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On the stratigraphy of the Last Glaciation on the Dolne Powiśle and the Elbląg Elevation area (Northern Poland)

DISCUSSION

This article is a reply for critical remarks of J. E. Mojski, referred to the stratigraphy of the Last Glaciation on Dolne Powiśle and Elbląg Elevation areas. Most of them is groundless or became an attempt to replace the results of so far done studies with his own suppositions. That refers also to correlation of the Toruń Glaciation with so called Kaszuby Stadial, which occurrence as glacial stadial, was due to last investigations absolutely excluded on mentioned areas.

INTRODUCTION

The issue of Geological Quarterly, Vol. 36, No. 2, contains the article of J. E. Mojski (J. E. Mojski, 1992) with several remarks on problem of stratigraphy of the Last Glaciation on areas of Dolne Powiśle and Elbląg Elevation. Author has cited there a lot of references but due to studied area and described problems his censure related mainly to lastly published works of A. Makowska.

Last year took place the scientific conference devoted to the Last Glaciation on area of Lower Vistula and on eastern coast of Poland, organized under the auspices of the Committees of Quaternary and Marine Studies of Polish Academy of Science. A. Makowska presented there lecture on Younger Pleistocene from mentioned areas and discussed in field selected outcrops from the Elbląg Elevation (Kadyny, Próchnik I, III) and from Lower Vistula (Gniew, Gniewskie Młyny — with participation of M. Błaszkiwicz) and also the core of borehole Pagórki with help of W. Rabek (A.

Makowska, 1992). Except of this lecture nobody — J. E. Mojski as conference organizer or anybody — has not presented any new results of studies on discussed by A. Makowska regional problem or their relations to just published works and discussion on them was only theoretical. Similar character have remarks and hypotheses of J. E. Mojski, related to some problems of structure and stratigraphy of Younger Pleistocene of Dolne Powiśle and Elbląg Elevation areas. Remarks of J. E. Mojski, except of negation, add nothing new to recognition of these areas and undocumented hypotheses only obfuscate or deform general view, based on former studies, carried on within frames of mapping and drilling works.

Newest stratigraphic divisions of Younger Pleistocene of Dolne Powiśle and Elbląg Elevation base on the settlement (on the turn of sixties and seventies) of position, course and composition of terrigenous and marine deposits of the Eemian Interglacial, studied firstly on Dolne Powiśle but later also on Elbląg Elevation areas. These deposits become now definite index horizon for significant part of mentioned areas (A. Makowska, 1979*a*, 1986*b*, 1992). Both on Dolne Powiśle and Elbląg Elevation such horizon lies lower than horizons regarded as Eemian in age by earlier authors, who — except of J. Samsonowicz (1951) and J. Nowak (1965) — have located it several tens meters upward (R. Galon, 1934, 1938; B. Halicki, I. Brodniewicz, 1961). Lower position of the Eemian horizon caused enlarging of the complex of deposits younger than the Eemian in additional glacial and intermorainic horizons, earlier undistinguished or included into the Middle Polish Glaciation. As a consequence, after determining position of the Eemian deposits, were distinguished five horizons of glacial tills, marked in my works with symbols BI–BV and separating them 4 intermorainic series (A. Makowska, 1972, 1973*a, b*). In this division most important are 3 main horizons of glacial tills and two detaching them intermorainic series — lower and upper — occurring on whole (BIII and BIV) or almost whole (BII) area. Next two horizons of glacial tills — lowermost (BI) and uppermost (BV) — occur only locally: in southern part of area, in marginal zone of the Pomeranian Phase and its background and on border of Żuławy Wiślane and near Zalew Wiślany.

This strongly simplified lithostratigraphic scheme could be referred both to Dolne Powiśle area with relatively simple geological structure and to Elbląg Elevation, where deposits are locally intensely glaciectonically disturbed. Presented above lithostratigraphic scheme of Younger Pleistocene deposits is in details more differentiated and complicated but outside zone of occurrence of the Eemian deposits it is not so univocally clear and uniform. The most important element of such differentiation are glaciectonic disturbances on the Elbląg Elevation and horizons of marine deposits found lastly in northern part of area, which according to my opinion are younger than the Eemian (A. Makowska, 1986*a, b*, 1991*a*). They are one of the objects of critical remarks of J. E. Mojski.

Nevertheless to some reservations for discussion principles I would like, in aim to avoid some misunderstandings and deformations of model of geological structure of studied areas, to explain some problems, indicated in article of J.E. Mojski, keeping presented there order of geographical units.

