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Stratigraphy of Late Quaternary deposits and their neotectonic record in the Konin area, Central Poland

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During many years' research, the stratigraphy of Quaternary deposits in the area surrounding Konin has elaborated. In the young Quaternary strata the Eemian fossil lakeland was established and the exposed Mikorzyn section was found. Previous geological and palynological analyses of the site prove a nearly complete sequence of Eemian and Vistulian deposits. Furthermore, archival records of drill cores indicate that older interglacial sediments may also have been deposited about 10 metres deeper in this particular area. To test this possibility, a relatively deep test borehole — Mikorzyn 1 was carried out in the distance about 70 metres only. The sedimentological and palynological core analyses prove the Eemian age of examined organic materials. The borehole, established only the presence of *ca.*10 m offset in the bottom part of the Eemian strata. This fact, as well as other faults and Tertiary coal injections into glacial sediments, confirmed the occurrence of neotectonic activity.

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INTRODUCTION

An extensive area around Konin (eastern Wielkopolska) is characterised by a great number of geological data both from numerous boreholes and extensive brown coal quarries. The fossil topography of the Mesozoic rocks is well studied and documented (Krygowski, 1952; Czarnik, 1967; Kozacki, 1972; Dadlez and Marek, 1974; Ciuk and Grabowska, 1991; Stankowski *et al*., 1992; Stankowski *et al*., 1995*a*, *b*; Stankowski, 1996; Widera, 1998). The configuration of this palaeosurface indicates the presence of tectonic activity during the Tertiary period. There are also indications of tectonic activity during the Quaternary, up to the Middle Vistulian.

A good example of Late Tertiary and Quaternary tectonic activity has been found in a geological section across Mikorzyn that was compiled on the basis of archived borehole records (Fig. 1). The Late Miocene coals, silts and clays are situated within a narrow interval either at around 45–55 m or about 85–105 m below the ground surface. This clearly suggests the presence of fault zones.

As it is seen on Figure 1, both the thickness and degree of stratigraphic completeness of the Quaternary deposits vary laterally. In this strata the tectonic structures are also present. The faults existing in the Mesozoic, Tertiary and Quaternary sediments are good indicators of Cenozoic repetitive tectonic movements which vary in age.

Until recently, deposits older than the Mazovian Interglacial (Holsteinian) *sensu lato* have been recorded in the Quaternary strata of the discussed area, while there has been little mention of the substantial glaciotectonic deformations, let alone evidence for Quaternary tectonic activity. More recently the presence of Early Pleistocene deposits and the existence of glaciotectonic structures and traces of neotectonic activity have been recognised (Stankowski and Krzyszkowski, 1991; Stankowski *et al*., 1995*a*, *b*; Stankowski, 2000; Stankowski *et al*., 2003).

This research was performed as an extensive sections mapping, deep cartography, sedimentological and mineralogical

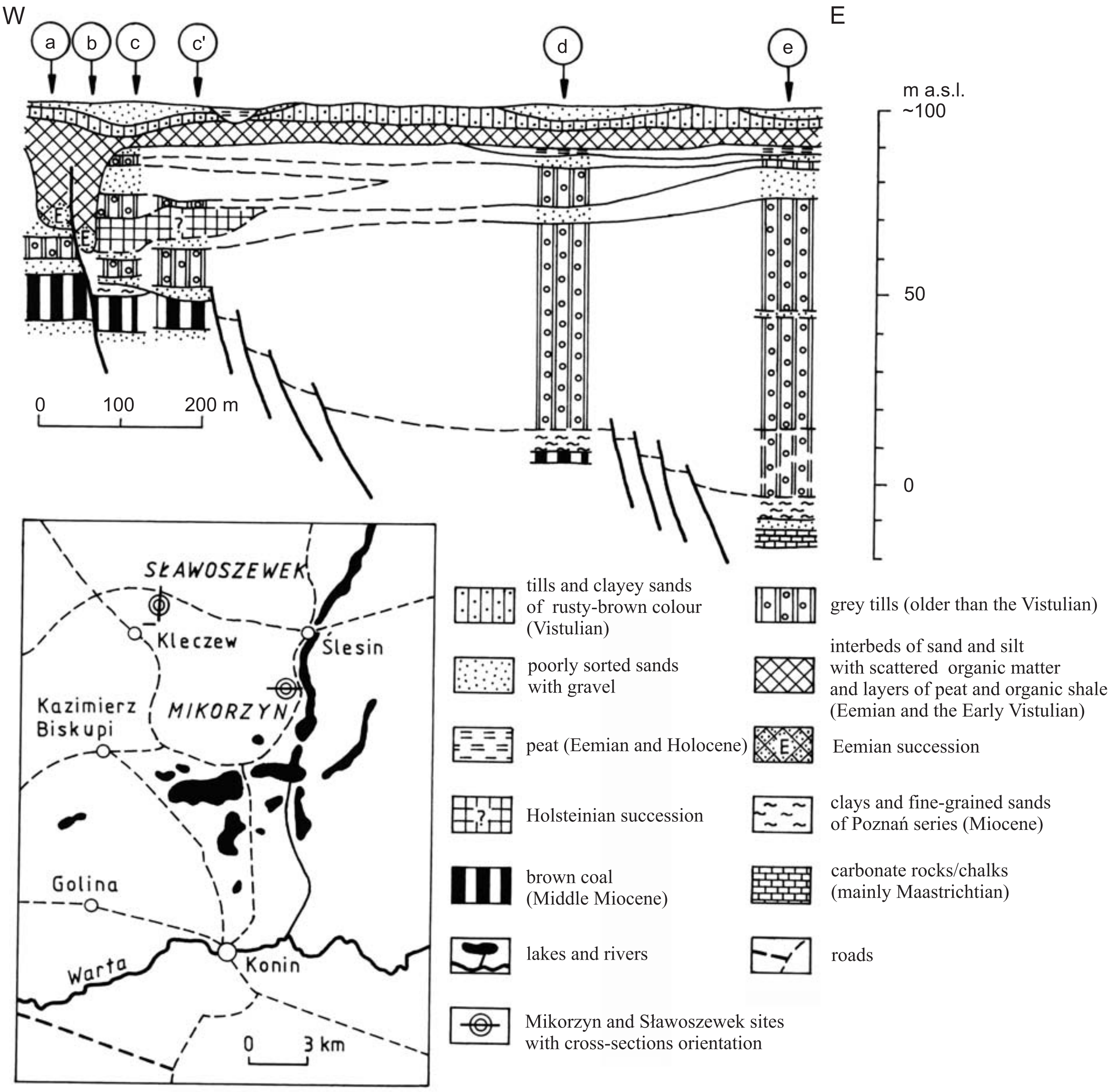

Fig. 1. A schematic geological cross-section of Mikorzyn sites

Geological profiles: a — Mikorzyn exposure, b — Mikorzyn 1 (borehole 1999), archival borings: c — PP 152, c‘ — 178, d — PP 156, e — 1121

studies, palynological analysis, as well as ^{14}C and TL/OSL datings.

