Geological Quarterly, 1999, 43 (1): 1–8

New approach to stratigraphy of palaeolake and glacial sediments of the younger Middle Pleistocene in mid-eastern Poland

Leszek LINDNER, Leszek MARKS

Lindner L., Marks L. (1999) — New approach to stratigraphy of palaeolake and glacial sediments of the younger Middle Pleistocene in mid-eastern Poland. Geol. Quart., 43 (1): 1–8. Warszawa.

Basing on 10 key sections from mid-eastern Poland, the three interglacials (Mazovian, Zbójnian and Lubavian, which follow the Sanian 2 (Wilgian) Glaciation and precede the Wartanian, are separated from one another by two glacial episodes. The older is the Liviecian Glaciation and the younger is the Krznanian Glaciation (named after the River Krzna). The Krznanian Glaciation occupies a stratigraphic location of the previous Odranian Glaciation. The latter is postulated to be incorporated into the Wartanian Glaciation as the maximum stadial. Such stratigraphic subdivision of the younger Middle Pleistocene of Poland indicates a very close relationship to the most recent stratigraphic schemes of glacial and interglacial units in Germany and in the Russian Plain.

Leszek Lindner, Institute of Geology, Warsaw University, Żwirki i Wigury 93, 02-089 Warszawa, Poland; Leszek Marks, Polish Geological Institute, Rakowiecka 4, 00-975 Warszawa, Poland, e-mail: lmar@pgi.waw.pl (received: November 19, 1998; accepted: December 30, 1998).

Key words: mid-eastern Poland, Middle Pleistocene, Mazovian Interglacial, Krznanian Glaciation, stratigraphy, palaeogeography.

INTRODUCTION

The paper presents a new approach to stratigraphy of the younger Middle Pleistocene of Poland, particularly to a number and age of the Middle Polish Glaciations (Saalian). This idea is based on denial of the Eemian age of sediments of the so-called Sztum Sea (*cf.* A. Makowska, 1994), as well as on numerous new evidence of a more southern limit of a till, geochronological and lithological parameters of which are typical for the Wartanian Glaciation (among others J. Nitychoruk, 1994; L. Marks *et al.*, 1995; L. Lindner, 1996, 1998; L. Lindner, S. Fedorowicz, 1996; B. Jaśkowski, B. J. Kowalski, 1997, 1998; S. Lisicki, 1998*a*). Significant role in this stratigraphic discussion has been played by new sites of the Zbójnian Interglacial in Poland (*cf.* P. Woźniak, 1989; Z. Janczyk-Kopikowa, 1991, 1998; T. Kuszell, 1997). All these facts supplement the previous conclusions, drawn from correlation of individual units of the Saalian Glaciation in mid-western Europe (*cf.* L. Marks, 1991), and the more recent opinions on evidence for four interglacials after the Sanian 2 Glaciation (Elsterian 2) in Europe (*cf.* L. Lindner, B. Marciniak, 1998).

YOUNGER MIDDLE PLEISTOCENE

Limits of the Middle Pleistocene are accepted in this paper by D. Q. Bowen (1978), i.e. the boundary Matuyama/Brunhes at the base (about 700 ka) and a beginning of the Eemian Interglacial at the top (about 128 ka). The younger Middle Pleistocene begins with the Sanian 2 Glaciation (=Wilgian) and terminates with the Wartanian Glaciation. Description of this interval is based among others on analysis of 10 sections of the Quaternary deposits (Grabówka, Nowiny, Goleń, Raczki Wielkie, Losy, Nidzica, Krępiec, Ossówka, Zbójno and Bedlno) from mid-eastern Poland (Figs. 1 and 2).

