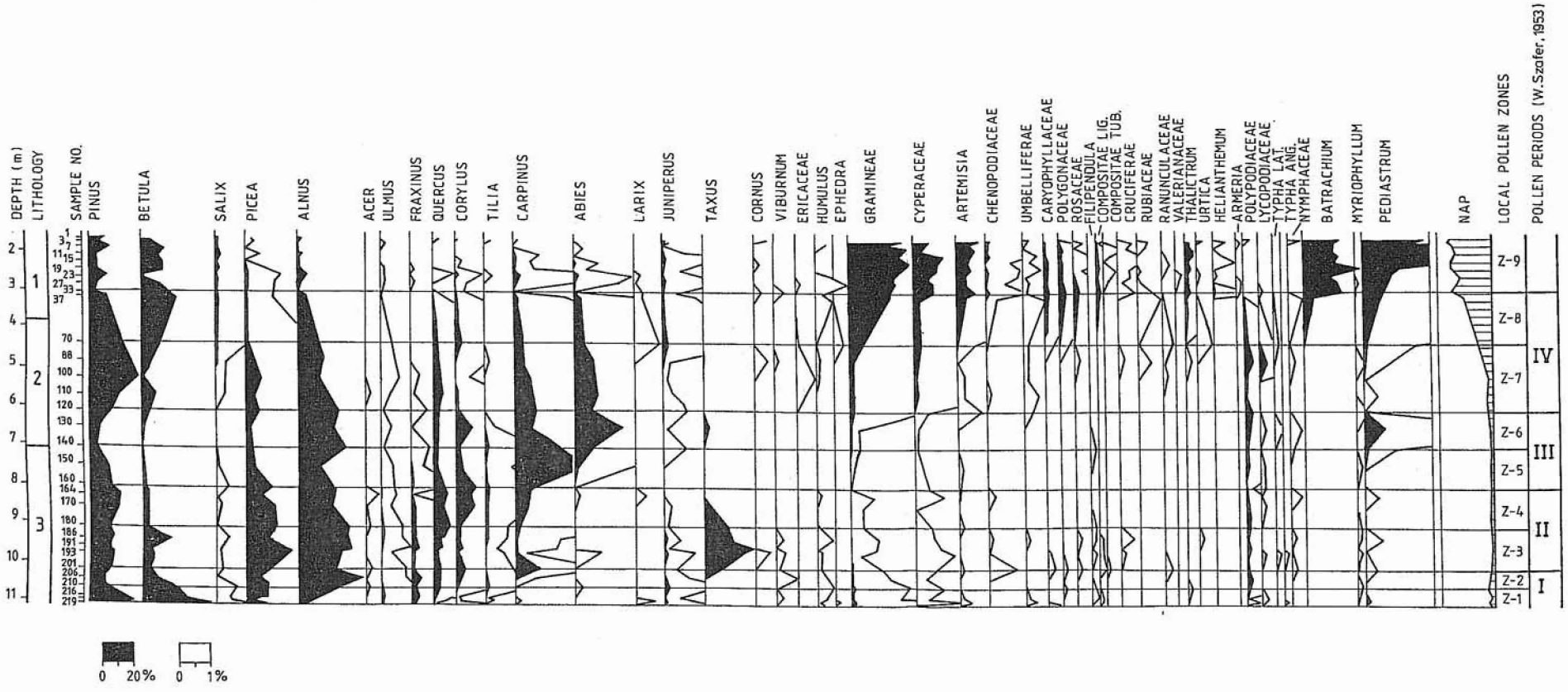

Fig. 3. Pollen diagram of sediments of the Mazovian Interglacial from the section ZA-76 at Zakrucze
1 — grey-green and grey-yellow lake silt, clayey in the bottom; 2 — peat, with pieces of wood in the bottom, slightly sandy above and passing into a peaty mud in the top; 3 — clayey, black lake silt, with pieces of bituminous shale in the bottom

Diagram pyłkowy osadów interglacjału mazowieckiego z profilu ZA-76 w Zakruczu
1 — mułek szarozielony i szarożółty, w spągu ilasty (jeziorny); 2 — torf, w spągu z kawałkami drewna, wyżej nieco piaszczysty, w stropie przechodzący w namuł torfowy; 3 — mułek ilasty czarny, w spągu z okruchami łupku bitumicznego (jeziorny)

for the first time. There are relatively abundant *Polypodiaceae, Juniperus, Viburnum, Humulus* and *Gramineae*, similarly as in the previous zone.

