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Palynostratigraphy of the Pleistocene in Poland and the Problem of the Age of Deposits from Besiekierz (Central Poland)

Palinostratygrafia plejstocenu Polski i problem wieku osadów z Besiekierza (Polska środkowa)

ABSTRACT

The paper deals with the pollen sequences of the Ferdynandów, Mazovian, Zbójno and Eemian Interglacials. A pollen diagram from Besiekierz is given and the pollen assemblage zones distinguished in it are discussed and referred to the Eemian Interglacial. Their reference to Eemian Interglacial suggests a need of reconsideration of geological position of this site. The problem of distinction of a new interglacial on the basis of the Losy profile diagram is also discussed. At the present time there seem to be not sufficient grounds for its distinction.

INTRODUCTION

A large number of works on the stratigraphy of the Quaternary in Poland were published in the eighties. Dealing with the subject on a local or a regional scale, they present stratigraphic schemes covering the whole of the Pleistocene or its fragments. Stratigraphic units, varying in rank, were distinguished, established, defined and compared; various were also the criteria used to distinction them (M.D. Baraniecka 1990, M. Harasimiuk et al. 1988, M.K. Krupiński and L. Marks 1986, L. Lindner 1984, 1987, 1988, L. Lindner and E. Brykczyńska 1980, J.E. Mojski 1985, S.Z. Różycki 1980).

The high rank of palaeobotanic documentation was emphasized in a number of the above-named works. However, not in all cases was the documentation complete. Particular samples were sometimes classified in much higher ranks than it would have been justified by the results of pollen analysis.

Intermorainic series can and should be distinguished on the basis of various criteria, but if palaeobotanic data are used as the basis for defining, certain conditions should be fulfilled, e.g. a relatively complete interglacial profile permitting a reconstruction of the full interglacial pollen sequence ought to be achieved (Z. Janczyk-Kopikowa 1987, Zasady ... 1988). This is essential when results of pollen analysis are to be adopted as the basis of palynostratigraphy, conceived as a method for the correlation of deposits in respect of age. In some cases a part of an interglacial profile can be referred to a proper palaeobotanically documented, chronostratigraphic unit. This happens when the samples provide documentation for the distinction of pollen assemblage zones characteristic of the pollen sequences of the interglacial climatic optima known to us.

On the basis of the complete interglacial pollen sequences W. Szafer (1953) presented "the Pleistocene stratigraphy in Poland from the floristic point of view". After the interglacial from Ferdynandów (Z. Janczyk-Kopikowa 1975) and that from Zbójno (L. Lindner and E. Brykczyńska 1980) have been published, one can speak of well characterized complete pollen sequences, which permit the acknowledgment of four different interglacials within the range of the mezo- and neo-Pleistocene in Poland. Regarding the Quaternary deposits from before the oldest (Narew) glaciation, it is hard to form an unambiguous opinion as to the number of warm periods and to obtain their clear floristic characters.

Four pollen periods can be distinguished in the interglacial pollen diagrams (W. Szafer 1953, Z. Janczyk-Kopikowa 1987 and others). The pollen sequences showing essential differences within periods II and III make a basis for the distinction of particular interglacials.

FLORISTIC CHARACTERISTICS OF THE FOUR INTERGLACIALS

Four periods of complete interglacial pollen sequences are distinguished: Ferdynandów, Mazovian, Zbójno, Eemian. Distribution of main discussed profiles of the interglacial deposits is shown on the Fig.1.

Ferdynandów Interglacial. The pollen sequence (Fig.2) bears the following distinctive features:

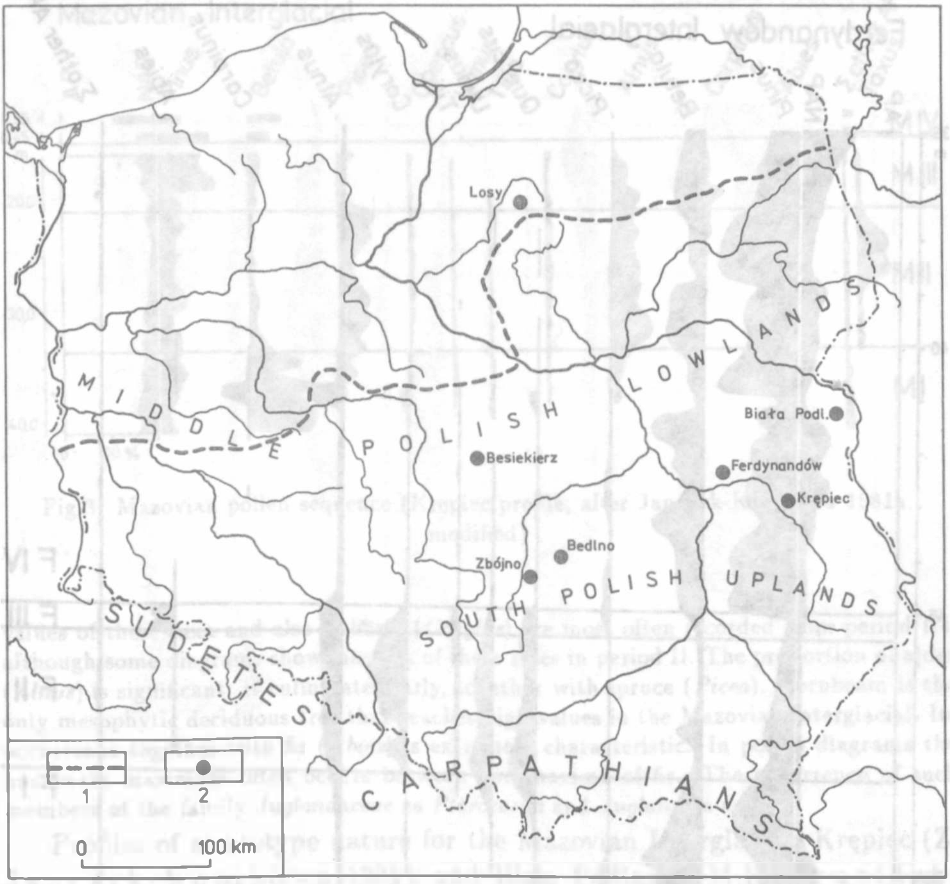

Fig.1. Distribution of main profiles of the interglacial deposits in Poland
1 — maximum extent of inland ice of the Vistulian glaciation; 2 — main profiles

The percentage of spruce (*Picea*) is low throughout the interglacial. Oak (*Quercus*) and elm (*Ulmus*) are dominant in the climatic optimum, reaching more or less equal values (about 20% each). The culmination of hazel (*Corylus* — maximum about 40%) occurs after the maxima of oak and elm. Low pollen values of linden (*Tilia*) are noted and hornbeam (*Carpinus*) appears sporadically, if at all. Short-lived but significant is the occurrence of fir (*Abies*) with a low proportion of yew (*Taxus*). The recurrence of the mild period in the upper part of the profile is expressed by the prevalence of deciduous forests with a high values of hornbeam (*Carpinus* — about 30%). The presence of such trees as *Pterocarya* and *Celtis* has been noted.

Profile of stratotype nature for the Ferdynandów Interglacial: Ferdynandów (Z. Janczyk-Kopikowa 1975). Profiles representative of the whole or part of the Ferdynandów pollen sequence:

Podgórze (T. Jurkiewiczowa et al. 1973)

Łuków (M. Sobolewska 1969)

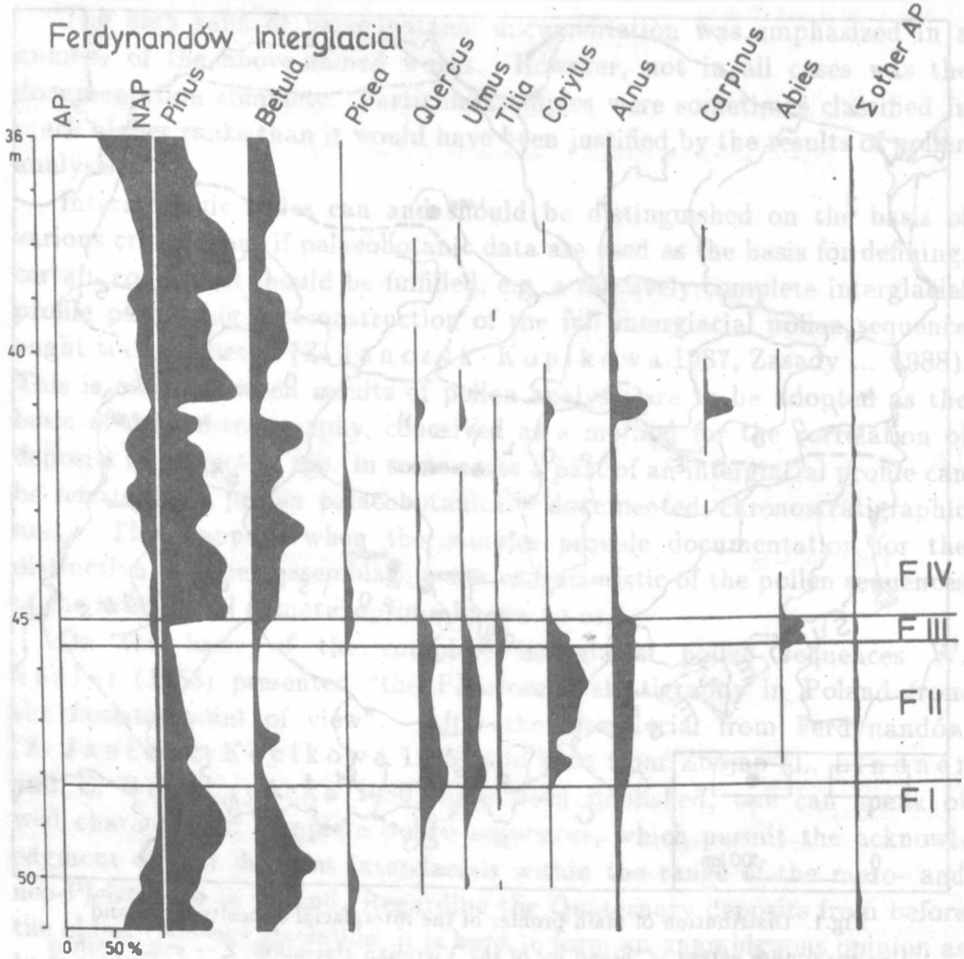

Fig.2. Ferdynandów pollen sequence (Ferdynandów profile, after Janczyk-Kopikowa 1975, modified)

Buczyna "pod brukiem" (Z. J a n c z y k - K o p i k o w a 1982a, 1991)
Lawki 7; Wola Grymalina 59 (D. K r z y s z k o w s k i and T. K u s z e l l 1987, T. K u s z e l l 1990)
Białobrzegi (Z. J a n c z y k - K o p i k o w a 1991)
Sosnowica (Z. J a n c z y k - K o p i k o w a 1991)