SANIAN 2 GLACIATION

Ice sheet of the Sanian 2 Glaciation, correlated with the oxygen isotope stage 12, reached northern slopes of the Carpathians and the Sudetes (L. Lindner, L. Marks, 1995). It deposited commonly a single or two tills. In the section Goleń (Figs. 1 and 2), between these tills there are lake sediments with a fragmentary pollen succession (*cf.* H. Winter, S. Lisi-

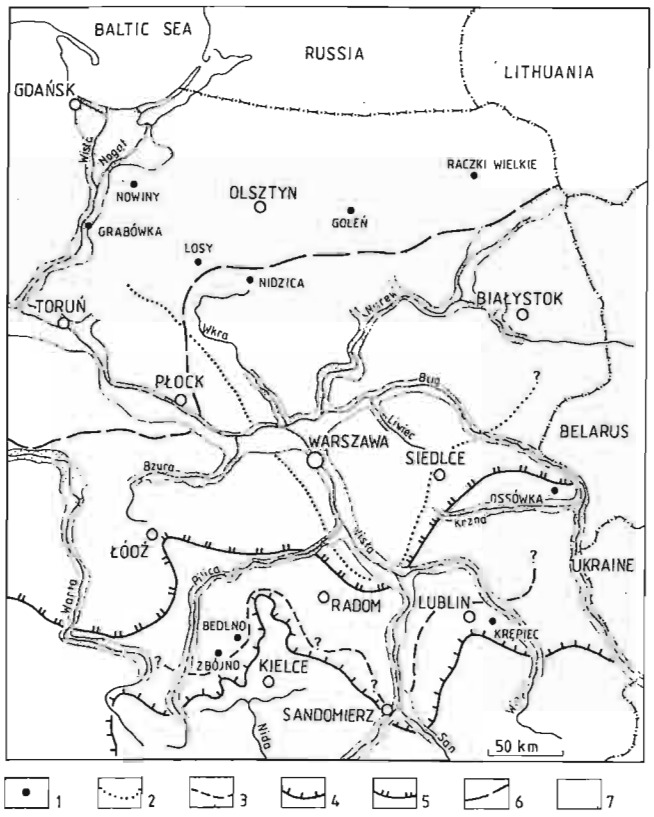

Fig. 1. Location of the study area in mid-eastern Poland

1 — main sections of interglacial sediments; maximum limit of ice sheets during the Scandinavian glaciations: 2 — Liviecian, 3 — Krznanian, 4 — Wartanian (Odranian Stadial), 5 — Wartanian (Wartanian s.s. Stadial), 6 — Vistulian; 7 — Late Glacial and Holocene river valleys

cki, 1998), components and location of which speak for a warm interstadial or a new interglacial, named recently the Mrongovian (*cf.* H. Winter, 1998; S. Lisicki, 1998*b*). Till of the Sanian 2 Glaciation occurs also at Krępiec (M. Harasimiuk, A. Henkiel, 1981; M. Harasimiuk *et al.*, 1988). According to L. Lindner (1992), it represents the youngest of the South Polish Glaciations (Fig. 2).

MAZOVIAN INTERGLACIAL

It is the oldest climatic warming within the so-called Great Interglacial (Fig. 2) according to S. Z. Różycki (1964, 1972), and is among the better examined climatostratigraphic units of the Pleistocene of Poland. In the presented area it occurs commonly, among others in the sections of lake sediments at Krępiec, Goleń and Ossówka (Figs. 1 and 2). Palynological analysis of the section Krępiec proved (*cf.* Z. Janczyk-Kopikowa, 1981) that deposition occurred during four vegetation periods, a climatic optimum during the third one with *Vitis*, and predominating *Carpinus* and *Abies*. Diatom analysis of these sediments indicates (*cf.* B. Marciniak, 1980, 1983) prevalence of nannoplanktonic diatoms in the bottom, partly replaced in the middle by littoral and reophilic species, and in the top by specimens, typical for shallowing and overgrowing of the lake with macrophytes. From a biostratigraphic point of view, these sediments are to be easily correlated with deposits of the Holsteinian Interglacial in Germany (*cf.* B. Urban, 1997) and the Likhvinian Interglacial in the Russian Plain (*cf.* N. S. Bolikhovskaya, N. G. Sudakova, 1996). They correspond to the oxygen isotope stage 11 in deep-sea sediments (*cf.* L. Lindner, B. Marciniak, 1998).

In the section Goleń, this interglacial is represented (H. Winter, S. Lisicki, 1998) by lake sediments, underlain by a till with petrographic coefficients typical for the Liviecian(?) Glaciation and covered by a till of the Odranian Glaciation. In the Lower Vistula Valley, bottom parts of tills of the Middle Polish Glaciations contain glacial rafts with marine sediments of the Mazovian (= Holsteinian) Interglacial (*cf.* A. Makowska, 1986). They are mainly sands and silts with pieces of *Cardium* sp., *C. echinatum*, *C. edule*, as well as forams of the Holstein Sea that undoubtedly occurred in the southern part of the Baltic Basin (*cf.* O. Kondratiene, V. Gudelis, 1983; L. Marks, 1988, 1994).