PERIOD II

Local pollen **zone Z-3** (*Picea-Taxus*). The curve of spruce, as well as of yew reach their maxima in this part of the diagram (samples 201–180), 30 and 34%, respectively. In spectra of these samples there are more *Pinus* and *Betula* than previously. *Fraxinus, Quercus, Corylus* and *Carpinus* are the admixture. There are also *Juniperus* and *Hedera.*

Local pollen **zone Z-4** (*Alnus-Quercus-Corylus*). The curves of oak and hazel reach here (samples 180–160) their maximum values in the diagram, i.e. 12.2 and 13.8%, respectively. Large role in plant communities is also played by *Picea* and *Pinus*. Content of *Taxus* in this zone is gradually decreasing, but the one of *Carpinus* increases. Picture of forest communities is supplemented by *Fraxinus, Ulmus, Tilia* and *Polypodiaceae*. Curves of herbs disappear. There are occasional pollen grains of highly thermophilous taxa as *Linum* and *Viscum.*

PERIOD III

Local pollen **zone Z-5** (*Carpinus-Alnus*) is predominated by a deciduous forest which is firstly composed of *Carpinus* (samples 160–140). Curve of this species reaches its maximum, being as high as 48.5%. There are abundant *Alnus, Corylus, Quercus, Tilia* and *Fraxinus.* Content of *Pinus* and *Picea* gradually decreases and *Abies* appears. Curve of herbs reaches minimum values in this zone.

Local pollen **zone Z-6** (*Abies-Carpinus*). The curve of *Abies* reaches its maximum (31.5%) in this zone (samples 140–120). A forest formed by fir with hornbeam is enriched in hazel, oak, alder and linden; the latter gradually decreases. There is also a small admixture of *Pinus* and *Picea.*

PERIOD IV

Local pollen **zone Z-7** (*Pinus-Abies*). In this part of the section (samples 120–70), the pine curve reaches its maximum (34.3%). A forest with predominant coniferous trees is enriched in *Alnus, Picea, Carpinus, Quercus, Corylus* and *Betula.* There are continuous curves of herbs as *Gramineae* and *Cyperaceae* in this zone, and also of *Humulus* and *Ericaceae*. There are also thermophilous bushes of *Viscum, Evonymus, Ligustrum, Buxus* and *Rhamnus* in the communities.

Local pollen **zone Z-8** (*Betula-Pinus*). In forest communities (samples 70–33) there are mainly *Betula* and *Pinus*, as well as *Alnus* and *Abies*. Thermophilous plants as *Corylus, Quercus* and *Carpinus* disappear. On the other hand, there are *Salix, Juniperus* and *Larix.* Content of herbs is distinctly increasing (to 25%). There are mainly *Gramineae, Cyperaceae, Artemisia, Compositae, Polygonaceae, Rosaceae, Caryophyllaceae, Thalictrum* and *Helianthemum.*

POST-INTERGLACIAL PERIOD

Local pollen **zone Z-9** (*Gramineae-Cyperaceae*) is predominated by herbs (samples 33–1), the curve of which reaches its maximum (29%). Except for *Gramineae* and *Cyperaceae*, there is abundant *Artemisia.* Besides, the pollen diagram contains continuous curves of *Caryophyllaceae, Polygonaceae, Compositae Lig.* and *Chenopodiaceae.* Pine, birch and willow are presumably represented by dwarf species and varieties.

DISCUSSION

Palynological diagram from Zakrucze reflects interglacial vegetation succession, starting with dense forest communities, predominated with coniferous trees (local pollen zone Z-1). It does not comprise a tundra phase. Development of forest communities leads to a climax which is represented by climatic optimum, corresponding to the local pollen zone Z-5. Minimum content of herbs is accompanied by development of a deciduous forest, predominated by hornbeam. Successive vegetation transformations indicate gradual drying and then, a climatic cooling. Deciduous trees are replaced by coniferous ones. Photocoenoses indicate gradual increase of herbs (local pollen zone Z-8). Species with high light demands as *Helianthemum* appear, what indicates loosening of vegetation cover. Forest communities disappear in the last local pollen zone (Z-9). On the other hand, presence of birch and willow indicates development of a thicket tundra, with dwarf species of these genera.