DOLNE POWIŚLE

J. E. Mojski accepts basic lithostratigraphic units of post-Eemian Pleistocene from Dolne Powiśle, it means — 3 main horizons of glacial tills and separating them intermorainic series — lower and upper, named by me in this region as the Gniew and Grudziądz formations and also partly the glacial till of BI horizon. Their acceptance is obvious because their occurrence on Dolne Powiśle, after setting proper position of the Eemian deposits, was documented with several tens of new borehole profiles, partly published in separated articles and partly presented in geological sections, added to the *Geological Map of Poland*, scale 1:200 000, finished on these areas in 1977 and to the *Detailed Geological Map of Poland*, scale 1:50 000, realizing up till now (A. Makowska, 1992). This scheme, related to Dolne Powiśle, was confirmed and adapted earlier by J. E. Mojski for Gdańsk and Kaszuby regions (J. E. Mojski, 1979a). Critical remarks of J. E. Mojski refer to uppermost horizon of glacial tills from Dolne Powiśle, it means tills of horizon BV. It is unclear because this till is distinguished also on other areas of northern Poland outside Dolne Powiśle and particularly in this region they are groundless. It was found just on the Grudziądz sheet, scale map 1:200 000 (A. Makowska, 1972, 1973a) and its occurrence was confirmed later on many areas of an extent of the Pomeranian Phase and indicated on sheets of detail maps as: Starogard Gdański and Sztum (W. Rabek, 1984, 1986), Skórcz (H. Listkowska, 1982), Kwidzyn and Gardeja (M. Kozłowska, I. Kozłowski, 1981; I. Kozłowski, K. Wrotek, 1980). It should be explained that the till of horizon BV only locally forms separate horizon, underlaid mainly with fluvioglacial deposits but in some places it lies directly on lower till of horizon BIV or joins with it in one horizon (BIV and BV). The extent of both tills separations is a problem for further studies. This till was not found on studied parts of Elbląg Elevation and due to that the opinion about retreat of continental glacier far to north is not still stated, as it was suggested by J. E. Mojski, although — in my opinion — it could not be excluded from regional point of view.

Next critical remarks of J. E. Mojski relate to lower intermorainic series (Gniew Formation) but more precisely — to differences between my interpretation of this series and interpretation of E. Drozdowski (1986) in outcrop Gniewskie Młyny, presented during last field conference, mentioned earlier. J. E. Mojski would like to regard this series in way it was described in older references (II Fluvioglacial — R. Galon, 1934, 1938) or as it was shown on map of scale 1:200 000 — Grudziądz sheet (A. Makowska, 1972, 1973a). But from time of publishing of general maps further investigations have been carried on, particularly on detail ones, results of which indicate significant genetic differentiation of discussed series. Without respecting results of these studies the critical remarks on series development or its genesis are still inconsiderate. Regarding the outcrop in Gniewskie Młyny J. E. Mojski imputed to me other opinion than one presented at outcrop. The deposits occurring in Gniewskie Młyny are — after me — the same sediments, which were demonstrated in Gniew within upland margin during the Vistulian conference in 1979. There I interpreted them as fluvial deposits with redeposited marine fauna, including into the Gniew Series (A. Makowska, 1979b). In similar way I interpreted them in later works (A. Makowska, 1986a, b). E. Drozdowski (1986) has assumed that they are marine

deposits of the Grudziądz Interstadial, inserted within the Gniew Series after scouring of glacial till of BIII horizon. Differences in opinions, except of problem of deposit genesis needed further studies, relate really to local problems, which are verified during enlarged regional analysis. E. Drozdowski has not questioned an occurrence of the Gniew Series, found on larger areas than surroundings of Gniew. Studies of this author, carried on in single outcrops at Lower Vistula — at sections from the Grudziądz Basin up to vicinity of Tczew and Malbork — refer mainly to upper parts of the post-Eemian profile, it means glacial tills of BIV and BIII horizons, separating them intermorainic Grudziądz Formation and sometimes also uppermost part of the Gniew Formation. These studies could not change so far my general interpretation of lithostratigraphy and genesis of Younger Pleistocene, based on rich cartographic and drilling material from almost all Dolne Powiśle area northward from the Toruń Valley (A. Makowska, 1992). But it should be pointed out that these investigations supply many new, significant for studied area data to general lithostratigraphic scheme and after spatial analysis they could be included into such scheme. The most important are so far the datings of deposits with TL method, done by E. Drozdowski, which became a principle for age interpretation of upper part of the post-Eemian complex on Dolne Powiśle (E. Drozdowski, 1980, 1986; E. Drozdowski, S. Fedorowicz, 1985, 1987). I would like to emphasize the concurrences of both — my and E. Drozdowski — interpretations, particularly the interpretation of marine deposits, described independently in new works of both authors in similar stratigraphic positions. The groundless denial of these facts do not explain any problems but they need only farther studies both in local outcrops and on larger areas. The marine deposits were lastly found in this region, near Kamionka (A. Makowska, 1990), where they occur within the Gniew Formation. It is unclear remark of J. E. Mojski that these deposits are overlaid with no more than one horizon of glacial till. Occurrence of one (in boreholes) glacial till over marine deposits near Kamionka results only from morphological situation because the drills were located in Liwa Valley and its close vicinity. Upper glacial tills are placed outside this valley that was explained in cited work (A. Makowska, *op. cit.*). Marine deposits occur here in analogous position as ones, known from Krastudy (A. Makowska, 1986a). The real problem is high position of marine deposits in both points that I have indicated several times. It could not be excluded an overthrusting or displacement of these deposits in meridian direction by continental glaciers, expanding on Dolne Powiśle area and it has not to change their stratigraphic position but any opinion on this problem should be documented. Recently basing on actual analysis of archival borehole materials from areas of occurrence of marine deposits (see — Kamionka — Krastudy) such overthrusting or other larger disturbances were not found except of these just described, for example in Ryjewo (A. Makowska, 1986b; E. Drozdowski, 1986). Near Żuławy Wiślane where undoubtedly has existed more intensive glacial exaration during succeeding transgressions of continental glaciers, a situation could be other than in Vistula Valley but this problem is still investigated. Analysis is complicated due to fact that the marine deposits are not described in any archival drill materials (that is a reason they were so far not found on western margin of Żuławy Wiślane and Gdańsk region). Only own descriptions of samples, outcrops or own drills could be credible material. Due to that very important are and will be in