M a z o v i a n I n t e r g l a c i a l. The characteristics of the pollen sequence (Fig.3):

The proportion of coniferous trees is significant throughout the interglacial, pine (*Pinus*) being dominant at its beginning and decline, while spruce (*Picea*), yew (*Taxus*) and fir (*Abies*) culminate in succession, attaining their maxima, most frequently, of 20-30%. The thermophilous deciduous trees — oak (*Quercus*), elm (*Ulmus*) and linden (*Tilia*) — dominate in none of the periods and their percentages are not high. The maximum

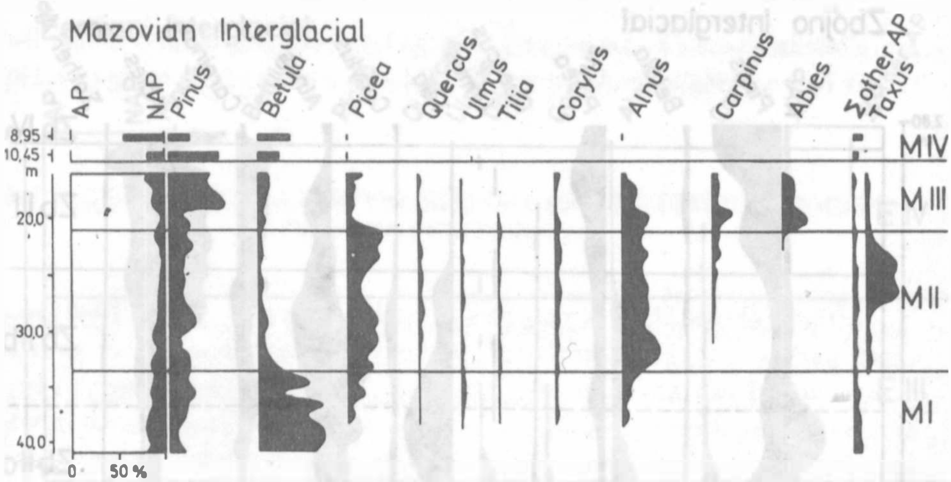

Fig.3. Mazovian pollen sequence (Krępiec profile, after Janczyk-Kopikowa 1981a, modified)

values of these taxa and also of hazel (*Corylus*) are most often recorded from period III, although some diagrams show maxima of these trees in period II. The proportion of alder (*Alnus*) is significant: it culminates early, together with spruce (*Picea*). Hornbeam is the only mesophytic deciduous tree that reaches high values in the Mazovian Interglacial. Its occurrence together with fir (*Abies*) is extremely characteristic. In pollen diagrams the hornbeam maximum often occurs between two maxima of fir. The occurrence of such members of the family *Juglandaceae* as *Pterocarya* and *Juglans* is noted.

Profiles of stratotype nature for the Mazovian Interglacial: Krępiec (Z. Janczyk-Kopikowa 1981), and Biała Podlaska (M.K. Krupiński 1988). Profiles representative of the whole or part of the Mazovian pollen sequence:

Adamówka (K. Bińka et al. 1987)
Barkowice Mokre (M. Sobolewska 1952)
Boczów (Z. Janczyk-Kopikowa and S. Skompski 1977)
Ciechanki Krzesimowskie (M. Brem 1953)
Cyganka (Z. Janczyk-Kopikowa 1982b)
Goleń (H. Winter 1986)
Gościęcin (A. Środoń 1957)
Jamno (M. Brzeziński and Z. Janczyk-Kopikowa 1991)
Karsy (D. Kosmowska-Suffczyńska and K. Szczepanek 1981)
Koczarki (Z. Borówko-Dłużakowa and W. Słowański 1991)
Maków Mazowiecki (M. Gołąbowa 1957)
Nowiny Żukowskie (J. Dyakowska 1952)
Olszewice (M. Sobolewska 1956b)
Poznań (H. Winter 1990a)
Przasnysz (W. Selle 1960, K. Mamakowa 1983)
Radziechowice - Kolonia Dubidze (Z. Borówko-Dłużakowa 1981)

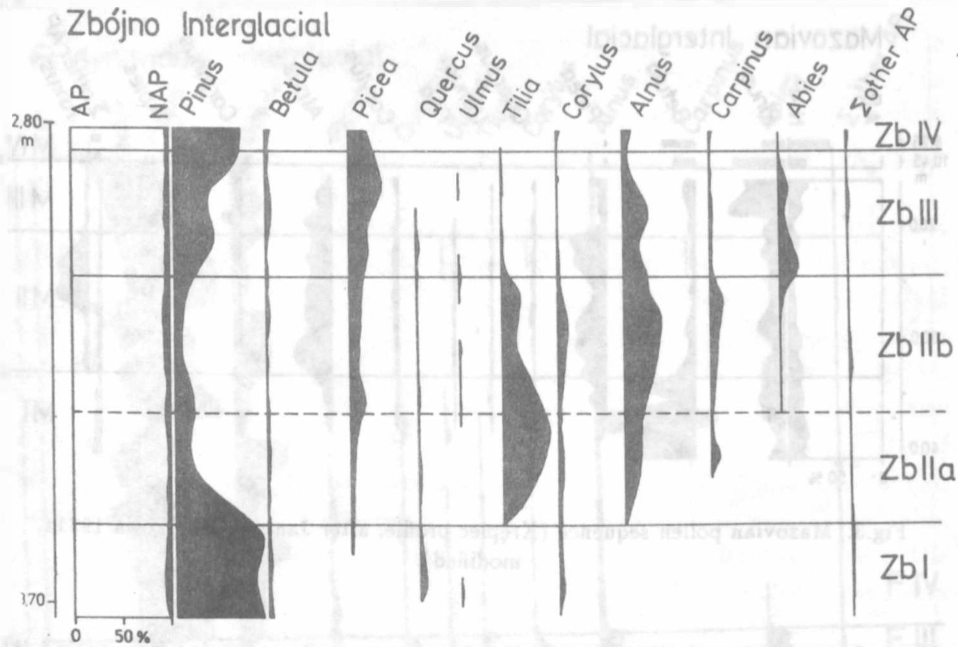

Fig.4. Zbójno pollen sequence (Zbójno profile, after Lindner and Brykczyńska 1980, modified)