Fluvial pattern of the Mazovian Interglacial in Poland has been considered to be reflected by relief of the Quaternary substrate (S. Z. Różycki, 1965; E. Rühle, 1955, 1967, 1973). They were L. Lindner *et al.* (1982) who postulated a present-like fluvial pattern of the Mazovian Interglacial. Lack of reliable dating methods makes the assumed water level of the Holstein Sea to be the most important index for reconstruction of a fluvial pattern of the Mazovian Interglacial. According to the studies in the Kaliningrad District of Russia and in the Hamburg region of northwestern Germany, this level is expected to be close to a sea level of the present Baltic Sea (*cf.* L. Marks, 1994, 1995). Therefore, outside the areas with undoubted glaciotectonic deformations or neotectonic movements, beds of the buried river valleys of the Mazovian Interglacial are to be located at similar altitudes as the beds of contemporary rivers in Central Europe (*cf.* Fig. 3).

LIVIECIAN GLACIATION

The Liviecian Glaciation in mid-eastern and northeastern Poland is represented by a separate till (L. Lindner, L. Marks, 1995; S. Lisicki, 1997), preserved among others in the section Raczki Wielkie (Figs. 1 and 2), and possibly also as a lowest till at Grabówka (Figs. 1 and 2). In other sections this till is absent (*cf.* Fig. 2), presumably due to glacial erosion. Close to its southernmost limit, a till of this glaciation was found in the vicinity of Kozienice and Dęblin, central Poland (M. Żarski, 1994). In the section Zbójno there are only silts, deposited in the extraglacial zone (L. Lindner, E. Brykczyńska, 1980). Geological setting of sediments of the Liviecian Glaciation suggests their correlation with the oxygen isotope stage 10 (*cf.* L. Lindner, L. Marks, 1995).

ZBÓJNIAN INTERGLACIAL

This interglacial is a successively younger, warm climatostratigraphic unit within the Great Interglacial (Fig. 2). In the presented area, its lake sediments are known from the

section Zbójno and presumably also from the section Raczki Wielkie (Figs. 1 i 2). In the section Zbójno, four periods of vegetation development were distinguished, with climatic optimum during the second period when drop of *Pinus* was accompanied at first by rapid development of *Tilia* (to 48%) and then, drop of *Tilia* (to 20%) with rise of *Alnus*, *Carpinus*, *Picea* and *Corylus*, accompanied by *Quercus* (L. Lindner, E. Brykczyńska, 1980). These sediments are represented by peat on silts of the Liviecian Glaciation and the underlying alluvia of the Mazovian Interglacial. They are covered by silts, sands and a till of the younger glaciation (L. Lindner, B. Marciniak, 1998). In the section Raczki Wielkie, deposits of this interglacial are presumably composed of two layers of peat, a pollen analysis of which was done by Z. Janczyk-Kopikowa (*cf.* P. Woźniak, 1989). The Zbójnian Interglacial is generally correlated with the oxygen isotope stage 9 (*cf.* L. Lindner, B. Marciniak, 1998).

KRZNANIAN GLACIATION

Geological data on the Pleistocene of mid-eastern Poland prove that the first post-Zbójnian glacial sediments are located at stratigraphic position of the previously distinguished Odranian Glaciation (Fig. 4). These deposits are, however, less widespread if compared with extents of the hitherto distinguished Middle Polish Glaciations (i.e. Odranian and Wartanian). They are connected with the Scandinavian ice sheet that presumably passed across the meridional reaches of the Pilica and Wieprz Rivers, as far south as the Krzna River (Krzna Stadial after E. Rühle, 1970) and therefore, should be named the Krznanian Glaciation. It could, however, even reach the northern slopes of the South Polish Uplands and had been miscorrelated with the Końskie (pre-maximum) Phase of the Odranian Glaciation (*cf.* L. Lindner, 1971, 1995, 1998; L. Lindner, S. Fedorowicz, 1996; L. Lindner, J. Semil, in print). In the whole mid-eastern Poland, the Krznanian Glaciation is represented by a till, preserved in most sections (Figs. 1 and 2). At Grabówka, this till presumably underlies the interglacial lake series, examined by A. Makowska (1977). At Nowiny, it is overlain by varved clays and silts that pass gradually upwards into sediments of the so-called Sztum Sea (*cf.* A. Makowska, 1979, 1986). This till occurs presumably also at Raczki Wielkie (P. Woźniak, 1989), whereas at Losy it is probably replaced by sands and gravels beneath sediments of the Lubavian Interglacial (*cf.* K. M. Krupiński, L. Marks, 1986). Thus, the Krznanian Glaciation seems to correspond to the oxygen isotope stage 8, i.e. to this global cooling which was previously correlated with the Odranian Glaciation (*cf.* L. Lindner, L. Marks, 1995).