future any new findings of these deposits both in outcrops and properly described borehole profiles.

ELBLĄG ELEVATION

Discussing the Elbląg Elevation J. E. Mojski has not limited to only critical remarks but basing on my many years' studies he attempted to deny their results and to put instead of them his own, not documented hypotheses. But it should be admitted that J. E. Mojski considers his opinions of similar value for interpretations as mine (J. E. Mojski, 1992, p. 226). But structure of the Elbląg Elevation is so complicated that it could not be recognized with hypotheses. They could be applied twenty years earlier, before general and detail geological mapping and new boreholes cutting whole Quaternary were done, but also then such opinions would need any investigative principles. But recently should be regarded the facts, resulted from these works, in other way a view of structure of Elbląg Elevation will deform or falsify. J. E. Mojski, having not complete evidence, resulting from his own studies, has made many mistakes in his opinions.

One of his essential mistakes is the assumption that the Elbląg Elevation is composed as a whole of glacitectonic slices, consisting of whole Pleistocene deposits, exarated from the Baltic bottom and overlaid one on the another. Such opinion is not original, it is a generalization of earlier settlements that within glacitectonic structures of this area occur — among others — glacitectonic slices and the deposits, forming the Elbląg Elevation are, at least in the part, pressed from the Baltic Basin and removed to place of their recent occurrence (A. Makowska, 1986a, 1991a). As a generalization such conception is unreal but is a backward in relation to current studies. It seems proper at general reviewing of some outcrops (particulary those demonstrated during field trips) or of some borehole profiles published so far by me, especially those interpereted earlier as glacitectonic slices (A. Makowska, 1991a). The blocky or slice hypothesis I have regarded starting studies of the Elbląg Elevation especially that were that time such suggestions (W. Piotrowicz, 1961). But during further investigations it was documented that structure of this unit was more complex and any generalizatións, related both to slices or to fold structures and to occurrence of deposits *in situ*, groundlessly imputed to me by J. E. Mojski, could not be applied here. There are areas on which is possible to distinguish larger or smaller glacitectonic slices or other blocks detached in frozen stage (that is very important for studies of bed sequences) from their matter basement and removed on farther distances that I have indicated several times (A. Makowska, 1986a, 1991a) but exist also such places on which occur only fold structures or lack of considerable disturbances within beds. These problems could be detaily discussed only on background of precise data, obtained during earlier and actual studies.

In polemic article of J. E. Mojski, except of general view of structure of the Elbląg Elevation, are — in the light of results of my studies — many other mistakes. Among more significant are: 1 — false opinions based on interpretation of section Kadyny —

Pęklewo — Pagórki; 2 — false opinions relate to the marine deposits from Próchnik II and Łęcze; and 3 — improper interpretation of the Elbląg Clays and red clays.

SECTION KADYNY — PĘKLEWO — PAGÓRKI

Basing on the section Kadyny — Pęklewo — Pagórki (A. Makowska, W. Rabek, 1990) J. M. Mojski, in spite of obvious facts resulting from this section, attempts to change author's interpretation for his own one, which should confirm a hypothesis of deep and common slice structure of the Elbląg Elevation. But such example was wrongly selected because this section does not confirm such conception but denies it. As was shown on discussed section only the upper part of occurring there deposits was glacitectonically disturbed but middle and lower parts of them lay in normal position and lack of evidences for an occurrence of slices or other larger glacitectonic structures.

The disturbances of upper part of profiles could be suspected according to position of the marine deposits (Yoldia, Elbląg Clays) in the Kadyny outcrop and in borehole profiles from Pęklewo and Pagórki. On discussed section are marked only bed foldings. They have conventional meaning and do not reflect real disturbances because these three points, with two boreholes among them, are insufficient for spatial interpretation of glacitectonic forms. But for anybody it is clear that these deposits lay here not *in situ*, against such interpretation evidences their overthrusting, reaching up to 100 m. With disturbance of such size is also excluded an occurrence of only the fold structures. There should take place also fracturing and displacements of beds relation or for larger distances. For illustrating such processes is enough to add on the section several interpreted lines of discontinuities within fold structures, which create an image of blocks or slices detached from their matter basement.