Rokitno (Z. Janczyk-Kopikowa 1983)
Ruda (Z. Janczyk-Kopikowa 1985a)
Serniki (M. Sobolewska 1956a)
Sewerynów (J. Jurkiewiczowa and K. Mamakowa 1960)
Stanowice (M. Sobolewska 1977)
Śledzianów (Z. Borówko-Dłużakowa 1974)
Węgorzewo (M. Sobolewska 1975)
Włodawa (A. Stachurska 1957)
Wylezin (J. Dyakowska 1956)

Zbójno Interglacial. The pollen sequence (Fig.4) presents itself as follows:

The proportion of linden pollen is conspicuous, reaching above 40% and accompanied by slight values of oak and elm, below 10%. The occurrence of linden coincides with the significant proportion of alder pollen, the maximum of linden coming before that of alder. The percentage of hornbeam pollen and that of hazel are not very high throughout the interglacial. The culminations of linden and alder are followed by those of fir. Spruce is the last of the taxa of the mesocratic period to attain its maximum.

Profile of stratotype nature for the Zbójno Interglacial: Zbójno (Z. Lindner and E. Brykczyńska 1980). Profiles representative of the whole or part of the Zbójno pollen sequence:

Konin — Marantów (Z. Borówko-Dłużakowa 1967, K. Erd 1987)

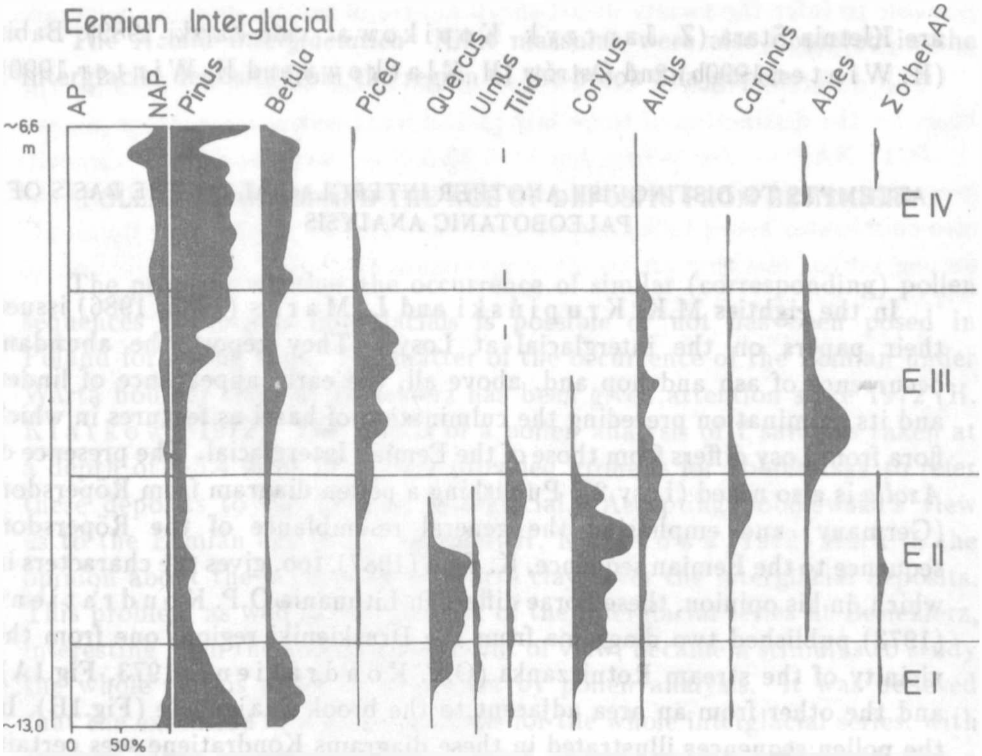

Fig.5. Eemian pollen sequence (Bedlno profile, after Środoń and Gołąbowa 1956, modified)

Raczki Wielkie (Z. J a n c z y k - K o p i k o w a 1985b)

E e m i a n I n t e r g l a c i a l. The pollen sequence (Fig.5) is characterized by the following features:

The proportion of oak and hazel pollen is high, their maxima being, more often than not, above 50%. Pollen values of elm are low, those of linden vary from region to region in Poland. The occurrence of hornbeam is common, significant and characteristic of a distinct pollen assemblage zone. Late culmination of alder and simultaneous occurrence of fir and spruce.

According to K. M a m a k o w a (1989), the characters permitting the unquestionable correlation of the Eemian diagrams are "... the expansion of trees and hazel in the following order: *Betula-Pinus, Ulmus, Quercus-Fraxinus, Corylus, Alnus, Taxus, Tilia, Carpinus, Picea-Abies* and the high *Corylus* values". Profile of stratotype nature for the Eemian Interglacial: Bedlno (A. Ś r o d o ń and M. G o ł ą b o w a 1956). Profiles representative of the whole or part of the Eemian pollen sequence, 99 in number of sites, are listed in K. M a m a k o w a's (1989a,b) work. The recently examined sites are Kletnia Stara (Z. Janczyk-Kopikowa: vide Żarski 1989). Babin (H. Winter 1990b) and Ostrów (H. Klatkowa and H. Winter 1990).