LUBAVIAN INTERGLACIAL

The Lubavian Interglacial is best represented by a lake marl in the section Losy near Lubawa (Figs. 1 and 2), geological setting and pollen diagram of which were examined by K. M. Krupiński and L. Marks (1985, 1986). The lake sediments from Grabówka, examined in a few samples only by Z.

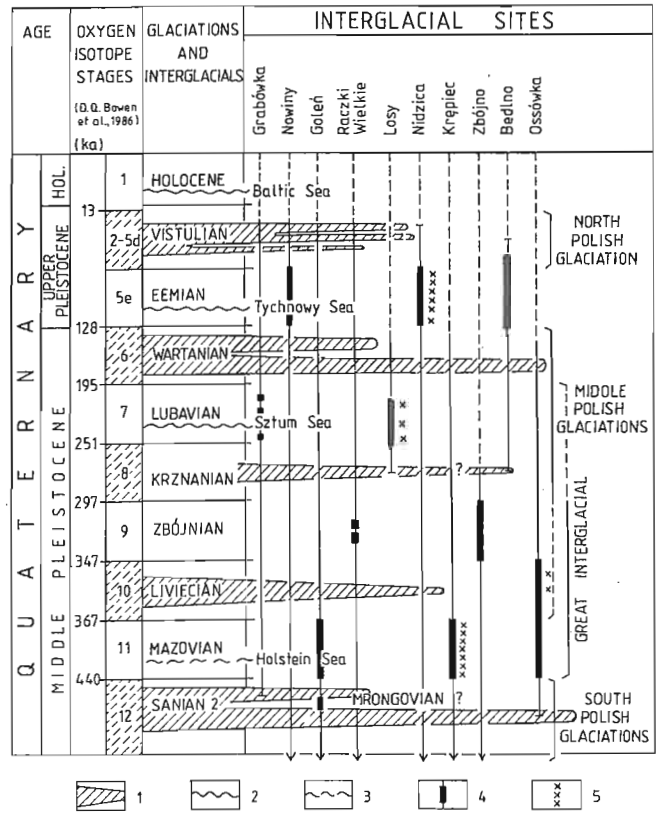

Fig. 2. Stratigraphic-palaeogeographic scheme of glaciations and interglacials during the younger Middle Pleistocene and the Late Pleistocene of Poland

1 — main tills; 2 — interglacial sea transgressions; 3 — probable interglacial sea ingressions (on the basis of redeposited marine sediments); 4 — section fragments with palynologic analysis; 5 — section fragments with diatom analysis; interglacial sites: Grabówka (A. Makowska, 1977), Nowiny (A. Makowska, 1986), Goleń (H. Winter, S. Lisicki, 1998), Raczki Wielkie (P. Woźniak, 1989), Losy (K. M. Krupiński, L. Marks, 1986), Nidzica (Z. Michalska in: B. Marciniak, W. W. Kowalski, 1978), Krępiec (M. Harasimiuk, A. Henkiel, 1981), Ossówka (B. Marciniak in: L. Lindner *et al.*, 1990; K. M. Krupiński, 1995), Zbójno (L. Lindner, E. Brykczyńska, 1980), Bedlno (A. Środoń, M. Gołąbowa, 1956)