The deposits occurring in middle and lower parts of section are not, as was stated above, glacitectonically disturbed. The sufficient evidence for that is the position of marine deposits of the Tychnowy Member, occurred without disturbances between Pęklewo and Pagórki, similiary (both in hypsometric and sequence positions) to their occurrence near Lower Vistula. Such primary, undisturbed position of these beds is indicated also by consequent diagram of pollen analysis of this part of profile in Pagórki, done by Z. Janczyk-Kopikowa (1991).

The red clays occurring in the section Kadyny — Pęklewo — Pagórki at the bottom of the Dolne Powiśle Formation, which J. E. Mojski would like regard probably as an analogous deposit to upper laid Yoldia Clays, could not be actually an indicator of marine genesis and of stratigraphy. Hitherto the studies have not documented their marine origin because these deposits have no remains of marine macrofauna but only foraminifers noticed so far in one site. According to lithology and structure I have described them as a sediment of limmno-periglacial basins, forming within the Baltic Basin during or after deglaciation (A. Makowska, 1986b, c, 1991a). Similar conclusions resulted from detail lithopetrographical and mineralogical studies (J. Moryl *vide* A. Makowska, 1991a). The red clays occur in variable stratigraphic positions, mainly within deposits of Younger Pleistocene from the Elbląg Elevation but also in undis-

turbed tectonically sediments older than the Eemian from Dolne Powiśle area. In many sites they are located on secondary place, among other as glacial sheets within glacial tills but on the Elbląg Elevation they have not everywhere such position. These deposits nearly always have more or less significant disturbances of their structure but it could not always result from glacitectonics. There could be regarded differences in bed stresses caused by, for instance, freezing of overlaid complex or by vertical pressure of the continental ice. There are no considerable evidences to settle, after J. E. Mojski, that they are indicators of glacitectonics. Next hypothesis of J. E. Mojski, that probable glacitectonic disturbances have formed before the Eemian Interglacial, should be also ignored due to fact that between red clays and overlaid them deposits of the Dolne Powiśle Formation, both in discussed profile and also in other known so far places with similar lithostratigraphic profiles, lack not only of glacial tills but also of any evidences of their remains in form of lags or coarser gravels.

The conception about abrasional destruction of surfaces above the red clays is also not confirmed in the mentioned section because on them occur mainly no marine but terrigenous deposits that it is good visible in the profile of Pagórki (A. Makowska, 1991*b*). All attempts of J. E. Mojski to insert into discussed profile his own hypotheses have to be ignored because they are not confirmed by facts.

MARINE DEPOSITS FROM PRÓCZNIK II AND ŁĘCZE

Second important problem, discussed in article of J. E. Mojski, relates to marine deposits from Próchnik II and Łęcze, dated for 50–30 ka. The author, without any proofs for his opinions, has negated results of my so far carried studies and doubtlessly decided that they are no marine deposits because the fauna described by me occur there within sandy glaci-fluvial sediments (from where it is known?), on secondary — but not first time — place. This problem is solved by J. E. Mojski with assuming of unreal data. They refer to lithology and genesis of deposits containing mentioned fauna, its secondary position and an objection that I have not precised sedimentary conditions of discussed sediments. All these facts were explained in my earlier work (A. Makowska, 1986*b*, p. 39-42, 58-59).

It could be only reminded here that marine fauna (except of Próchnik I) occur not within sands as would like to see it J. E. Mojski but in more fine deposits — clays, silts, sandy silts or silty sands — lithologically more similar to deposits of, for instance, Tychnowy Sea. In Próchnik II and Łęcze sites this fauna has occurred undoubtedly on primary place that were indicated by its position within sediment and other features, described by me in cited work. In both sites have been found marine and fresh-water fauna, strictly separated. How J. E. Mojski could explain such fact assuming secondary and probably several times replaced position of this fauna? Marine fauna was not so poor, as J. E. Mojski has suggested, but it contained numerous specimens. From Łęcze site were described 4 species and 2 genera of marine molluscs but from Próchnik II site — valves of of large marine bivalva, very weathered (not damaged as stated J. E. Mojski but weathered in their primary place) and they have completely destroyed

after their excavation from sediment. These valves could not survive any water transport. I have collected many saved fragments of such shells.

The profiles of deposits from Łęcze and Próchnik II document univocally the marine transgression into fresh-water continental basins. In both cases were no mixing of fauna; it seems that the continental environment has transformed consequently into marine one. In Łęcze site according to the results of pollen analysis Z. Janczyk-Kopikowa (*vide* A. Makowska, 1986b) has found gradual increase of salinity of fresh-water lacustrine basin before the main marine transgression that undoubtedly documents here an event of transgression. Other problem is an age of these transgressions. In Łęcze site it was determined by dating of organic lacustrine deposits with ^{14}C method for 35.1 ± 1.5 ka BP. The marine transgression have taken place after this date, generally in the Grudziądz Interstadial. It was not known before from southern part of the Baltic Basin.