ATTEMPTS TO DISTINGUISH ANOTHER INTERGLACIAL ON THE BASIS OF PALEOBOTANIC ANALYSIS

In the eighties M.K. Krupiński and L. Marks (1985, 1986) issued their papers on the interglacial at Losy. They report the abundant occurrence of ash and hop and, above all, the early appearance of linden and its culmination preceding the culmination of hazel as features in which flora from Losy differs from those of the Eemian Interglacial. The presence of *Azolla* is also noted (Losy 2). Publishing a pollen diagram from Röpersdorf (Germany) and emphasing the general resemblance of the Röpersdorf sequence to the Eemian sequence, K. Erd (1987), too, gives the characters in which, in his opinion, these florae differ. In Lithuania O.P. Kondratiene (1973) published two diagrams from the Druskieniki region; one from the vicinity of the stream Rotniczanka (O.P. Kondratiene, 1973, Fig.1A), and the other from an area adjacent to the brook Snajgupele (Fig.1B). In the pollen sequences illustrated in these diagrams Kondratiene sees certain differences and regards them as separate.

Type — I sequence (Eemian)	Type — II sequence (Snajgupele)
1. Proportion of thermophilous deciduous trees up to 75%. Order of their appearance and expansion: oak with elm, next linden and, at last, hornbeam.	1. Stretched curves for thermophilous trees, notably linden.
2. Alder and hazel pollen appear and expand nearly simultaneously in the middle of the oak period.	2. Oak curve with two peaks, the lower peak being somewhat higher than the upper.
3. Abundant occurrence of hazel pollen (200%*), its maximum falling between the maxima of oak and linden.	3. Oak and linden pollen appear nearly simultaneously.
4. Pine pollen values do not exceed 10% in the climatic optimum and single grains of spruce pollen appear sporadically.	4. The alder pollen spreads before the spreading in hazel pollen.
	5. Hazel pollen values usually reach 100%.* Its maximum is noted above the maximum of linden, towards the end of the second maximum of oak.

*Percentage values of hazel pollen were calculated with AP assumed to be 100% without *Corylus* pollen.

The *Azolla interglaciatica* Nikit massulae were also observed in the interglacial deposits from the region of the brook Snajgupele.

POLLEN DIAGRAM AND THE AGE OF DEPOSITS FROM BESIEKIERZ

The problem whether the occurrence of similar (corresponding) pollen sequences in various interglacials is possible or not has been posed in Poland for a long time. The matter of the occurrence of the Eemian under Warta boulder clays at Besiekierz has been given attention since 1972 (H. Klatkowa 1972). The results of a pollen analysis of 7 samples taken at a depth of 4-5.4 m at Besiekierz provided grounds for Sobolewska to refer these deposits to the Eemian Interglacial. Accepting Sobolewska's view as to the Eemian age of the samples, H. Klatkowa (1972) stuck to the opinion about the occurrence of Warta clays over the interglacial deposits. This problem as well as the position of the interglacial series at Besiekierz, interesting from the stratigraphic point of view, became a stimulus to study the whole of this series of Besiekierz by pollen analysis. It was believed that the execution of a pollen analysis for the whole interglacial series, with samples taken appropriately close apart, would perhaps provide us with a picture of the full interglacial pollen sequence.

The results of this analysis are presented in pollen diagram (Fig.6), which illustrates the interglacial pollen sequence and is divided into four pollen periods (W. Szafer 1953, Z. Janczyk-Kopikowa 1987). Local pollen assemblage zones have also been distinguished; they are partly connected with one another, that is, the upper boundary of the preceding zone makes the lower boundary of the following one. The zones are designated by the symbol B for Besiekierz and by Arabic numerals from the bottom upwards. At attempt has been made to correlate them with the regional pollen zones described and defined for the Eemian Interglacial by K. Mamakowa (1988, 1989).

The late-glacial pollen spectra with which the sequence from Besiekierz begins show the dominance of forestless tundra-type or steppe-tundra-type vegetation: open ground plants are present. The high proportion of *Gramineae*, *Chenopodiaceae* and other plants typical of dry habitats and especially the marked percentage of *Artemisia* give evidence of the presence of the steppe element in this flora. The presence of light-demanding dwarf shrubs and shrubs, including *Betula sec. Nanae*, *Salix*, *Ephedra*, *Helianthemum*, *Hippophaë* *Juniperus*, *Empetrum* and *Ericaceae* makes it possible to infer the locally dwarf shrub nature of tundra and the existence of shrub thickets.

The differentiation of the picture of forestless vegetation became the basis for the distinction of three late-glacial local pollen assemblage zones.

B-1: NAP — *Juniperus*; depth: 5.90-6.00 m, samples 77-79. Deposit: grey clay. A NAP maximum of 46.4% is noted in this zone. *Juniperus* also culminates here (3.2%) and so does *Salix* (1.6%). *Gramineae* dominate among herbs, reaching an absolute maximum of 17.0%, the proportion of *Artemisia* being also significant (12%).

A comparison of the B-1 zone with the late-glacial zones distinguished at other sites shows that it may be correlated (in view of its great similarities, simply convergence) with the NAP — *Juniperus* zone distinguished by K. Mamakowa (1988, 1989) in the diagram from Warszawa-Wawrzyszew, from which its name is derived, worked out by Krupiński.