Janczyk-Kopikowa (*cf.* A. Makowska, 1977), are presumably of the same age. The same interglacial seems to be represented by marine sediments with Lusitanian mollusc shells (*cf.* A. Makowska, 1986) of the so-called Sztum Sea at Nowiny (Figs. 1 and 2). At Losy, four periods of vegetation development were distinguished. The first one was predominated by birch shrubs or forest with *Pinus* and *Larix*. *Picea*, *Quercus* and *Ulmus* were also present during the second, and *Tilia* during the third period. The fourth period indicates development of *Corylus*, accompanied by *Ulmus*, *Alnus* and *Tilia*. Diatoms in these deposits are different from the typical ones of the Eemian (B. Marciniak, pers. inform.). Deposits of the Lubavian Interglacial at Losy are overlain by glaciofluvial sands with gravel and till of the Wartanian Glaciation (K. M. Krupiński, L. Marks, 1986). The lake sediments at Losy represent a warming which presumably corresponds to the oxygen isotope stage 7 (*cf.* L. Lindner, B. Marciniak, 1998).

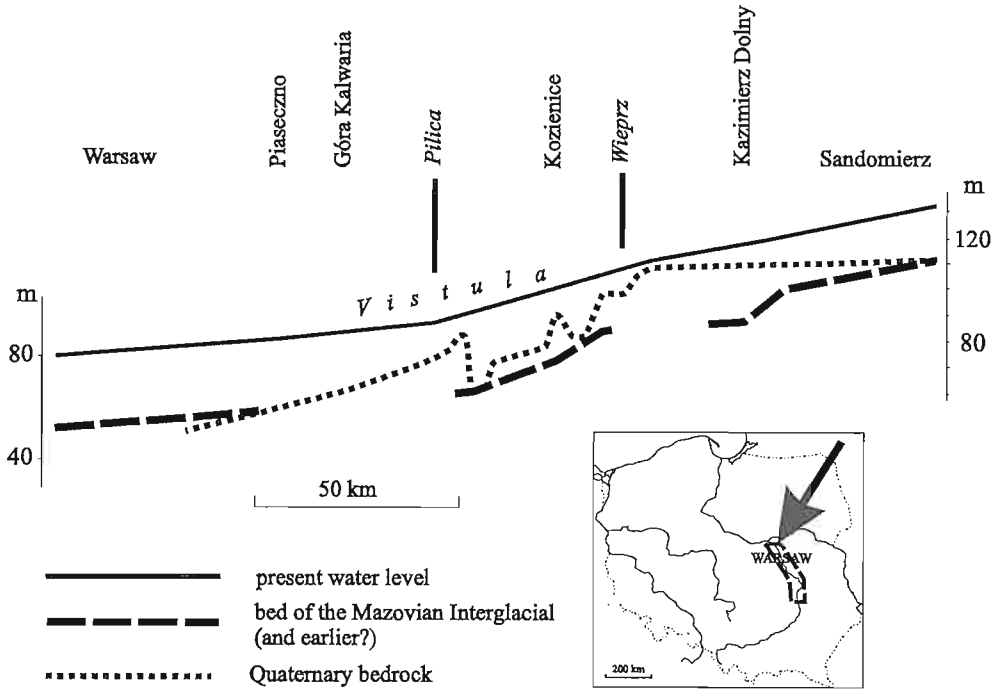

Fig. 3. Longitudinal section of the Middle Vistula valley from Sandomierz to Warsaw

WARTANIAN GLACIATION

Sediments of this glaciation comprise presumably the pre-maximum (Odranian?) and the maximum stadial (Wartanian *s.s.*), and the till occurs commonly in the presented sections Grabówka, Goleń, Raczki Wielkie and Losy (Figs. 1 and 2). In the Bełchatów region, two tills of this age are interbedded with sands (*cf.* L. Lindner, 1984). Recent examination of this till in Poland suggests further southward limit of the ice sheet during the Wartanian Glaciation or even its correspondence to the maximum (or close to maximum) limit of the Scandinavian ice sheet during the Middle Polish Glaciations (*cf.* L. Marks *et al.*, 1995; L. Lindner, S. Fedorowicz, 1996; B. Jaśkowski, B. J. Kowalski, 1997, 1998). Basing on petrographic composition of tills in the area occupied by the ice sheet of the Wartanian Glaciation and in its forefield, a traditional concept of the ice sheet limit in that time seems questionable (*cf.* J. Winnicki, 1997; S. Lisicki, 1998*a*). The Wartanian Glaciation corresponds to the oxygen isotope stage 7 (*cf.* L. Lindner, L. Marks, 1995).