The presented pollen diagram indicates several characteristic features. They are:

— presence of the curve of *Taxus* in the lower part of the diagram, terminating before a climatic optimum,

— high content of coniferous trees in a spectrum,

— presence of pollen grains of the type *Ephedra,*

— curve of spruce, maximum of which precedes a climax of fir,

— absence of beech.

When comparing the diagrams, an attention was paid firstly to similarities of presented successions and geographical location of the sites, from which they are known. Therefore, in the palynological diagram from the section at Sewerynów near Przedbórz (about 30 km to the northwest from Zakrucze) and correlated to the Mazovian Interglacial (I. Jurkiewiczowa, K. Mamakowa, 1960), a floristic succession starts with termination of the period II (after W. Szafer, 1953), followed by the period III (fir-hornbeam). Number of non-tree pollen (NAP) during the period III is as low as at Zakrucze, what corresponds well to the most extensive development of the interglacial forest. The period IV is also indicated by pine-birch forest that is gradually replaced by tundra vegetation, well recorded at the section Zakrucze as the post-interglacial local pollen zone Z-9.

Also at the relatively close sites of interglacial sediments at Barkowice Mokre (*cf.* M. Sobolewska, 1952) and Olsze-

wice (*cf.* M. Sobolewska, 1956*a*), and even at sites in the Lublin Region: Nowiny Żukowskie (*cf.* J. Dyakowska, 1952), Syrniki (*cf.* M. Sobolewska, 1956*b*) or Krępiec (*cf.* Z. Janczyk-Kopikowa, 1981), there are similar pollen successions. Much role is played by coniferous trees, with considerable participation of alder which, together with spruce and similarly as at Zakrucze, indicates the early climax.

Close similarity to the diagram from Zakrucze is indicated also by the far-distant section of the Mazovian Interglacial from Gościęcin in the Lower Silesia (*cf.* A. Środoń, 1957), Adamówka in the Sandomierz Basin (*cf.* K. Bińka *et al.*, 1987), and even the sites in southern Podlasie which have been discovered lately at Biała Podlaska (*cf.* K. M. Krupiński *et al.*, 1988), Komarno (*cf.* K. M. Krupiński, L. Lindner, 1991), Ossówka (*cf.* K. M. Krupiński, 1995), Woskrzenice (*cf.* K. Bińka, J. Nitychoruk, 1995), Kaliłów (*cf.* K. Bińka, J. Nitychoruk, 1996) and Wilczyn (*cf.* K. Bińka *et al.*, 1996).

Final reference of the section at Zakrucze to the Mazovian Interglacial enabled another approach to age of the sediments, younger than the South-Polish Glaciations (Sanian 1 and Sanian 2) in the Holy Cross Region. Basing on the data, the lower silt (layer 9 at Fig. 2), peat (layer 10 at Fig. 2) and the upper silt (layer 11 at Fig. 2) should be accepted to represent lake-marshy deposition during the Mazovian Interglacial. The lake has been formed in a karst depression already at the end of the Sanian 2 Glaciation or at the turn of this glaciation and the following interglacial. The younger sand with gravel represent distinct stratigraphical hiatus, including presumably the Liwiecian Glaciation and the following Zbójnian Interglacial. The sand was deposited by glaciofluvial waters that eroded even the upper part of the analyzed lake sediments. Runoff occurred in ice-sheet forefield of the Odranian Glaciation and was connected with its maximum extent or the first retreat phases (L. Lindner, 1977*a*).

CONCLUSIONS

The section at Zakrucze represents pollen succession which is typical for the Mazovian Interglacial.

Reference of lake sediments from this section to the Mazovian Interglacial speaks for initial development of covered karst features in this area during a pre-interglacial period.

Absence of covering of sediments of the Mazovian Interglacial by till or its residuum confirms a maximum extent of the ice-sheet of the Odranian Glaciation to the northwest of this section (L. Lindner, L. Marks, 1995) — at the present watershed between drainage basins of Nida and Pilica Rivers.

Preserved two older (than the Mazovian Interglacial) tills in the Małogoszcz–Zakrucze region should represent the two South-Polish Glaciations (Sanian 1 and Sanian 2).