The marine deposits from Próchnik had not so far any age datings. They were distinguished as probably separate horizon only basing on occurrence of other than in Łęcze marine fauna. Their stratigraphic position is not precised clearly and there are no sure evidences of it. By the way, the studies of last years could only settle that the lithological profile of these deposits become more comparable to profiles from Łęcze and it is not excluded that they could be the deposits of the same stratigraphic horizon. Similar stage of recognition as Próchnik II have also marine members from Próchnik I site or from Kamionek Wielki. In any case they are marine deposits with fauna on primary place (regarding various types of tanathocenosis) and — as resulted from so far done studies — are younger than the Eemian Interglacial. Marine deposits from mentioned sites occur recently at high absolute altitudies and it is sure that they are not located in places of their sedimentation, as was indicated earlier (A. Makowska, 1986b). These deposits have changed their primary position, they were folded and removed on some, recently unprecised distances. In all mentioned sites they are mainly continental deposits with traces of short-term marine transgression. They were not subjected to long transport and they could not come directly from area of recent Elbląg Elevation but from the land, which was extended toward north or north-west, on area of recent Zalew Wiślany or farther in these directions.

ELBLĄG CLAYS AND RED CLAYS

The next problem resulting from article of J. E. Mojski is discussion on the Elbląg Clays. At the beginning should be explained here a fundamental misunderstanding. J. E. Mojski applied a term "Elbląg Clays" in its older meaning, including both red and grey clays without fauna as well as probably grey clays with molluscs, it means Yoldia Clays. I have separated these deposits also in termonology, retaining the name "Elbląg Clays" only for the Yoldia Clays (A. Makowska, 1986b, c, 1991a). Such differentiation is reasonable because red clays become completely separate sediment than Yoldia ones, they have no macrofauna and other genesis (about last one was mentioned above) and they occur in different stratigraphic positions. Also they are known from other areas of Poland (W. Słowański, 1975). But Yoldia Clays, as resulted from

hitherto done studies, are characteristic only for Elbląg and probably Ryjewo vicinities. It was not also found several repeating of these deposits in the same profile, except of Suchacz, where they form two independent horizons. Apart from this site they commonly occur within intermorainic series, named the Kadyny Formation, between glacial tills of BII (Toruń) and BIII (Świecie) horizons. Deposits of this formation are strongly glacitectonically disturbed that is visible in section Kadyny — Pęklewo — Pagórki. As it was mentioned earlier, these deposits could not be only folded but overthrust from farther distances. My suspicions that deposits constituting the Elbląg Elevation should come, at least in their part, from the Baltic Basin (A. Makowska, 1986b) relates mainly to such series, within which occur the Elbląg Clays (Yoldia Clays) and concurrent sediments, it means, red clays occurring together with Yoldia Clays in deformation structures, also lacustrine deposits and locally — glacial tills, underlying them.

The Elbląg Clays (Yoldia Clays) represent facies of deepest sea comparable with other marine members found on the Elbląg Elevation and in the Vistula Valley. This fact was earlier indicated by R. Galon (1938).

On considerable area of the Elbląg Elevation, particularly in regions where these clays occur at high hypsometric position they could locate only on secondary place. According to my interpretation the Elbląg Clays, similar as other deposits occurring within disturbed Kadyny Formation and marine deposits of Łęcze Formation, are younger than the Eemian. Datings of deposits from Łęcze allow to include them into the Grudziądz Interstadial. Also actual datings of the Elbląg Clays and of other deposits of the Kadyny Formation have not excluded possibilities of their post-Eemian age. An exception are two data from Suchacz which could indicate the Eemian or older age of the Elbląg Clays (A. Makowska, 1986b). But these data were so far unsure principle for defining stratigraphic position of discussed clays. This problem should be further studied.

But it needs to indicate that the Eemian age of the Elbląg Clays is not only one alternative for actual settlements because deposits of such type could origin in the Baltic Basin several times and such situation was noticed also in the Holocene.

FINAL REMARKS

Concluding remarks in article of J. E. Mojski, except of mentioned here problems, relate mainly to correlation of the Toruń Glaciation with so called Kaszuby Stadial and to a value of the Krastudy Interglacial. First problem should be more detailly explained because it became a misunderstanding, continued from a dozen or so years and it refers to next false conceptions of J. E. Mojski, related to stratigraphy of Younger Pleistocene of described areas. J. E. Mojski (1979a, p. 228) stated that „... The equivalent of glacial till, which A. Makowska regarded as «indexing» deposits of the Toruń Glaciation, has been known from tens years in the Lower Vistula Valley and mostly it was assumed as stadial counterpart...“. Such counterparts could be, as one can suspect, Kaszuby glacial till and the Kaszuby Stadial. J. E. Mojski writes farther „...Names of the lithostratigraphic units not only of the Last Glaciation but of whole

Pleistocene have in all cases the temporary meaning...“ and „...the name «Kaszubski» could be replaced with «Toruński» or inversely“.