LITHOLOGY AND STRATIGRAPHIC INTERPRETATION OF THE QUATERNARY STRATA NEAR KONIN

A synthetic section of the Quaternary stratigraphy of eastern Wielkopolska considered in the context of Pleistocene glaciations and interglacials (Stankowski, 1995; Stankowski, 1996*a*, *b*; Stankowski, 2000*d*, *e*) can be given as follows:

— Holocene — gyttjas together with a cover of peat and soil reflecting climatic warming;

— North-Polish Glacial = Vistulian (horizons of sediments from top to the bottom):

a) the sands with gravels, fine sands and silts left after the decay of the inland ice, together with periglacial structures of late glacial in age and organic intercalations,

b) the sandy tills from the short-lived maximum extent of last inland ice,

c) the medium and fine sands with thin gravel layers of the long-lived Early Vistulian. In this time the area was developing in periglacial conditions interrupted by periods of warming up (lenses and layers of organic deposits);

— Eemian Interglacial — optimum, and sediments of the so-called “Eemian complex” layers of sand and gravel which include periglacial structures and numerous lenses and layers of organic deposits of the fossil lakeland environment;

— Middle-Polish Glacial — relatively thin bipartite glacial tills divided by sandy deposits;

— Mazovian Interglacial (an equivalent of the Holsteinian complex) — layers of sand and gravel and occasional lenses of organic deposits, only Konin–Marantów site palynologically documented; poorly preserved elements of erosional palaeosurfaces;

— South-Polish Glacial — a thick succession of poorly-distinguishable glacial tills. In the border zone few metres thick glaciotectonic structures;

— Augustów Interglacial (an equivalent of the Cromerian complex) — discontinuous, thin sands and gravels with discontinuity surfaces. Unfortunately, the organic deposits were not found up to now in the Konin area;

— the Oldest Glacial — packets of glacial tills comprising two poorly defined units, divided by thin discontinuous layers of sand and gravel;

— Early Pleistocene — fine-grained sands and coarse sands with periglacial and loadcast structures.

MIKORZYN AND SŁAWOSZEWEK NEOPLEISTOCENE SECTIONS

The litho-, palyno- and chronostratigraphy of the Quaternary succession of the area surrounding Mikorzyn and Sławoszewek, with reference to the synthetic Quaternary section described above for the area of Konin, was described by Stankowski *et al.* (1999). Then, the basis for analysis was an extensive Eemian to Early Vistulian section near Mikorzyn (Fig. 1 profile a and Fig. 2 profile a), which was available for direct field observation, along with the Eemian organic deposits exposed in the quarry near Sławoszewek (Stankowski *et al*., 1999). It would not be possible to show the boundary between the Eemian and Vistulian deposits without palynological analysis. The Eemian optimum sediments is reduced there to a very thin sequence of deposits. However, the deposits of Eemian optimum and upper lying thick complex of organic interbeddings, up to Brörup, can be described as the "Eemian complex".

In this study two sites were analysed geologically and palynologically: the borehole drilled at Mikorzyn 1 in 1999 (Fig. 1, profile b and Fig. 2, profile b) and Sławoszewek 1998 exposure (Fig. 3, Stankowski, 2000) situated only 150 m NW of the Sławoszewek locality described by Stankowski *et al.* (1999). The position of the interglacial organic deposits from Sławoszewek 1998 is similar to that illustrated by profiles d and e in Figure 1. These two new profiles, Mikorzyn 1 and Sławoszewek 1998, are about 12 km apart.

In both the Mikorzyn and Sławoszewek sections, there occur organic deposits which are geologically interpreted as belonging to the Eemian Interglacial. At Mikorzyn 1 the base of the organic succession lies approximately 10 m deeper than the organic deposits studied earlier at the Mikorzyn exposure (Stankowski *et al*., 1999; Fig. 2).

The mentioned differences lead to questions:

— are there two different interglacial series in the superposition (Fig. 1, profiles c and c')?;

— is it possible that there exists the direct contact between two interglacials of different age?

In the mine quarry near village Sławoszewek in section (Fig. 4) situated about 100 m west of the Sławoszewek 1998 profile, the Holocene organic deposits lie immediately above the Eemian sediments. Alternatively, the observed differences in altitudes of the organic deposits may be due to neotectonic activity. In order to resolve these questions, geological and palynolgical analyses were performed.

LITHOLOGICAL AND POLLEN ANALYSIS OF THE MIKORZYN 1 AND SŁAWOSZEWEK SECTIONS

The Mikorzyn 1 section is 44 m thick and begins with massive grey till (Fig. 2 profile b). Directly above the till there is *ca*. 2.5 m thick layer of poorly sorted sand with thin silt interlayers. At 39.2–28 m depth, there occurs a organic succession >11 m thick. This is mostly dominated by organic silt of variable density, but also includes layers of organic shale, mostly as thin interbeds, though there is a layer about 1.8 m thick (at 33.9–32.1 m depth). Within the organic succession, there are two interbedded layers of fine-grained sand, located at depths of 35.7–34.3 m and 31.2–29.5 m, which contain organic matter.

The organic succession is covered by a 20 cm thin layer of clayey sand with gravels (28.0–27.8 m depth). This thin layer can be related to the till of the Middle Polish Glaciation, known from archival boreholes (Fig. 1 profiles c and c'). However, it is not clear whether this interpretation is correct. These deposits may not be *in situ*, but redeposited.

The uppermost part of the section (27.8–1.5 m depth) consists of poorly sorted sands, containing diffuse gravels and thin gravelly layers. Within the sand layer there is a 2 m thick (20.0–18.0 m depth) layer of silt. The top 1.5 m of the section consists of clayey sand with a thin soil cover.

The Mikorzyn 1 section (Fig. 2 profile b) differs significantly from the Mikorzyn exposure (Fig. 2 profile a; *cf.* Stankowski *et al*., 1999). First, the organic unit is located at a different depth and is characterised by a different succession, differences in the thickness of the organic shale layer, and in the number of interbedded sand layers. The interbedded sands indicate interruptions in the biogenic sedimentation. The borehole shows a record of considerable palaeoenvironmental changes, with interbedded sand layers of sand and clayey sands with gravels overlying the organic deposits, which are not present in the Mikorzyn exposure (Fig. 2 profile a).

A palynological analysis was performed on material from the Mikorzyn 1 section. The samples were subjected to maceration with 10% KOH, 10% HCl, 40% HF, and Erdtmann's acetolysis. Sporomorphs were counted to a total of 500 AP, or on an 8 cm^2 surface when the pollen frequency was low. The POLPAL programme was used to draw the diagrams.