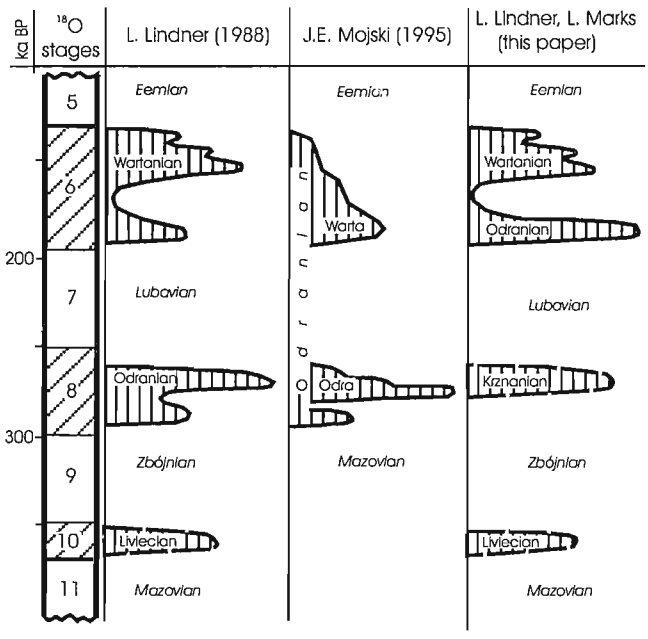

Fig. 4. Possible variants of correlation of the younger Middle Pleistocene in Poland

FINAL REMARKS

The presented facts postulate a considerable revision of predominant concepts (e.g. L. Lindner, K. Grzybowski, 1982; L. Lindner, 1992; J. E. Mojski, 1993) of the Middle Polish Glaciations in Poland (Fig. 2). They suggest also a more reliable correlation of the main younger Middle Pleistocene climatostratigraphic units in Poland with similar units in Germany and the Russian Plain (Fig. 5).

Therefore, the recently distinguished two new interglacials, i.e. Reinsdorf and Schöningen (Fig. 5) at Schöningen in central Germany (*cf.* B. Urban, 1995, 1997), should be, however, considered for equivalents of the Zbójnian and the Lubavian (*cf.* L. Lindner, B. Marciniak, 1998), although they are not separated by tills from each other and from the prece-

ding Holsteinian Interglacial. At Schöningen, the lake sediments of the Holsteinian Interglacial, together with the preceding and the following stadials and interstadials, are underlain by a till of the Elsterian 2 Glaciation. Deposits of the youngest pre-Saalian Interglacial in this section are overlain by a till of the Drenthe Stage, mantled in turn with extraglacial(?) deposits of the Warthe Stage and by the Eemian series (B. Urban, 1997).

In the section Chekalin of the Russian Plain (*cf.* N. S. Bolikhovskaya, N. G. Sudakova, 1996), there are also two new interglacials examined recently i.e. Chekalinian and Cherepietskian, younger than the Likhvinian Interglacial and also without any separation by glacial deposits. Deposits of the Likhvinian Interglacial in this section are underlain by a till of the Okanian Glaciation and this in turn, by deposits of the Byelovezhian Interglacial (*op. cit.*). The mentioned three younger interglacials in this section are separated by deposits of the Kaluganian and Zhizdrinskian climatic coolings (Fig. 5). Deposits of the youngest interglacial (Cherepietskian) are covered by two tills of the Dnieperian Glaciation (N. S. Bolikhovskaya, N. G. Sudakova, 1996).

All these data suggest considerable similarity in a number and climatostratigraphic rank of units of the younger Middle Pleistocene in Germany, Poland and the Russian Plain. Both in Germany and in the Russian Plain, these units remarkably resemble a sequential warming and coolings which were identified in Poland as the Great Interglacial *sensu* S. Z. Różycki (1964, 1972) or the Mazovian Interglacial *s.l.* of E. Rühle (1973). A concept of this rhythm seems to be still acceptable for the territory of Poland but only in the case of buried depressions, influenced by neotectonic processes and fluvial activity (M. D. Baraniecka, 1975; D. Krzyszkowski, 1991; W. Pożaryski *et al.*, 1994). At the ancient morainic plateaux in Poland, there survived tills that separate deposits of the Mazovian, Zbójnian and Lubavian Interglacials, suggesting ice sheet advance at least twice, i.e. during the Livieian and the Krznanian Glaciations. These advances could be possible due to the most favourable conditions for ice sheet development to the south of the Baltic Sea.