Translated by Leszek Marks

REFERENCES

BARANIECKA M. D. (1990) — Revision proposals of the Quaternary stratigraphy for the Detailed Geological Map of Poland 1 : 50 000 in the light of main stratigraphic survey results in the recent 20 years (in Polish with English summary). Kwart. Geol., **34**, p. 149–166, no. 1.

BIŃKA K., NITYCHORUK J. (1995) — Mazovian (Holsteinian) lake sediments at Woskrzenice near Biała Podlaska. Geol. Quart., **39**, p. 109–120, no. 1.

BIŃKA K., NITYCHORUK J. (1996) — Geological and palaeobotanical setting of interglacial sediments at the Kaliłów site in southern Podlasie. Geol. Quart., **40**, p. 269–282, no. 2.

BIŃKA K., LINDNER L., NITYCHORUK J. (1996) — Geological setting and palaeobotanic analysis of lake sediments of the Mazovian Interglacial at Wilczyn in southern Podlasie, preliminary report (in Polish with English summary). In: Stratygrafia plejstocenu Polski (ed. L. Marks). Mat. II Konf., p. 29–38.

BIŃKA K., MARCINIAK B., ZIEMBIŃSKA-TWORZYDŁO M. (1987) — Palynologic and diatomologic analysis of the Mazovian Interglacial deposits in Adamówka (Sandomierz Lowland) (in Polish with English summary). Kwart. Geol., **31**, p. 453–470, no. 2/3.

DYAKOWSKA J. (1952) — Pleistocene flora of Nowiny Żukowskie on the Lublin Upland (in Polish with English summary). Biul. Państw. Inst. Geol., **67**, p. 115–181.

FILONOWICZ P., LINDNER L. (1986) — Szczegółowa Mapa Geologiczna Polski 1:50 000, ark. Piekoszów. Inst. Geol. Warszawa.

FILONOWICZ P., LINDNER L. (1987) — Objaśnienia do Szczegółowej Mapy Geologicznej Polski 1:50 000, ark. Piekoszów. Inst. Geol. Warszawa.

HAKENBERG M. (1973) — Szczegółowa Mapa Geologiczna Polski 1:50 000, ark. Chęciny. Inst. Geol. Warszawa.

HAKENBERG M. (1974) — Objaśnienia do Szczegółowej Mapy Geologicznej Polski 1:50 000, ark. Chęciny. Inst. Geol. Warszawa.

HAKENBERG M., LINDNER L. (1971) — Quaternary deposits of the middle Nida valley (in Polish with English summary). Acta Geol. Pol., **21**, p. 241–264, no. 2.

HAKENBERG M., LINDNER L. (1973) — Holocene history of the middle Nida valley (in Polish with English summary). Acta Geol. Pol., **23**, p. 435–444, no. 2.

JANCZYK-KOPIKOWA Z. (1981) — Pollen analysis of the Pleistocene sediments at Kaznów and Krępiec (in Polish with English summary). Biul. Inst. Geol., **321**, p. 249–258.

JURKIEWICZOWA I., MAMAKOWA K. (1960) — The interglacial at Sewerynów near Przedbórz (in Polish with English summary). Biul. Inst. Geol., **150**, p. 71–103.

KRUPIŃSKI K. M. (1995) — Pollen stratigraphy and succession of vegetation during the Mazovian Interglacial (in Polish with English summary). Acta Geogr. Lodz., **70**.

KRUPIŃSKI K. M., LINDNER L. (1991) — Interglacial flora at Komarno near Biała Podlaska, eastern Poland (in Polish with English summary). In: Geneza, litologia i stratygrafia utworów czwartorzędowych (ed. A. Kostrzewski). UAM Ser. Geogr., **50**, p. 511–518.

KRUPIŃSKI K. M., LINDNER L., TUROWSKI W. (1988) — Geologic-floristic setting of the Mazovian Interglacial sediments at Biała Podlaska (E Poland). Acta Palaeobot., **28**, p. 29–47, no. 1/2.

LINDNER L. (1976) — Pleistocene Periglacial and Periglacial-soil structures in the western part of Holy Cross Mts. Acta Geol. Pol., **26**, p. 405–411, no. 3.

LINDNER L. (1977*a*) — Pleistocene glaciations in the western part of the Holy Cross Mountains (Central Poland) (in Polish with English summary). Studia Geol. Pol., **53**.