The succession of the pollen from Mikorzyn 1 is represented by 20 local pollen assemblage zones (Table 1, Fig. 5), which allow to distinguish the Eemian Interglacial and the older part of the Vistulian. Although the studied deposits occur

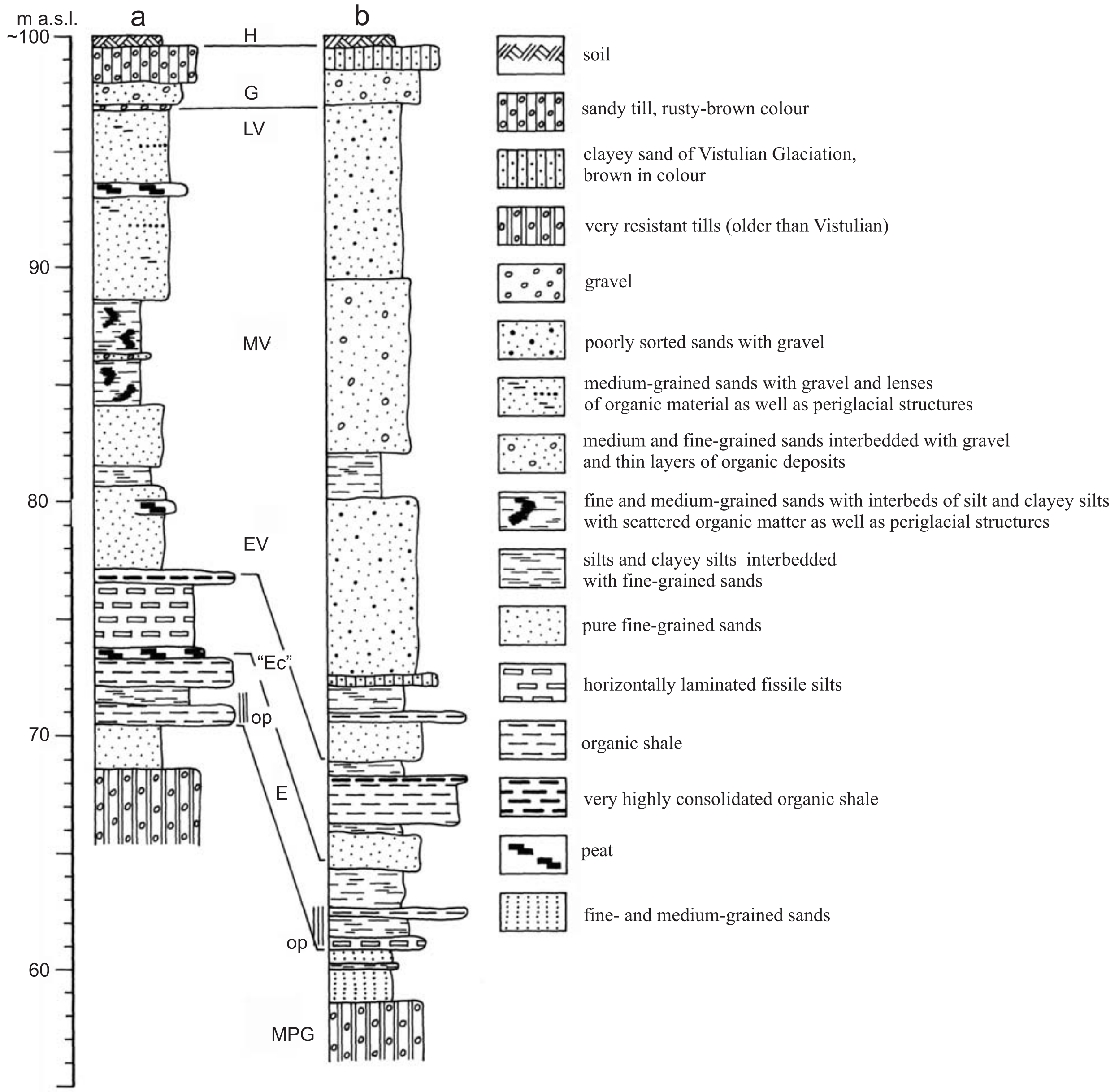

Fig. 2. Simplified geological profiles of Mikorzyn sites

a — exposure, **b** — Mikorzyn 1 (borehole 1999); MPG — Glacial deposits of Middle Polish age; E — Eemian organic deposits (op — climatic optimum), "Ec" — "Eemian complex" deposits, EV — Early Vistulian, sands, silts with organic matter, MV — Middle Vistulian silts and sands with organic matter, LV — Late Vistulian sands with gravels and organic matter, G — deposits of Vistulian glacial cover, H — Holocene soil

several metres below the organic deposits that were described in the Mikorzyn exposure section (Stankowski *et al*., 1999), both palynological successions are similar.

The Eemian Interglacial in the borehole is represented by relatively thin deposits, which, as in the Mikorzyn exposure, reach 3 m in thickness, out of which not more than 0.7 m represents the climatic optimum.

A comparison of the two diagrams from Mikorzyn (the exposure and the borehole — Fig. 6) shows that the pollen successions of pollen closely resemble each other. Both sections show an almost identical course of pollen curves, and similar percentage values for the amount of pollen of individual taxa. This permitted us to distinguish very similar local pollen zones. The only difference was the lack in Mikorzyn 1 of those sediments which in the Mikorzyn exposure represent the M-3 *Pinus-Betula-Ulmus* and M-4 *Quercus-Fraxinus-Ulmus* zones. However, both these two zones are only 0.1 m thick suggesting a lack of recovery during drilling and not the presence of a local sedimentary hiatus.

The boundary between the Eemian Interglacial and Vistulian is difficult to determine at Mikorzyn, which requires explanation. In the Mikorzyn exposure section the boundary was consistent with the boundary between the M-11 *Pinus-Betula*-NAP/M-12 NAP-*Pinus-Salix* zones, based on the growth of NAP up to 38% as well as the presence of *Betula nana* pollen (Stankowski *et al*., 1999). In the boundary between