AGE		OXYGEN ISOTOPE STAGES (D.Q. Bowen et al., 1986)	GERMANY (B. Urban, 1997)		POLAND		RUSSIAN PLAIN (N. S. Bolikhovskaya, N.G. Sudakova, 1996)
QUATERNARY	HOL.	1	HOLOCENE		HOLOCENE		HOLOCENE
	UPPER PLEISTOCENE	2 - 5d	WEICHSELIAN		VISTULIAN		VALDAYNIAN
		5e	EEMIAN		EEMIAN		MIKULINIAN
	MIDDLE PLEISTOCENE	6	WARTHE ORENTHE	SAALE COMPLEX	WARTANIAN ODRANIAN	MIDDLE POLISH GLACIATIONS	MOSCOWIAN DNIEPERIAN
		7	SCHÖNINGEN		LUBAVIAN		CHEREPIETSKIAN
		8	?		KRZNANIAN		ZHIZDRINSKIAN
		9	REINSDORF		ZBÓJNIAN		CHEKALINIAN
		10	?		LIVIECIAN		KALUGANIAN
		11	HOLSTEINIAN		MAZOVIAN		LIKHVINIAN
		12	ELSTERIAN 2		SANIAN 2		OKANIAN

Fig. 5. Correlation of the main climatostratigraphic units of the Late Quaternary in mid-eastern Europe

Sediments of the Schöningen Interglacial are covered by a till of the Drenthe Stage (B. Urban, 1995), and sediments of the Cherepietskian Interglacial by two tills of the Dnieperian Glaciation (N. S. Bolikhovskaya, N. G. Sudakova, 1996). This fact results in two conclusions. The first one is that the glacial episode, distinguished in Poland at the traditional position of the Odranian Glaciation, i.e. between the interglacials Zbójnian and Lubavian, is presumably older than the Drenthe Stage in Germany and the Dnieperian Glaciation in the Russian Plain. In this paper, the name of the Krznanian Glaciation is proposed for this glacial event (Figs. 4 and 5). The second conclusion is a proposal to accept the previous limit of ice sheet of the Odranian Glaciation as of the maximum stadial of the Wartanian Glaciation.

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NOWE SPOJRZENIE NA STRATYGRAFIĘ OSADÓW JEZIORNYCH I LODOWCOWYCH MŁODSZEJ CZĘŚCI ŚRODKOWEGO PLEJSTOCENU W POLSCE

Streszczenie

Przedstawiono nowy pogląd na stratygrafię młodszej części środkowego plejstocenu Polski, a zwłaszcza na liczbę i wiek zlodowaceń środkowopolskich. Charakterystyka tego okresu została oparta między innymi na analizie 10 profili osadów czwartorzędowych (Grabówka, Nowiny, Goleń, Raczki Wielkie, Losy, Nidzica, Krępiec, Ossówka, Zbójno i Bedlno) ze środkowowschodniej i północno-wschodniej Polski (fig. 1 i 2). Podstawą rozważań było wyłączenie z interglacjału eemskiego osadów tzw. morza sztumskiego, coraz liczniejsze doniesienia o bardziej południowym zasięgu gliny zwałowej o parametrach geochronologicznych i litologicznych właściwych dla zlodowacenia warty, odkrycie nowych stanowisk interglacjału zbójna w Polsce oraz przeprowadzona rekonstrukcja sieci rzecznej interglacjału mazowieckiego w Polsce środkowej (fig. 3). Nawiązano do wcześniejszych prób korelacji poszczególnych jednostek zlodowacenia solawy w środkowo-zachodniej Europie (L. Marks, 1991) oraz opinii o występowaniu 4 interglacjałów młodszych od zlodowacenia sanu 2 (elstery 2) na kontynencie europejskim (L. Lindner, B. Marciniak, 1998). Umożliwiło to nieco inne spojrzenie na zagadnienie zlodowaceń środkowopolskich (fig. 2 i 4) oraz na bardziej uzasadnioną korelację głównych jednostek podziału klimatostratygraficznego młodszej części środkowego plejstocenu Polski z analogicznymi jednostkami na obszarze Niemiec i Równiny Rosyjskiej (fig. 5).