B-2: *Hippophaë*; depth: 5.80-5.90 m, samples 74-76. Deposit: clayey silt. The high pollen values of *Hippophaë* (max. 15%) with the constant occurrence of *Populus* and *Helianthemum* are the characteristic feature of the zone. There are still high NAP values (above 39%), of which *Artemisia* forms 13.2%, while *Gramineae* and *Cyperaceae* 6% each. The maximum values of redeposited sporomorphs are 7.4% in sample 76 from a depth of 5.89 m.

On comparing the occurrence of *Hippophaë* pollen, one can refer this zone to the *Hippophaë-Betula* zone from Warszawa-Wawrzyszew (K. Mamakowa 1988,1989).

B-3: *Artemisia* - *Betula*; depth: 5.68-5.80 m, samples 71-73. Deposit: brown gyttja. The NAP values still keep within limits of 30%. Here *Artemisia* attains a maximum of 13.6%, *Hippophaë*, *Juniperus*, *Helianthemum*, *Populus* and *Salix* being present. *Pleurospermum austriacum* and *Linnea borealis* are noted sporadically. Amidst *Betula* pollen, with values reaching 43.0%, there are grains whose morphology permits the statement that a contribution of *Betula nana* pollen in this zone is possible (the number of its grains has not been established).

B-4: *Pinus* - *Betula*; depth: 4.40-5.70 m, samples 45-70. Deposit: gyttja. This zone is characterized by forest spectra. *Pinus* and *Betula* are both represented and reach their maxima here. The proportion of NAP ranges from 4.4 to 15.0%. There are, in addition, *Populus*, *Juniperus*, *Ephedra* and *Helianthemum*. *Quercus*, *Ulmus* and *Fraxinus* appear for the first time.

B-5: *Pinus* - *Betula* - *Ulmus*; depth: 3.92-4.40 m, samples 39-44. Deposit: gyttja. The *Pinus* and *Betula* pollen is most abundant here, the

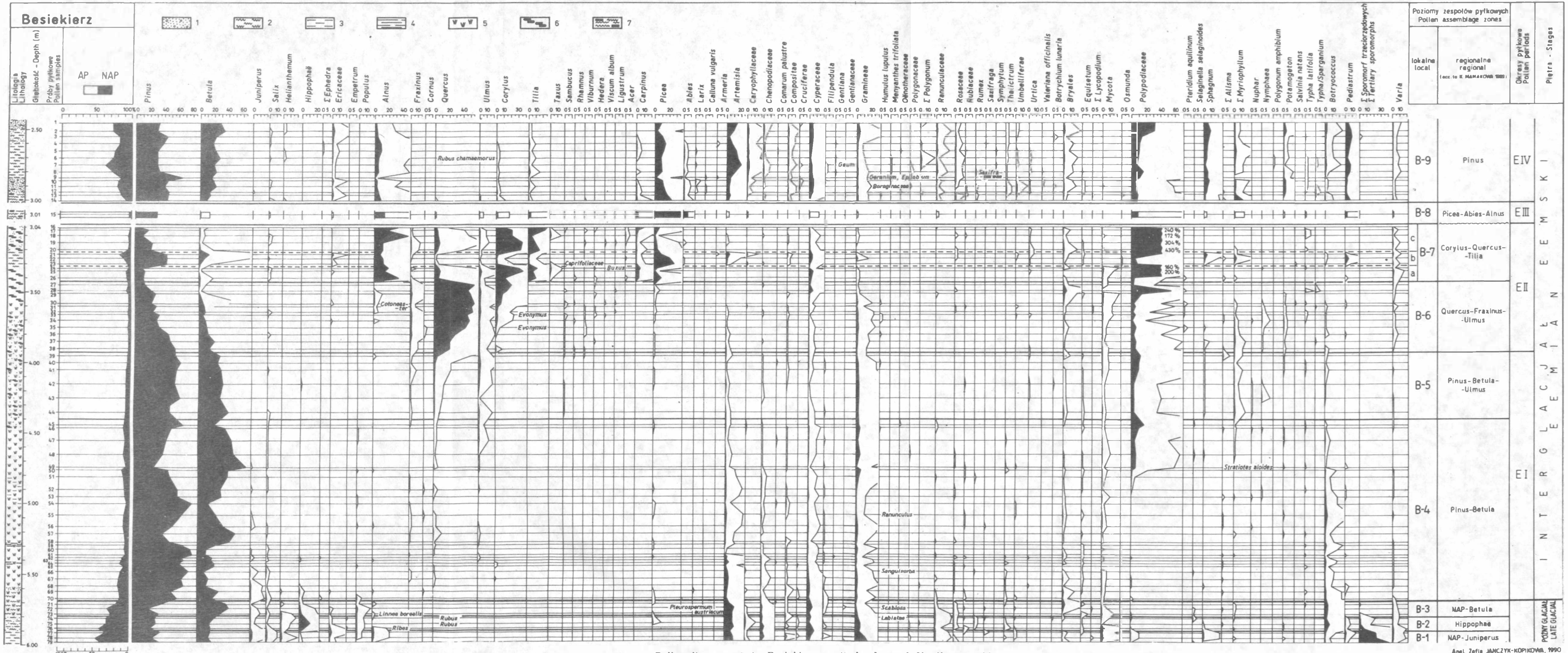

Fig. 6. Pollen diagram of the Besiekierz profile by Janczyk-Kopikowa 1990

1 — sand; 2 — silt; 3 — clay; 4 — shale; 5 — gyttja; 6 — peat; 7 — peat mud

occurrence of *Ulmus* pollen being constant (up to 3%). *Fraxinus* is also present and *Sambucus, Rhamnus frangula, Viburnum* and *Humulus* appear.