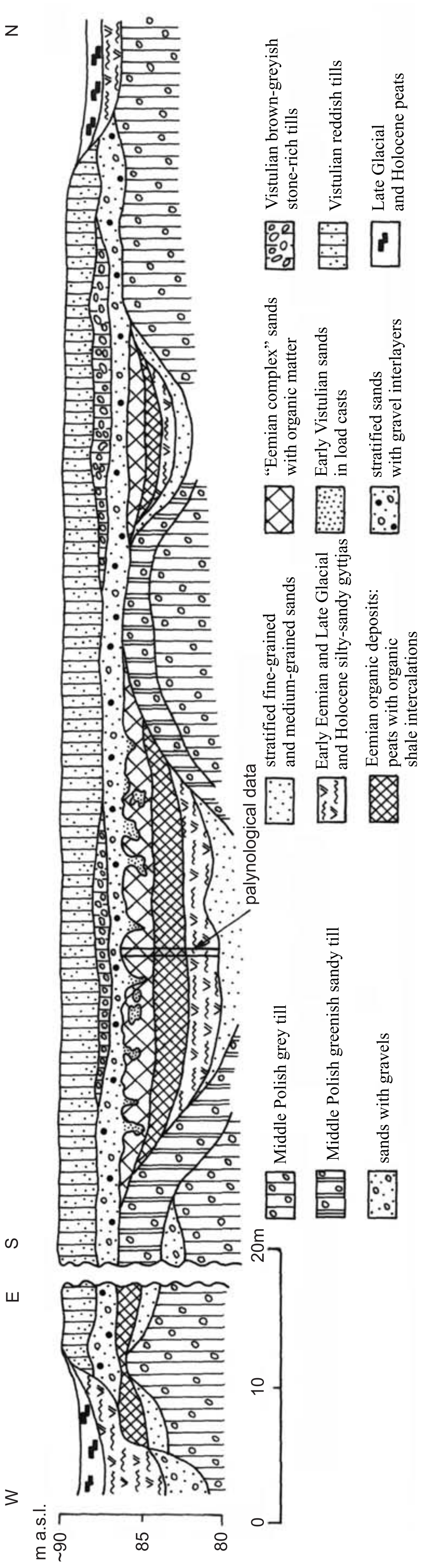

Fig. 3. Generalised section of the Sławoszewek 1998 exposure

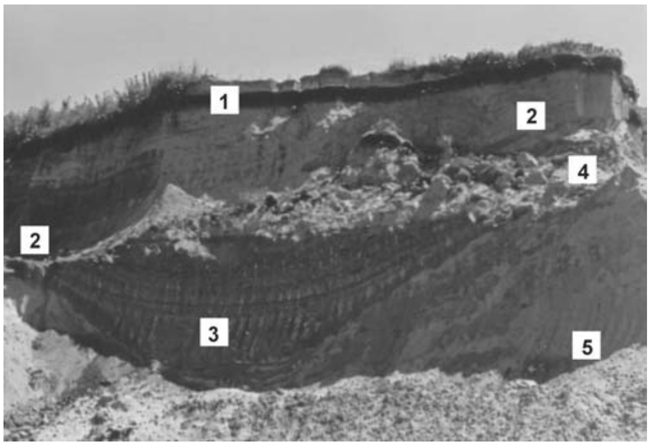

Fig. 4. Sławoszewek 2001 — Holocene and Eemian deposits in direct contact

1 — Holocene peats and organic sands, 2 — Late Glacial silts, gyttjas with thin peat layers, 3 — Eemian gyttjas, silts, peats and organic shale with three interbeddings of very consolidated organic shale, 4 — Vistulian Glaciation sands and tills, 5 — Middle Polish tills

these zones in both profiles (the exposure and the borehole, M1-9/M1-10), there is a change in the type of sediments from organic shale to more mineral-rich organic silt, and the pollen spectra are disturbed. At both sites individual pollen grains of Tertiary were noted, but above all there are significant admixtures of *Carpinus, Alnus glutinosa* type and *Corylus* pollen, which are assumed to have been reworked.

Considering the new pollen data from the M1-10 NAP-*Pinus-Salix* zone (the borehole), some lower values of NAP and higher values of *Pinus* (75%) than in the analogous M-12 NAP-*Pinus-Salix* zone (the exposure), it seems that the NAP-*Pinus-Salix* zone is better interpreted as the Eemian Interglacial. In consequence the boundary between the Eemian Interglacial and the Vistulian should be placed between the M1-10/M1-11 (M-12/M-13 — the exposure). This is based on the increase of the NAP values and marked decrease in *Pinus sylvestris* pollen.

Sedimentation of the organic silt in the M1-11 NAP-*Betula nana-Juniperus* zone was interrupted, and a layer of pollen-free sand *ca*. 1.6 m thick was deposited in the basin.

The Brörup Interstadial (*sensu* Andersen, 1961) is represented by four pollen zones, but only the older birch part is similar in nature to the Mikorzyn profile (the exposure). The birch phase is bipartite with a clearly marked cooler oscillation in climate (M1-13 NAP-*Betula*), similar to that on the diagram from the Mikorzyn exposure, which was correlated with the colder oscillation between Amersfoort and Brörup, *sensu* Zagwijn (1961).

The Rederstall Stadial is represented by *ca*. 0.30 m thick deposits, while the equivalent layer in the Mikorzyn exposure is 2 m thick (Stankowski *et al*., 1999). Despite this, the M1-16 Poaceae-*Artemisia-Betula nana* pollen zone correlates very well with the younger part of the equivalent zone of the other profile.

The M1-17 *Betula*-NAP and M1-18 *Pinus-Betula*-Poaceae zones correlate with the Odderade Interstadial, as do the equivalent zones in the Mikorzyn exposure (Stankowski *et al*., 1999). In both profiles (the exposure and the borehole), sedimentation of organic silts within the *Pinus-Betula*-Poaceae zones was interrupted, and clastic sand *ca*. 2 m thick was de-