It will be possible to agree with such opinion, regarding obligatory principles of term fixing, if they really belong to the same chronostratigraphic units. But in the case of Toruń Glaciation and Kaszuby Stadial they are various units. The Toruń Glaciation in its glacial part, an equivalent of which is glacial till of the Malbork and Toruń horizons (BI and BII), is younger unit because it occurs after the Eemian Interglacial and Brörup Interstadial (A. Makowska, 1980, 1991*b*, 1992), but the Kaszuby Stadial, referred to the Kaszuby glacial till, is older unit, preceding the Brörup Interstadial (Konin) and separating it from the Eemian Interglacial (J. E. Mojski, 1979*a*, 1992). Beside it both units are distinguished basing on other principles. Distinction of the Toruń Glaciation bases on precise lithostratigraphic profiles, in which the position of the Toruń glacial till at the basement is documented in sites of the Eemian and Brörup deposits but location of the Kaszuby Stadial between the Eemian and Brörup is conceptual and compilatory. Due to that these two units could not be compared. Also last studies of the Pagórki profile from the Elbląg Elevation indicated definitely that proposed by J. E. Mojski from many years conception of occurrence of the glacial stadial between the Eemian and Brörup is false because in northern Poland lack of glacial deposits of such stadial (Z. Janczyk-Kopikowa, 1991; A. Makowska, 1991*b*). According to results of those studies the Kaszuby Stadial should not be recently distinguished.

J. E. Mojski for a long time has correlated the Kaszuby Stadial, distinguished by him, in Gdańsk and Kaszuby regions (J. E. Mojski, 1979*a*) with the Toruń Stadial (recently — glacial) from Lower Vistula area but such correlation was only in one way. The Kaszuby Stadial was a continuation of so called Szczecin Stadial (E. Rühle *vide* M. Książkiewicz et al., 1965; J. E. Mojski, 1969). It had not primary its equivalent on Poland area in form of glacial till horizon that was indicated by S. Z. Różycki (1972), who denied a conception of glacial stadial between the Eemian and Brörup. J. E. Mojski also earlier (1970) shared this opinion, replacing the Szczecin Stadial (glacial) with the Sandomierz one (loess), distinguished by S. Z. Różycki (1970). Return of J. E. Mojski to this older conception of glacial stadial between the Eemian and Brörup was possible due to results of my studies at Lower Vistula, where after setting proper position of the Eemian deposit were distinguished within the post-Eemian complex five horizons of glacial tills (A. Makowska, 1972, 1973*a, b*), among them — three main horizons, covering whole studied area. Similar three till horizons were distinguished later by J. E. Mojski and J. Sylwestrzak (1976) on Gdańsk and Kaszuby regions. Lowermost of them J. E. Mojski (1979*a, b, d*) has identified with so called grey-green till, forming lower of two till horizons, distinguished earlier by Z. Kotański (1956) on western margin of Żuławy Wiślane. Basing on this till J. E. Mojski (1977) has distinguished the Żuławy Stadial of similar stratigraphic position as the Szczecin one.

Later J. E. Mojski has renamed the Żuławy Stadial on Kaszuby one (J. E. Mojski, 1979*a*) and corresponding with it till he correlated with the Toruń till on Dolne Powiśle (A. Makowska, 1977), attempting to include the last one into distinguished by him glacial stadial between the Eemian and Brörup (J. E. Mojski, 1984, 1985). It was — as I noticed above — one way, groundless interpretation. From the beginning

of my studies on the Pleistocene of Dolne Powiśle I have not accepted any connection of any post-Eemian glacial horizons, lastly distinguished on this area, with the Szczecin Stadial and afterwards with their nominal equivalents, fixed by J. E. Mojski. I indicated it in the correlation table, published in the article in 1980 (A. Makowska, 1980). For such correlation have not allowed the results of studies of the Eemian series, underlying on large areas of Dolne Powiśle the glacial tills: Malbork (BI) and Toruń (BII) ones. Within this series over the deposits from interglacial optimum occur in many places sediments, which I have connected with post-optimum climatic warming. It was confirmed by pollen analysis from Mniszek, done by K. Tobolski (E. Drozdowski, K. Tobolski, 1972) and later this warming was named by me as the Mniszek warming (A. Makowska, 1979a). Similarly as K. Tobolski (*op. cit.*) I have suspected that it could relate to the Brörup Interstadial (A. Makowska, 1975) and due to that it was not possible to locate the Toruń glacial till, laying over whole Eemian series, between the Eemian Interglacial and Brörup Interstadial.

Beside it also correlation of the Kaszuby glacial till with the Toruń one was not clear. If the Kaszuby till corresponds to grey-green glacial till, distinguished by Z. Kotański (1956), then after this author such till covers on the Gniew deposits of the Gniew Series (*op. cit.*, p. 305, 312) and correlates according to me with till of horizon BIII (Świecie Stadial) but not with BII one (Toruń Glaciation) and according to results of last studies of E. Drozdowski (1986, p. 42) also with younger till (BIV).