LINDNER L. (1977*b*) — Małogoszcz, condition of accumulation and age of kame terraces in the eastern part of the Przedbórz-Małogoszcz Range (in Polish with English summary). In: Czwartorzęd zachodniej części regionu świętokrzyskiego (eds. L. Lindner, Z. Michalska). Przew. Symp. Teren., p. 34–42. Wyd. Geol. Warszawa.

LINDNER L. (1980) — An outline of chronostratigraphy of the Quaternary in the Góry Świętokrzyskie Mts region (in Polish with English summary). Kwart. Geol., **24**, p. 689–710, no. 3.

LINDNER L. (1995*a*) — Till sequences and local moraines in the Holy Cross Mountains area in central Poland. In: Glacial deposits in North-East Europe (eds. J. Ehlers, S. Kozarski, Ph. Gibbard), p. 329–337. A. A. Balkema. Rotterdam.

LINDNER L. (1995*b*) — Frost weathering of the pre-Quaternary rocks and its influence on landscape evolution in the northwestern margin of the Holy Cross Mts (in Polish with English summary). Acta Geogr. Lodz., **71**, p. 149–164.

LINDNER L., MARKS L. (1995) — Outline of palaeomorphology of the Polish territory during the Scandinavian glaciation (in Polish with English summary). Prz. Geol., **43**, p. 591–594, no. 7.

LINDNER L., ZIEMBIŃSKA-TWORZYDŁO M. (1974) — The Eemian Interglacial deposits at Zakrucze, near Małogoszcz (western part of the Świętokrzyskie Mts) (in Polish with English summary). Kwart. Geol., **18**, p. 636–646, no. 3.

LINDNER L., DZIERŻEK J., LAMPARSKI Z., MARKS L., NITYCHORUK J. (1995) — Outline of Quaternary stratigraphy in Poland; main glacial and interglacial horizons and their extents (in Polish with English summary). Prz. Geol., **43**, p. 586–591, no. 7.

SOBOLEWSKA M. (1952) — Interglacial at Barkowice Mokre near Sulejów (in Polish with English summary). Biul. Państw. Inst. Geol., **66**, p. 245–284.

SOBOLEWSKA M. (1956*a*) — Pollen analysis of the interglacial deposits of Olszewice on the Wieprz River (in Polish with English summary). Biul. Inst. Geol., **100**, p. 271–290.

SOBOLEWSKA M. (1956*b*) — Pleistocene vegetation of Syrniki on the River Wieprz (in Polish with English summary). Biul. Inst. Geol., **100**, p. 143–192.

SZAFER W. (1953) — Pleistocene stratigraphy of Poland from the floristical point of view (in Polish with English summary). Rocz. Pol. Tow. Geol., **22**, p. 1–60, no. 1.

ŚRODOŃ A. (1957) — Interglacial flora from Gościęcin near Koźle (Sudetic Foreland) (in Polish with English summary). Biul. Inst. Geol., **118**, p. 7–60.

ŻOŁNIERZ A. (1971) — Kames structures in the Przedbórz–Małogoszcz Range (in Polish with English summary). Rocz. Nauk.-Dydakt. Wyższej Szkoły Pedagogicznej w Krakowie, **40**, Pr. Geogr., **5**, p. 121–136.

OSADY INTERGLACJALNE W ZAKRUCZU KOŁO MAŁOGOSZCZA (REGION ŚWIĘTOKRZYSKI) W ŚWIETLE NOWYCH DANYCH

Streszczenie

Wykonane ostatnio badania palinologiczne osadów jeziornych z profilu Zakrucze koło Małogoszcza (fig. 1 i 2) nie potwierdziły wcześniejszej sugestii o możliwości wiązania ich z interglacjałem eemskim (por. L. Lindner, M. Ziembińska-Tworzydło, 1974). Z badań tych wynika, że zachowany w analizowanych osadach materiał pyłkowy dokumentuje cztery (I–IV) okresy rozwoju flory typowej dla interglacjału mazowieckiego (fig. 3). Osady te wypełniają obniżenie rzeczno-krasowe rozcinające gliny zwałowe dwóch zlodowaceń południowopolskich (sanu 1 i sanu 2). Analizowane osady interglacjalne występują poza zasięgiem lądolodów zlodowaceń środkowopolskich (odry i warty) i przykryte są jedynie serią glacifluwialną pierwszego z tych zlodowaceń oraz młodszymi osadami rzeczno-zboczowymi.