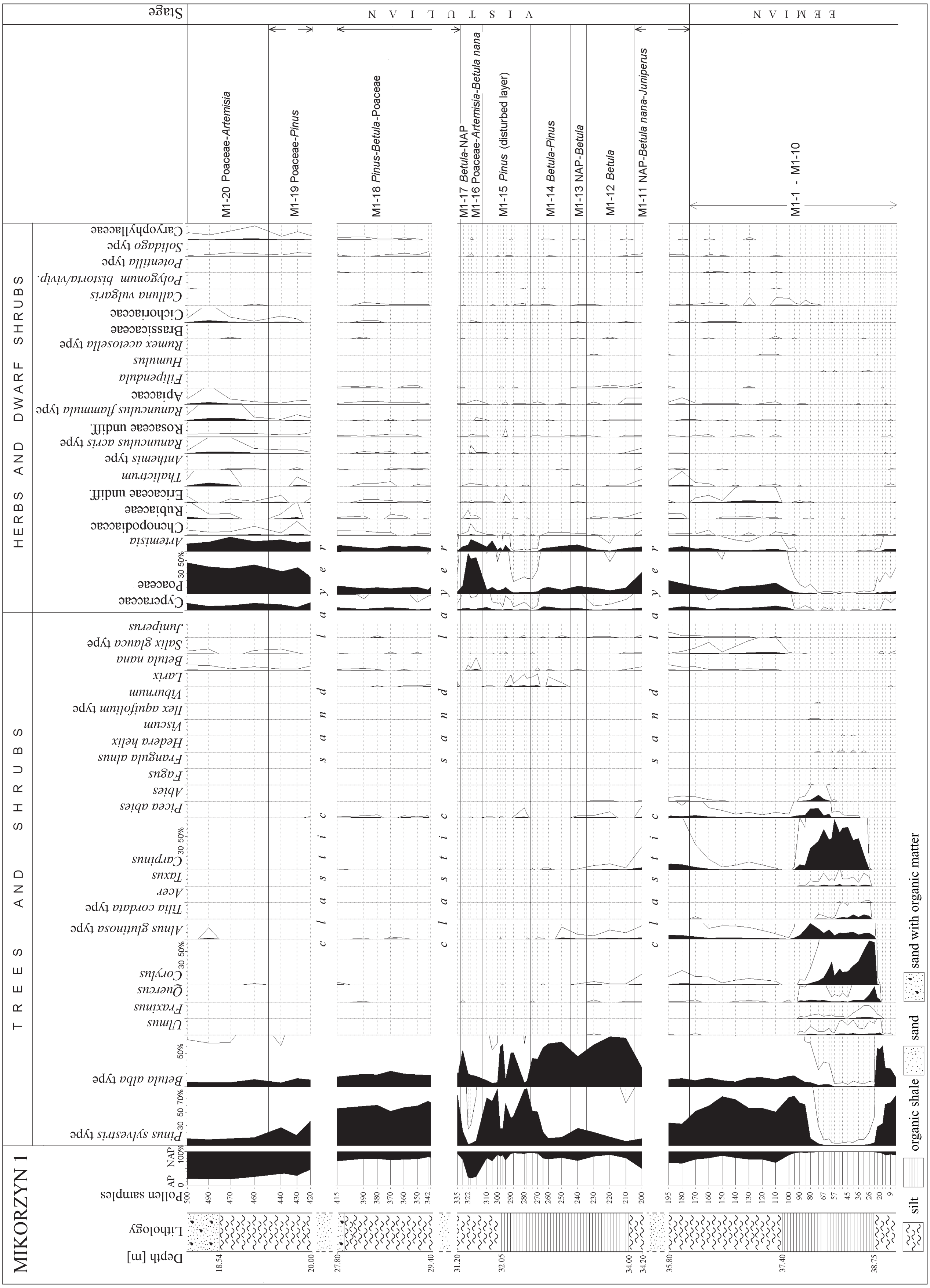

Fig. 5. Simplified pollen diagram of the deposits from the Mikorzyn 1 borehole

Table 1

A description of the local pollen assemblage zones from the Mikorzyn 1 borehole

Local pollen assemblage zones	Description of the local pollen assemblage zones
Vistulian	
M1-20 Poaceae-*Artemisia*	maximum values of NAP throughout the profile (76%), especially Poaceae (47%) and *Artemisia* (21%); no upper boundary
M1-19 Poaceae-*Pinus*	very high values of NAP (66%); *Pinus sylvestris* type prevails among trees; no lower boundary
M1-18 *Pinus-Betula*-Poaceae	AP values exceed 84%; domination of *Pinus sylvestris* type (52%); no upper boundary
M1-17 *Betula*-NAP	rapid increase in AP values to 94%, mainly because of a rise in *Betula alba* type pollen (55%)
M1-16 Poaceae-*Artemisia-Betula nana*	rapid increase in NAP values; Poaceae (61%) and *Artemisia* (18%) prevail among herbs, which are also characterised by a remarkable variety of taxa
M1-15 *Pinus* disturbed layer	AP values persist high; abrupt changes in the values of *Pinus sylvestris* type (max. 86%) and *Betula alba* type (max. 64%)
M1-14 *Betula-Pinus*	AP values are again high, mainly because of a rise in *Betula alba* type pollen (67%); rise in *Pinus sylvestris* type pollen towards the top of the zone (52%)
M1-13 NAP-*Betula*	NAP values (max. 26%) are higher than in the preceding zone; domination of *Betula alba* type pollen (46%) among trees
M1-12 *Betula*	high proportion of AP (92%); *Betula alba* type prevails (75%)
M1-11 NAP-*Betula nana-Juniperus*	high NAP values (max. 51%), particularly Poaceae (32%) and *Artemisia* (7%); pollen values of *Betula nana* and *Juniperus* exceed 1%
Eemian	
M1-10 NAP-*Pinus-Salix*	NAP values reach 35% (mainly Poaceae and *Artemisia*); domination of *Pinus sylvestris* type (75%) among trees; *Betula nana* is represented by a continuous curve
M1-9 *Pinus*-NAP	still high proportion of tree and shrub pollen (*Pinus sylvestris* type — max. 73%)
M1-8 *Pinus-Picea-Carpinus*	domination of *Pinus sylvestris* type; pollen values of *Carpinus* (8%), *Picea abies* (4%) and *Alnus glutinosa* type (14%) are lower than in the previous zone
M1-7 *Picea-Abies-Carpinus*	*Carpinus* pollen decreases (60–32%), *Abies* (10%) and *Picea abies* (14%) have their maxima; rise in *Alnus glutinosa* type pollen (up to 24%)
M1-6 *Carpinus-Corylus-Alnus*	maximum values of *Carpinus* throughout the profile (76%); rises in *Alnus glutinosa* type and *Corylus* pollen values (respectively to 14 and 35%); the ascending *Picea abies* curve exceeds 5% towards the end of the zone
M1-5 *Carpinus-Corylus-Tilia*	high values of *Carpinus* (64%); rises in *Tilia cordata* type and *Alnus glutinosa* type pollen (respectively 7 and 11%); *Corylus* pollen values fall to 19%
M1-4 *Corylus-Tilia-Alnus*	maximum values of *Corylus* (66%) throughout the profile; the curves of *Tilia cordata* type (4%) and *Taxus* (2%) begin
M1-3 *Corylus-Quercus*	*Corylus* up to 64% and *Quercus* up to 24%; the *Alnus glutinosa* curve begins
M1-2 *Betula-Pinus-Ulmus*	AP values up to 95%; *Betula alba* type (62%) and *Pinus sylvestris* type (33%) prevail, low *Ulmus* pollen values (3%)
M1-1 *Pinus*	high pollen proportion of trees and shrubs (AP 91%); pollen of *Pinus sylvestris* type is dominant (max. 75%); no lower boundary

posited in the basin. The pollen spectra of the sediments below and above the layer of sand are similar, suggesting that, despite the large thickness of the sand layer, the sediments represent the same interstadial. Besides, the high AP values noted in the M1-18 zone (84%) exclude the correlation of these spectra with any younger interstadial of the Vistulian.

The boundary between the Early and Middle Vistulian (Plenivistulian) has not been marked in the diagrams. Above the M1-18 zone in the Mikorzyn 1 profile, there is a layer of clastic sand with an average thickness of up to 8 m. Despite this discontinuity, and correlation with the Mikorzyn exposure, it was assumed that the two youngest zones (M1-19 Poaceae-*Pinus* and M1-20 Poaceae-*Artemisia*) are most likely to represent the oldest Plenivistulian stadial (Schalkholz Stadial).