Wyróżnione ostatnio na obszarze Niemiec w profilu Schöningen (por. B. Urban, 1995, 1997) dwa nowe interglacjały: reinsdorf i schöningen (fig. 5), mimo że nie są oddzielone od siebie i starszego od nich interglacjału holsztyńskiego pokładami glin zwałowych, to jednak należy uznać za odpowiedniki interglacjałów: zbójna i lubawy (por. L. Lindner, B. Marciniak, 1998). Osady jeziorne interglacjału holsztyńskiego w tym profilu, wraz z poprzedzającymi i następującymi po nim stadiałami i interstadiałami, leżą na glinie zwałowej zlodowacenia elstery 2, a osady najmłodszego z wymienionych interglacjałów (schöningen) przykryte są gliną zwałową stadium drenthe i wyżej leżącymi osadami ekstraglacjalnymi(?) stadium warthe oraz osadami eemskimi (B. Urban, 1997).

Na obszarze Równiny Rosyjskiej w profilu Czekalin (por. N. S. Bolikhovskaya, N. G. Sudakova, 1996) wyróżniono ostatnio dwa nowe interglacjały: czekaliński i czerepiecki, jako młodsze od interglacjału lichwińskiego i również nie rozdzielone osadami lodowcowymi. Leżą one na glinie zwałowej zlodowacenia oki i na niżej położonych osadach interglacjału białowieskiego. Są one w tym profilu rozdzielone osadami odpowiadającymi ochłodzeniom klimatycznym: kaluskiemu i żizdrińskiemu (fig. 5), a osady najmłodszego z tych interglacjałów (czerepieckiego) przykryte są dwiema glinami zwałowymi zlodowacenia dnieprowskiego.

Stwierdzono daleko idące podobieństwo w liczbie i randze klimatostratygraficznej jednostek młodszej części środkowego plejstocenu na obszarze Niemiec, Polski i Równiny Rosyjskiej. Zarówno w Niemczech, jak i na Równinie Rosyjskiej, wykształcenie tych jednostek w dużym stopniu przypomina rytm ociepleń i ochłodzeń klimatycznych identyfikowanych na obszarze Polski w interglacjale wielkim (w rozumieniu S. Z. Różyckiego, 1964, 1972) czy też interglacjału mazowieckiego *s.l.* (w rozumieniu E. Rühlego, 1973). Nowsze dane potwierdzają istnienie tego rytmu w owym czasie na obszarze Polski, ale tylko w obrębie kopalnych systemów obniżeń, których rozwój był uwarunkowany procesami neotektonicznymi i działalnością rzeczną (por. fig. 3). W strefie kopalnych wysoczyzn polodowcowych przetrwały na obszarze Polski pokłady glin zwałowych oddzielające interglacjały mazowiecki, zbójna i lubawy, wskazujące na co najmniej dwukrotną transgresję lądolodu skandynawskiego.

Z dotychczas zebranych materiałów dotyczących plejstocenu Polski oraz z przykrycia osadów interglacjału schöningen przez glinę zwałową stadium drenthe (B. Urban, 1995), a osadów interglacjału czerepieckiego przez dwie gliny zwałowe zlodowacenia dnieprowskiego (N. S. Bolikhovskaya, N. G. Sudakova, 1996), mogą wynikać ponadto dwa kolejne wnioski. Pierwszym z nich jest to, że wyróżniany na obszarze Polski środkowo-wschodniej epizod glacjalny w dotychczasowej pozycji zlodowacenia odry, oddzielającego interglacjały zbójna i lubawy, jest prawdopodobnie starszy od stadium drenthe w Niemczech i zlodowacenia dnieprowskiego na Równinie Rosyjskiej. W niniejszym artykule proponuje się dla niego nazwę zlodowacenia krzny. Drugim wnioskiem jest propozycja uznania dotychczasowego rozprzestrzenienia lądolodu skandynawskiego o zasięgu zlodowacenia odry za stadiał maksymalny zlodowacenia warty (fig. 4).