Concluding that the correlation of the Kaszuby' and Toruń glacial tills is still open problem but correlation of the Kaszuby Stadial with Toruń Glaciation, proposed by J. E. Mojski (1992, Table 1) should not be accepted because it falsifies stratigraphic position of glacial tills of the Toruń Glaciation and of whole post-Eemian profile from Dolne Powiśle.

The second problem, discussed by J. E. Mojski in his final remarks, is a value of the Krastudy Interglacial. This event was distinguished according to occurrence in Krastudy of marine deposits with warm-favouring fauna (A. Makowska, 1986b) but not only because earlier analyses of whole post-Eemian complex of Pleistocene deposits from Dolne Powiśle have induced me to attribute larger value to this period than to younger Grudziądz Interstadial. These two periods differ considerably on Dolne Powiśle area, both in course of interglacial processes and amount and type of accumulated deposits. So far done studies indicated also possibility of intensive development of Pleistocene seas during the Krastudy Interglacial. The marine deposits in Krastudy, found later also in Kamionka (A. Makowska, 1990) involve some discussions with their actual high location that could suggests they are overthrust or displaced in relation to their primary position. Occurrence of these deposits is unquestioned because according to actual analyses they behave as constant layer, appearing within undisturbed intermorainic series (Gniew Formation) between generally undeformed glacial tills of the Toruń Horizon (BII) and Świecie Horizon (BIII). If it is evidenced that the marine deposits are disturbed or displaced in any way such fact will not exclude possibility of an occurrence of deposits of the Krastudy Sea on area of the Baltic Basin. Except of marine sediments within the Gniew Formation are noticed also lacustrine and organic deposits, needed farther studies but now they could document an interglacial period.

Here could be more detailedly discussed the kame deposits, distinguished by J. E. Mojski on the Gdańsk region and included with the Kaszuby glacial till in one glacial horizon (J. E. Mojski, 1979*a, b, c*, 1980, 1984, 1985). These deposits should be studied because they contain — according to my opinion — fine valve fragments of fresh-water molluscs that was visible in demonstrated by J. E. Mojski (1979*c*) outcrop in Oliwa during the Vistulian conference. These valves, among which I have found distinct specimen of bivalve *Pisidium moitessierianum* Paladilhe (in my collection), do not confirm a kame genesis of discussed deposits but could indicate more warm period of their accumulation, probably — if they are not the Eemian deposits — corresponding with the Krastudy Interglacial.

His critical remarks J. E. Mojski finished with an opinion, conformable to my own, about real necessity of farther studies on Dolne Powiśle and Elbląg Elevation areas. During last twenty years intensive scientific studies of whole Quaternary cover have been carried on there. They have recognized not only its undersurface structure but also have penetrated with drills whole Quaternary profile up to the basement (A. Makowska, 1992). These works are not yet finished and except of obtained results appear also new problems, needing farther investigations. It is not necessary to stimulate them, they are really very interesting and promising because as states J. E. Mojski (1992, p. 229) "...The Vistula Stage is very promising object for further studies." and it is true, adding only that if such studies are carried on personally.

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Aurelia MAKOWSKA

O STRATYGRAFII OSTATNIEGO ZLADOWACENIA NA DOLNYM POWIŚLU I WZNIESIENIU ELBLĄSKIM (DYSKUSJA)

Streszczenie

Artykuł jest odpowiedzią na uwagi J. E. Mojskiego, dotyczące stratygrafii ostatniego zlodowacenia na Dolnym Powiślu i Wzniesieniu Elbląskim (J. E. Mojski, 1992). Z racji omawianego obszaru i poruszonych zagadnień, uwagi te dotyczą w większości moich prac publikowanych w ostatnich latach. Moje podziały stratygraficzne młodszego plejstocenu oparte są na przewodnim poziomie lądowych i morskich osadów eemskich, których skład i położenie zostało ustalone na przełomie lat sześćdziesiątych i siedemdziesiątych (A. Makowska, 1979a). Występują one zarówno na Dolnym Powiślu, jak też na Wzniesieniu Elbląskim. W nadległym kompleksie poeemskim wyróżniono 5 poziomów glin zwałowych (BI–BV) i 4 dzielące je serie międzymorenowe nazwane formacjami (A. Makowska, 1972, 1973a, b, 1977, 1986b, 1992). Najważniejsze znaczenie mają 3 główne poziomy glin zwałowych (BII–BIV), obejmujące cały lub prawie cały omawiany obszar, i dwie dzielące je serie międzymorenowe — dolna i górna. Dwa pozostałe poziomy glin (BI i BV) występują tylko lokalnie w północnej części obszaru. J. E. Mojski zgłasza zastrzeżenie do gliny najwyższej