The pollen diagram from Sławoszewek 1998 was divided into six local pollen zones, which are briefly described in Table 2. The interpretation of the diagram (Fig. 7) suggests that this section represents an older part of the Eemian Interglacial. The youngest distinguished zone (S-6 *Carpinus-Alnus-Tilia*) was correlated with an older part of the *Carpinus* regional pollen zone described by Tobolski (1991).

The correlation of local pollen assemblage zones of the Mikorzyn profiles and the Sławoszewek profile, with the regional pollen assemblage zones of Tobolski (1991) is given in Table 3.

REMARKS ON THE NEOPLEISTOCENE VEGETATION DEVELOPMENT IN THE AREA STUDIED

The history of the vegetation as recorded in the organic deposits started at a time when dense pine communities with a little birch admixture *(Betula alba* type) covered the whole Mikorzyn region (the *Pinus* zone).

After this phase of pine domination the role of birch grew rapidly prior to a subsequent phase of pine domination (*Betula-Pinus-Ulmus* and *Pinus-Betula-Ulmus* zones). The succeeding reconstruction of the forest communities was mainly related to the expansion of oak (M-4 *Quercus-Fraxinus-Ulmus*). The high values of *Quercus* pollen noted in the Mikorzyn exposure (55%), at Sławoszewek 1998 (54%) and in the nearby sites of Jóźwin/84 (58%) and Jóźwin/76

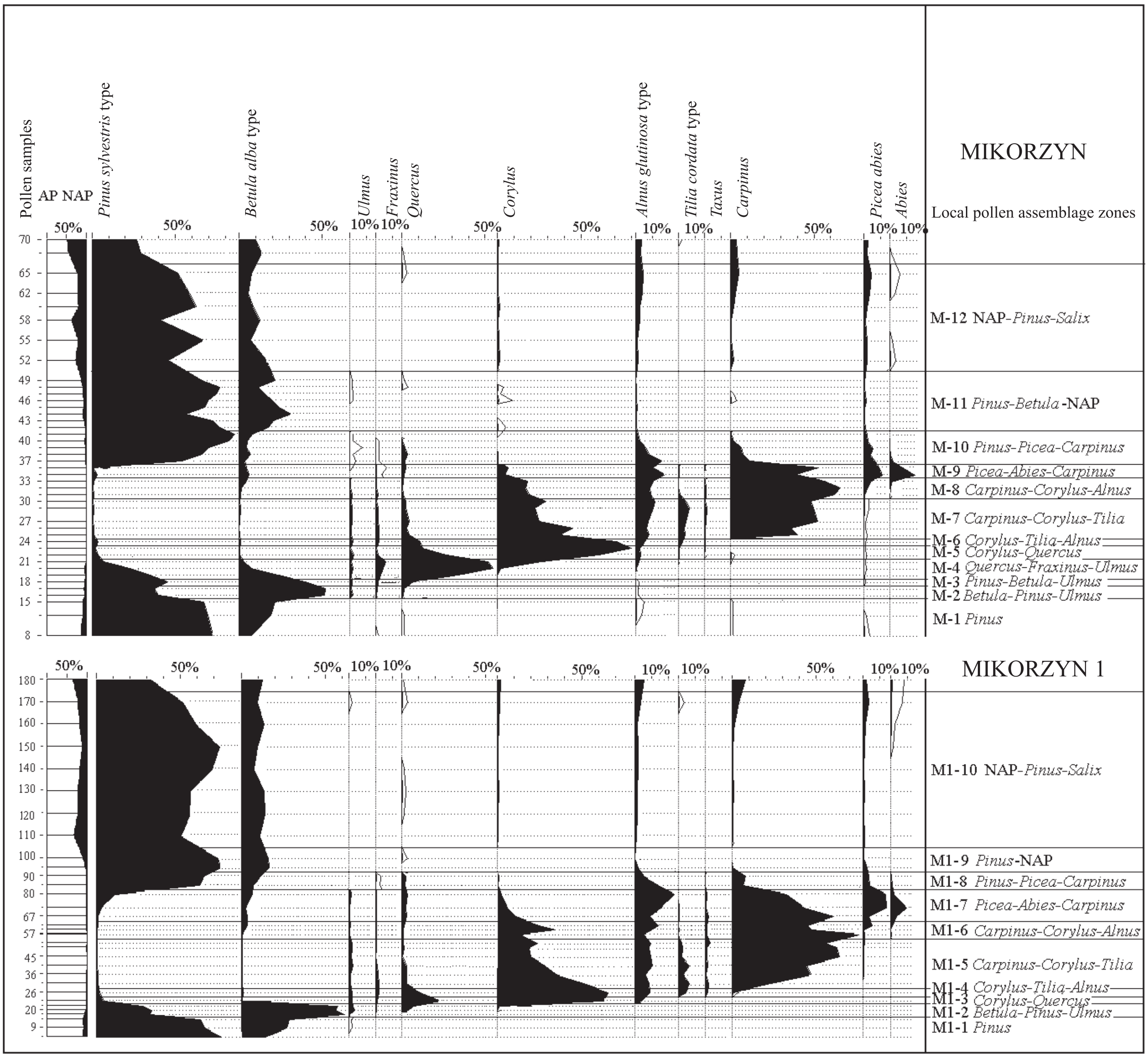

Fig. 6. Simplified pollen diagrams of the deposits belonging to the Eemian Interglacial from the Mikorzyn exposure and borehole

T a b l e 2

A description of the local pollen assemblage zones from the Sławoszewek 1998 site

Local pollen assemblage zones	Description of the local pollen assemblage zones
S-6 *Carpinus-Alnus-Tilia*	rises in *Carpinus*, *Alnus glutinosa* type and *Tilia cordata* type pollen values (respectively to 34, 20 and 12%); no upper boundary
S-5 *Corylus-Tilia-Alnus*	pollen values of *Corylus* (61%) persist high; slight rises in *Alnus glutinosa* type (6%) and *Tilia cordata* type pollen (5%); fall in *Quercus* pollen values (17%)
S-4 *Corylus-Quercus*	high values of *Corylus* pollen (51%), *Quercus* falls to 34%; low *Taxus* (2%) and *Alnus glutinosa* type (2%) pollen values
S-3 *Quercus-Fraxinus*	domination of *Quercus* (54%), *Fraxinus* exceeds 6%; rise in *Corylus* and fall in *Pinus sylvestris* type pollen towards the top of the zone
S-2 *Pinus-Betula-Ulmus*	domination of *Pinus sylvestris* type (58%) and *Betula alba* type (42%), low *Ulmus* pollen values (1%)
S-1 *Betula-Pinus*	high AP values (91%), especially Betula *alba* type (56%) and *Pinus sylvestris* type (50%); no lower boundary