B-6: *Quercus - Fraxinus - Ulmus*; depth: 3.40-3.90 m, samples 27-38. Deposit: gyttja and peat. The dominance of *Quercus* (max. 56.2%) is characteristic of this zone. *Fraxinus*, too, reaches maximum of 3.2% here; *Ulmus* pollen ranges from 1 to 3.2%. A rapid increase in the *Corylus* pollen values (to 22.2%) is observed in the younger part of the zone. *Hedera helix, Ligustrum* and *Viscum album* are also recorded present in this zone. The NAP values lie bellow 5%.

B-7: *Corylus - Quercus - Tilia* ; depth 3.04-3.40 m, samples 16-26. Deposit: peats and silt. This zone is characterized by the dominance of *Corylus* pollen, which attains a maximum of 36.2%. *Tilia* having appeared in this zone, has a maximum of 25.6% after the culmination of *Corylus* in the younger part of the zone. *Carpinus* also appears. The presence of *Acer* and *Buxus* pollen is noteworthy. The *Alnus* pollen values, with a culmination of 47%, are significant and so is the low — but related only to this zone — proportion of *Taxus* (1.8%).

The B-7 zone is not optimally developed. Disturbances are observed in the course of pollen curves. Silt occurs at a depth of 3.21-3.32 m, inside the peat series in the profile. The pollen spectra from the silt (samples 21-23) differ considerably from those from the over- and underlying samples of the peat. *Pinus* (to 45.4%) and *Picea* (to 27.8%) dominate in samples 21-23, the proportion of *Betula* being 14.4%. The pollen values of thermophilous deciduous trees decrease rapidly, not exceeding 5%. NAP reaches 15.2%. This phenomenon can be interpreted in many ways: changes in the course of pollen curves may result either from the displacement of deposits in the profile or from the destruction of the forest by fire, or, lastly, the picture of changes may have been brought about by a climatic swing. There are no distinct findings to support one of those alternatives. The diagram from Besiekierz is not the only one that records such a phenomenon. Similar changes in the course of pollen curves have been observed and discussed at the sites of Góra Kalwaria (S o b o l e w s k a 1961) and Żyrardów 2/69 (M.K. K r u p i ń s k i 1978). This problem is also dealt with by K. M a m a k o w a (1989).

B-8: *Picea - Abies - Alnus*; depth: 3.01-3.03 m, sample 15. Deposit: peaty mud. In this sample *Picea* pollen attains an absolute maximum of 36.2%. A 5.8% peak of *Abies* pollen is also noted here. The pollen values of other taxa are: *Pinus* — 30.4%, *Betula* — 1.4% and *Alnus* — 13.8%. The pollen values of thermophilous deciduous trees reach 5% and NAP — 2.6%.

This is the only pollen spectrum that can be referred to the *Picea-Abies-Alnus* zone (K. M a m a k o w a 1988, 1989).

From zone B-7 upwards the pollen diagram from Besiekierz, as a rule, loses its trsnsparent nature. The reference of sample 15 (depth: 3.01 m) to the *Picea-Abies-Alnus* zone results in that the *Carpinus-Corylus-Alnus* zone is not distinguishable in the diagram from Besiekierz. Consequently, it should be assumed that there is a hiatus between the last peat sample (16 at a depth of 3.04) and the first (lowest) sample of peaty silt (15 at 3.01 m), covering at least a period of the prevalence of forests with dominant *Carpinus*. This is hiatus marked in the diagram.

The fact that only the pollen spectrum of one sample can be referred to the generally well-developed *Picea-Abies-Alnus* zone (K. M a m a k o w a 1988, 1989) suggests another break in the accumulation of deposits, a gap between sample 15 (3.01 m) and sample 14 (3.00 m). This time the change of spectra takes place within the macroscopic homogeneous deposit — peaty mud. Also this hiatus is marked in the pollen diagram.

B-9: *Pinus*; depth: 2.24-3.00 m, samples 1-14. Deposit: peaty mud, humus sand and silt. The dominance of *Pinus* is distinct in this zone. Its maximum is 64.8%. The *Betula* pollen values increase gradually from 8.6 to 33.6% and *Picea* ranges between 2.2 and 22.6%. The pollen values of *Tilia, Corylus, Carpinus* and *Abies* do not reach 1%. An increase in NAP is observed, the pollen walues of *Artemisia*, with a maximum of 20.4%, being noteworthy.

Zone B-9 has been acknowledged to be the final interglacial zone at Besiekierz, although the high values of *Artemisia* are generally associated with the first stadial of the Vistulian (K. M a m a k o w a 1988, 1989, K. T o b o l s k i 1986) and in accordance with these criteria the B-9 zone might be referred to the Early Vistulian. However, the occurrence of *Artemisia* pollen at Besiekierz seems to be more closely related to the developing steppe nature of plant communities than to a significant fall in temperature. It is also thought that the pollen of thermophilous deciduous trees occurring in the B-9 zone derives from the plants which made up the forest. Neither long distance transport nor redeposition, since it would have been a selective redeposition, has been assumed to account for these taxa. The taxa under discussion withdraw gradually, which can be clearly seen on the curves for oak, elm, hazel and hornbeam.

The discontinuity of the pollen sequence from Besiekierz starting from the B-7 zone causes the incomplete nature of its picture. Nevertheless, the results obtained with this profile permit the following statements:

1. The deposits do not represent the Ferdynandów, Mazovian or Zbójno Interglacial. The previously discussed pollen sequences of these interglacials are not reflected in the diagram from Besiekierz.