poziomu BV, której wydzielenie jest jednak na Dolnym Powiślu w pełni uzasadnione. Występuje ona w strefie zasięgu fazy pomorskiej, gdzie tworzy samodzielny pokład podścielony osadami wodnolodowcowymi lub nakładą się na glinę starszą poziomu BIV. Została zaznaczona na szczegółowych mapach geologicznych wykonanych w tej strefie. Kolejne zastrzeżenia J. E. Mojskiego dotyczą różnic między moją interpretacją dolnej serii międzimorenowej (formacji Gniewu) a interpretacją E. Drozdowskiego (1986) w odstąpieniu w Gniewskich Młynach. Moim zdaniem istotą różnic są jedynie określenia genetyczne osadów, które winny być przedmiotem dalszych badań, natomiast interpretacja stratygraficzna jest wyłącznie sprawą lokalną. Ogólnie biorąc, badania E. Drozdowskiego, obejmujące głównie górną część profilu poeemskiego Dolnego Powiśla, nie zmieniają mojego schematu stratygraficznego opracowanego dla większych obszarów i obejmującego cały młodszy plejstocen wraz z interglacją eemskim.

Omawiając Wzniesienie Elbląskie J. E. Mojski usiłuje zaprzeczyć dotychczasowym wynikom moich badań i wprowadzić w to miejsce własne poglądy, nazywając je hipotezami. Popelnia jednak przy tym wiele błędów. Podstawowym błędem jest pogląd o całkowitej i, obejmującej wszystkie utwory plejstocenske, łuskowej budowie Wzniesienia Elbląskiego oraz o pochodzeniu tych wszystkich osadów z obszaru współczesnego Bałtyku. Jest to uogólnienie wcześniej podanych przeze mnie informacji, że w zaburzonych glacictonicznych strukturach Wzniesienia Elbląskiego występują m. in. łuski glacictoniczne oraz, że osady częściowo pochodzą z obszaru basenu bałtyckiego (A. Makowska, 1986b). Uogólnienie tego na całą budowę Wzniesienia Elbląskiego jest jednak zniekształceniem jej obrazu, gdyż jest ona bardziej złożona i obok łusek zawiera struktury fałdowe oraz strefy, w których zaburzenia glacictoniczne są minimalne lub nie ma ich wcale. Kolejne błędy popełnia J. E. Mojski, gdy wbrew interpretacjom autorskim usiłuje uzasadnić głęboką budowę łuskową Wzniesienia Elbląskiego na przykładzie przekroju Kadyny — Pęklewo — Pagórki (A. Makowska, W. Rabek, 1990). Przekrój ten nie jest potwierdzeniem, lecz zaprzeczeniem takiej budowy, a hipotezy J. E. Mojskiego dotyczące tego przekroju muszą być odrzucone wobec braku potwierdzenia w faktach.

Stwierdzenia J. E. Mojskiego na temat osadów morskich z Próchnika I i Łęcza, który konkluduje, nie podając podstaw takich wniosków, że nie są to osady morskie, a występujące w nich mięczaki znajdują się na wtórnym złożu, mijają się z prawdą. Wyniki badań tych osadów określające ich morską genezę i pierwotne złoża fauny zostały podane w mojej pracy z 1986 r. (A. Makowska, 1986b). Kolejne błędne, moim zdaniem, poglądy J. E. Mojskiego dotyczą iłłów czerwonych i yoldiowych (elbląskich). J. E. Mojski łączy je w jedno wydzielenie litostratygraficzne, natomiast ja (*op. cit.*) oddzielam je od siebie, przyjmując że różnią się genezą (tylko ily yoldiowe stanowią niewątpliwie osad morski) oraz częściowo wiekiem. Iły czerwone mogą mieć różny wiek, natomiast ily yoldiowe są według moich dotychczasowych poglądów młodsze od eemu, na co wskazuje m. in. ich położenie w przekroju Kadyny — Pęklewo — Pagórki, nawet przy założeniu, że są one tu nasunięte z dalszych obszarów. Wiek iłłów yoldiowych winien jednak podlegać dalszym badaniom, zwłaszcza za pomocą datowań metodą TL.

Jednym z ostatnich problemów poruszonych w artykule J. E. Mojskiego jest korelacja zlodowacenia toruńskiego, którego odpowiednikiem są gliny zwałowe poziomów BI i BII, z tzw. stadią kaszubskim. Uważam, że korelacja taka jest wykluczona. Obydwie jednostki są różnowiekowe, gdyż zlodowacenie toruńskie w części glacialnej jest jednostką młodszą od brórupu, natomiast stadia kaszubski jest starszy od tego interstadia. Ponadto ostatnie badania wykonane na Wzniesieniu Elbląskim wykazały, że między optimum eemskim a brórupem nie było stadia glacialnego (Z. Janczyk-Kopikowa, 1991; A. Makowska, 1991b), wobec czego wydzielenie stadia kaszubskiego, zajmującego od lat tę pozycję, pozbawione jest podstaw.