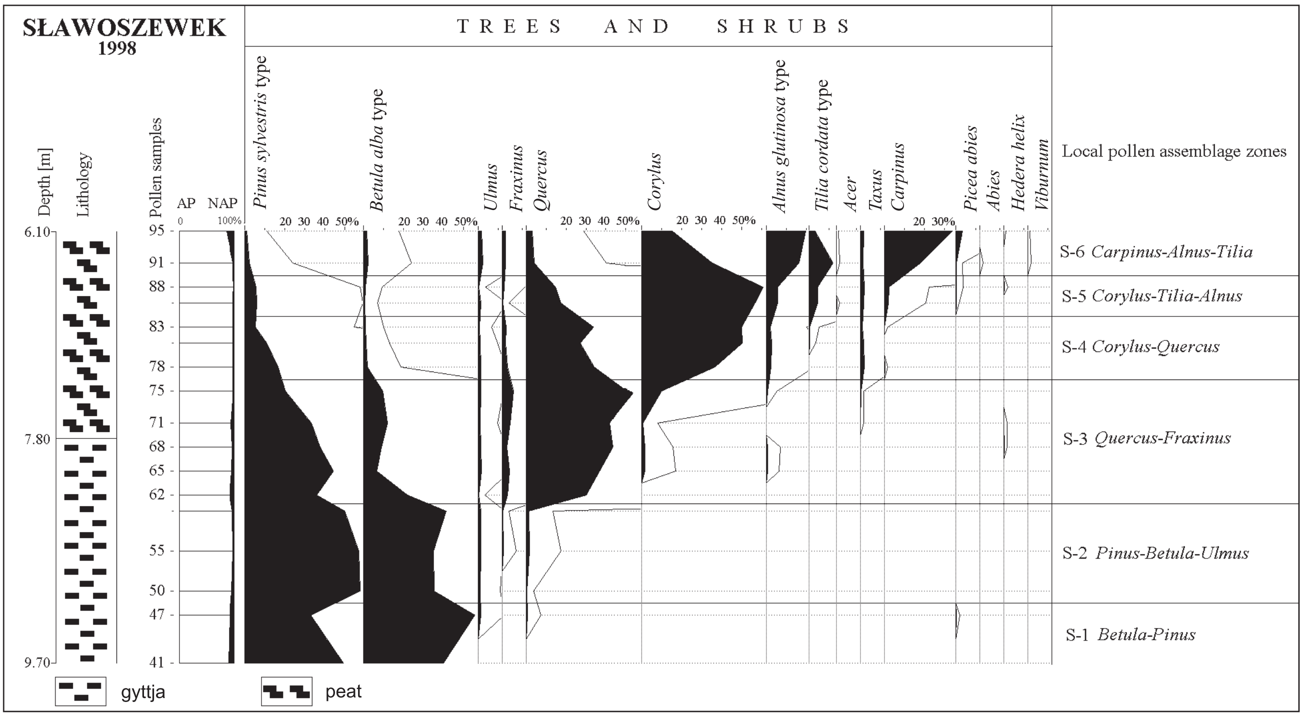

Fig. 7. Simplified pollen diagram of the deposits from the Sławoszewek 1998 site

Table 3

Correlation of the local pollen assemblage zones in the Mikorzyn borehole and exposures as well as the Sławoszewek 1998 site with the regional pollen assemblage zones (Konin region)

Mikorzyn 1 (borehole) Local pollen assemblage zones	Mikorzyn (exposure) Local pollen assemblage zones	Sławoszewek 1998 Local pollen assemblage zones	Regional pollen assemblage zones (Tobolski, 1991)		Chronostra-tigraphy	
M1-20 Poaceae-*Artemisia* M1-19 Poaceae-*Pinus* clastic sand layer	M-25 Poaceae-*Pinus*		*Salix-Equisetum*		Schalkholz Stadial	V I S T U L I A N
M1-18 *Pinus-Betula*-Poaceae, clastic sand layer M1-17 *Betula*-NAP	M-24 *Pinus-Betula*-Poaceae, clastic sand layer M-23 *Betula*-NAP		V-II	*Pinus* *Pinus-Betula*	Odderade Interstadial	
M1-16 Poaceae-*Artemisia-Betula nana*	M-22 Poaceae-*Artemisia-Betula nana* M-21 NAP-*Betula nana-Pinus*		NAP		Rederstall Stadial	
M1-15 *Pinus* - disturbed layer M1-14 *Betula-Pinus* M1-13 NAP-*Betula* M1-12 *Betula*	M-20 *Pinus-Betula-Larix* M-19 *Pinus* II M-18 NAP-*Pinus* M-17 *Pinus* I M-16 *Betula-Pinus* M-15 NAP-*Betula* M-14 *Betula*		V-I	*Pinus* *Betula*-NAP *Betula-Larix* NAP-*Betula*	Brörup Interstadial	
M1-11 NAP-*Betula nana-Juniperus*, clastic sand layer	M-13 NAP-*Betula nana-Juniperus*		*Artemisia*-NAP		Herning Stadial	
M1-10 NAP-*Pinus-Salix* M1-9 *Pinus*-NAP M1-8 *Pinus-Picea-Carpinus*	M-12 NAP-*Pinus-Salix* M-11 *Pinus-Betula*-NAP M-10 *Pinus-Picea-Carpinus*		E-III	*Pinus*		E E M I A N
M1-7 *Picea-Abies-Carpinus*	M-9 *Picea-Abies-Carpinus*			*Picea-Abies*		
M1-6 *Carpinus-Corylus-Alnus* M1-5 *Carpinus-Corylus-Tilia*	M-8 *Carpinus-Corylus-Alnus* M-7 *Carpinus-Corylus-Tilia*	S-6 *Carpinus-Alnus-Tilia*	E-II	*Carpinus*		
M1-4 *Corylus-Tilia-Alnus* M1-3 *Corylus-Quercus*	M-6 *Corylus-Tilia-Alnus* M-5 *Corylus-Quercus*	S-5 *Corylus-Tilia-Alnus* S-4 *Corylus-Quercus*		*Corylus*		
	M-4 *Quercus-Fraxinus-Ulmus*	S-3 *Quercus-Fraxinus*		*Quercus*		
	M-3 *Pinus-Betula-Ulmus*	S-2 *Pinus-Betula-Ulmus*	E-I	*Pinus-Betula*		
M1-2 *Betula-Pinus-Ulmus* M1-1 *Pinus*	M-2 *Betula-Pinus-Ulmus* M-1 *Pinus*	S-1 *Betula-Pinus*		*Betula*		

(68%) (Tobolski, 1991) confirm the importance of *Quercus* in the local forest communities. Simultaneously with this expansion of oak, pine decreased, but remained significant, especially at Sławoszewek (S-3 *Quercus-Fraxinus*).