2. The pollen sequence from Besiekierz does not correspond with the sequence presented by O.P. Kondratiene (1973) for the Snajgupele Interglacial.

3. The separation of pollen assemblage zones at Besiekierz and their close correlation with the Eemian regional zones distinguished by K. Mamakowa (1988, 1989) refer the Besiekierz deposits to the Eemian Interglacial with emphasis laid on the incompleteness of the Eemian pollen sequence at this site.

FINAL REMARKS

On the basis of the study of data which have been obtained so far by pollen analysis and would serve do distinguish a new unit (new interglacial) in the stratigraphical schemes of the Quaternary of Poland (see M.K. Krupiński and L. Marks 1985, 1986) and so a unit whose distinction would be based on palynostratigraphy, it should be stated that at present there is no profile which could provide grounds for such a distinction. To the full extent is here supported the opinion expressed earlier (Z. Janczyk-Kopikowa 1987) that only complete interglacial pollen sequences may be used to establish and define new stratigraphical units. At the present time we are in a position to distinguish four interglacials within the range of the mezo- and neo-Pleistocene in Poland on palynostratigraphical bases, namely, the Ferdynandów, Mazovian, Zbójno and Eemian interglacials.

The correlations of the Eemian and Mazovian interglacials with the interglacials from outside Poland are unambiguous: Eemian Interglacial = Eemian = Mikulino; Mazovian Interglacial = Holstein = Likhwin. As to the correlation of the Ferdynandów and Zbójno interglacials, the situation is not so obvious. The Ferdynandów Interglacial correlates well with the Shklov Interglacial from the Russian Plain, whereas its palaeobotanical correlation with the sites in Western Europe is not simple. The Zbójno Interglacial has not, as yet, its unambiguous counterparts outside Poland.

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STRESZCZENIE

W latach osiemdziesiątych ukazalo się wiele prac o stratygrafii czwartorzędu. Prezentowane schematy stratygraficzne nie we wszystkich swych fragmentach mialy pełną dokumentację paleobotaniczną. W niniejszym artykule scharakteryzowano te cieple piętra plejstocenu glacjalnego (interglacjały), dla których dokumentacja florystyczna jest pełna. Są to interglacjały: ferdynandowski, mazowiecki, zbójnowski i eemski.

Sukcesja pyłkowa interglacjału ferdynandowskiego (ryc. 2) charakteryzuje się niewielką w całym interglacjale rolą świerka. W optimum klimatycznym panują dąb i wiąz, osiągając wartości po około 20%. Kulminacja leszczyny przypada po maksimach dębu i wiązu. Lipa notowana jest w niewielkich ilościach. Grab nie występuje w ogóle lub jedynie sporadycznie. Krótkotrwała, ale znacząca jest rola jodły łącznie z nikłym udziałem cisa. Powtórne ocieplenie zarejestrowane w górze profilu wyrażone jest panowaniem lasów liściastych ze znacznym udziałem graba. Stwierdza się występowanie takich drzew, jak *Pterocarya* i *Celtis*.

Sukcesja pyłkowa interglacjału mazowieckiego (ryc. 3) charakteryzuje się dużą rolą drzew iglastych w całym okresie. Sosna dominuje na początku i u schyłku interglacjału, zaś świerk, cis i jodła kulminują kolejno. Drzewa liściaste ciepłolubne — dąb, wiąz i lipa — nie osiągają zbyt wysokich wartości. Z mezofitycznych drzew liściastych jedynie udział graba jest znaczny. Jego współwystępowanie z jodłą jest ogromnie charakterystyczne. Znaczący jest też udział olszy, która kulminuje wcześnie, łącznie ze świerkiem. Stwierdza się występowanie takich drzew, jak *Pterocarya* i *Juglans*.

Sukcesja pyłkowa interglacjału zbójnowskiego (ryc. 4) charakteryzuje się wybitną rolą lipy przy nikłym udziale dębu i wiązu. Notuje się współwystępowanie lipy wraz ze znaczącym udziałem olszy. W całym interglacjale niewielki jest udział leszczyny i graba. Jodła kulminuje po maksimach lipy i olszy, a jako ostatni osiąga swe maksimum świerk.

Sukcesja pyłkowa interglacjału eemskiego (ryc. 5) charakteryzuje się wysokim udziałem dębu i leszczyny, często powyżej 50%. Wartości wiązu są niskie, lipy zmienne w zależności od regionu Polski. Powszechny i znaczący jest udział graba. Olsza kulminuje późno. Świerk i jodła wsp[illegible]występują; najwyższe wartości jodły notowane są w środkowej Polsce.

Przedyskutowano także sprawę sukcesji pyłkowej w Losach. Uznano, że jak dotychczas brak jest wystarczających argumentów florystycznych wynikających z diagramu profilu Losy, które upoważniałyby do wyróżnienia nowego interglacjału na podstawach palinostratygraficznych.

Przeanalizowano także sukcesję pyłkową interglacjału z Besiekierza (ryc. 6). Wydzielone w diagramie lokalne poziomy zespołów pyłkowych dają się dobrze skorelować z regionalnymi poziomami pyłkowymi wyróżnionymi przez K. M a m a k o w ą (1988, 1989) dla interglacjału eemskiego. Tym samym utrzymane zostało odniesienie przez Sobolewską (patrz H. K l a t k o w a 1972) osadów z Besiekierza do interglacjału eemskiego.