Very high values of *Corylus* pollen in the Mikorzyn exposure diagram (max. 80%) and only slightly lower values in the neighbouring sites of Jóźwin/76 and Jóźwin/84 (Tobolski, 1991) indicate a marked expansion of hazel (*Corylus-Quercus, Corylus-Tilia-Alnus* pollen zones*)*. The considerably lower values of *Corylus* in the Sławoszewek profile are puzzling (max. 61%) and the accompanying relatively high values of *Quercus* (34–17%) suggest a local diversity of forest communities reflecting local environmental variability.

A further reconstruction of the forest communities saw the appearance of hornbeam (the *Carpinus-Corylus-Tilia* zone). Values of *Carpinus* that exceed 75% in the *Carpinus-Corylus-Alnus* zone are among the highest in Poland (Mamakowa, 1989).

Yew occurred at the maximum expansion of hazel, yet low pollen counts suggest that its occurrence was only sporadic, though increasing slightly at the hornbeam expansion. Similar low values of *Taxus* pollen are noted at other sites in the region, e.g. Władysławów and Jóźwin/76 (Tobolski, 1991), indicating that yew was rather limited in the forest communities of the Konin region.

The expansion of spruce and fir in the *Picea-Abies-Carpinus* zone caused further changes in the forest communities. Although the pollen values of *Abies* in both profiles from Mikorzyn are similar to those at the nearby Jóźwin/76 site (Tobolski, 1991), they belong among the lowest values noted for this zone in Poland. Spruce pollen counts vary from about 14% at Mikorzyn to 44% at Jóźwin/76 (Tobolski, 1991). At other sites in the Konin region (Jóźwin/84, Kazimierz, Władysławów), the *Picea-Abies* zone does not occur or is incomplete (Tobolski, 1991).

The end of the interglacial is primarily marked by the dominance of pine, although, despite the deterioration in climate, such trees as hornbeam, alder and spruce also survived into the *Pinus-Picea-Carpinus* zone. A general tendency throughout the NAP-*Pinus-Salix* zone is the increase in importance of herbaceous communities. The dense pine forest of the preceding zone was undergoing a gradual thinning.

The initial part of the Vistulian, represented by the M1-11 NAP-*Betula nana-Juniperus* zone in the Mikorzyn 1 profile is characterised by the spread of diverse open communities. The high proportion of Poaceae pollen (32%) points to a spread of grass communities with, presumably, an abundance of *Artemisia* in dry habitats. Shrub communities with dwarf birch and shrub willow occurred in damp habitats.

Recession of open communities and evolution of dense forest communities were caused by interstadial warming, correlated with the Brörup (M1-12–M1-15). The spread of birch communities, characteristic for the early part of the interstadial, was well marked in the Mikorzyn area. However, birch expansion was disturbed by a short cooling, which resulted in the temporary domination of herbaceous communities (M1-13 NAP-*Betula*).

Changes in the pollen curve of Mikorzyn 1 are related to the younger part of the Brörup (M1-15 *Pinus*). They comprise a sharp reduction in pollen of *Pinus sylvestris* type, and a twofold, very sharp and sudden increase in pollen of *Betula alba* type. These changes are difficult to interpret because they are unrelated to regional vegetation changes. For both diagrams: the Mikorzyn exposure (Stankowski *et al*., 1999) and Władysławów (Tobolski, 1991) pollen diagrams indicate that pine communities with limited birch participation covered the entire Konin region.

The vegetation evolution related to the second stadial of the Early Vistulian is better recorded in the Mikorzyn exposure diagram. Climate deterioration and accompanying herbaceous plant expansion caused a gradual retreat of forest communities (Stankowski *et al*., 1999). The M1-16 Poaceae-*Artemisia-Betula nana* zone represents a deforested period with dominant grass communities and the participation of motherwort. The increase in *Betula nana* pollen (2%) indicates an expansion of communities resembling shrub-tundra with dwarf birch accompanied by shrub willow (*Salix glauca* type).

The sudden expansion of tree birch, and the accompanying recession of herbaceous plants in the M1-17 *Betula*-NAP zone, indicates milder climate conditions. This is the first part of the next warm period, correlated with the Odderade Interstadial. The spread of pine and pine-birch communities in the M1-18 *Pinus-Betula*-Poaceae zone suggests further amelioration.

The two youngest zones most probably represent the Schalkholz Stadial. Presumably, residual pine communities are still present in the M1-19 Poaceae-*Pinus* zone, whereas at the beginning of the period represented by the younger zone (M1-20 Poaceae-*Artemisia*), the landscape was deforested, and dominated by shrub communities.

DISCUSSION AND CONCLUSIONS

The palynological data proved decisive in establishing the age of the organic succession in the Mikorzyn 1 section. They provide a record of Eemian and Early Vistulian deposition that is almost the same as in the Mikorzyn exposure (Stankowski *et al*., 1999). The two sequences of Eemian organic deposits, which are only 70 m apart from each other, are situated about 10 m in depth differences (*cf*. Figs. 1, 2, 5 and 6). This suggests that tectonic activity took place around Mikorzyn during both the Eemian Interglacial and the Vistulian Glaciation until to the period of ice sheet advance during the Leszno Phase.

The tectonic activity of Quaternary strata in the Mikorzyn area, was observed during sedimentological investigations and getting samples from Mikorzyn exposure (Stankowski *et al*., 1999). A normal fault 3–5 m with NNE–SSW strike, dipping 65º ESE was noted in the Early Vistulian deposits. Since the quarry had already been closed down, it was not then possible to establish whether the fault reached the Eemian organic deposits.

A further research of existing fault was undertaken by the Mikorzyn 1 borehole. The results of the palynological analyses proved the fault continuation, and about 10 m of vertical throw of the Eemian deposits.

A record of Late Quaternary movements and deformation of the substrate was noted in the same quarry a few years ago, 350 m SW of the Mikorzyn site. A injection structure of brown coal was discovered (Stankowski *et al*., 2003). It was over 20 m high and a few metres wide at the base, decreasing in width upwards. The structure top ended at the bottom of the Last Glaciation deposits (Stankowski *et al*., 1999; Stankowski, 2000).

The Late Quaternary tectonic activity of the Konin area has already been presented in the Konin-Przydziałki site (Stankowski, 1996). The timing of tectonic movements is well documented by previous stratigraphic investigations (Stankowska and Stankowski, 1979, 1991; Pazdur *et al*., 1981; Stankowski, 1991; Stankowski *et al*., 1992).

Both the fault and the injection structure likely developed as a result of Late Quaternary movements of the substrate that were controlled either by basement tectonics, salt tectonics, subglacial erosion processes or by glacioisostatic activation of older structures by the inland ice of the last glaciation.

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