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# PALAEOENVIRONMENTAL AND CLIMATIC CHANGES DURING THE EARLY PLEISTOCENE RECORDED IN THE LACUSTRINE-BOGGY-FLUVIAL SEDIMENTS AT KOMORNIKI, NE POLAND

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**Abstract:** The lacustrine-boggy-fluvial sequence at Komorniki, NE Poland was subject to complex (geological, palynological, diatomological and malacological) investigations. These sediments occur between the Narevian and Nidanian glaciations tills and belong to the Augustovian Interglacial of Poland correlated with the Cromerian 1 Interglacial of the Netherlands. Two cold stages of a glacial rank and one warm stage of interglacial rank (with dominant pollen of *Quercus, Ulmus, Carpinus, Alnus, Tilia* and *Corylus* in sediments corresponding to the climatic optimum) have been distinguished in the pollen succession. The latter is similar to that known from the Augustovian Interglacial profiles at Szczebra, Kalejty and Czarnucha. Diatom succession from the Komorniki section includes certain unidentified, apparently new small species of *Stephanodiscus, Staurosirella* and *Pseudostaurosira* side be side with the Pleistocene extinct taxon of *Stephanodiscus niagarae* var. *insuetus* and a relatively widespread species of *S. rotula* characterizing by some morphological peculiarities. In the composition of the malacofauna the fluvial extinct species of *Fagotia wuesti* and *Sphaerium* cf. *rivicola* are the most important molluscs for the biostratigraphy. Among them, *Sphaerium* cf. *rivicola* is known from the late Tiglian in the Netherlands. *Fagotia wuesti* is characteristic of the Bavel Interglacial in the Netherlands, as well as of the Borntal and Artern interglacials in Germany.

**Key words:** lithology, pollen analysis, diatoms, malacofauna, palaeoenvironment, Lower Pleistocene, NE Poland.

## SITE DESCRIPTION

The geologic mapping in scale of 1:50,000 carried out in 1998 at the sheet Sztabin included the drilling of the borehole at Komorniki that was located in the southern part of the Augustów Plain. Thickness of Quaternary deposits in this borehole makes up 136.5 m. The lacustrine-boggy-fluvial sediments are occurred in the depth range from 88.7 to 131.9 m. They are underlain by one thin till and are overlain by 6 tills (Ber, 2000). An ancient lacustrine-boggy-fluvial sequence is represented by sands of varying grain size (126.2–131.9 m), replaced by successive silty sands with plant detritus, silty clays with peat intercalations, remains of fossil flora and fauna, sandy silts and silts with fauna, silts with peat (107.0–126.2 m), which are overlain by medium-grained sands with plant detritus alternating with silty clays and clayey silts with detritus (88.7–107.0 m).

## MATERIALS AND METHODS

The method of pollen analysis has been used for analysing 118 samples of organic sediments. Samples were prepared using 10% KOH, 10% HCl, $ZnCl_2$ (1.89 g/cm$^3$) and Erdtman's acetolysis. The results are presented in a pollen diagram, prepared by computer programme POLPAL. The calculation are based on the basic pollen sum including trees+shrubs (AP) and dwarf shrubs+herbs (NAP).

Twenty nine samples were taken for diatom analysis. The samples were cleaned using hydrochloric acid and hydrogen peroxide. After washing with water, samples were treated

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with heavy liquid (KJ and $CdJ_2$) following the standard procedure which separates diatom valves from mineral sediment by centrifuging. The cleaned valves were mounted in Elyashev's aniline-formaldehyde and observed with a Zeiss-Jena Amplival light microscope with an oil immersion objective (100x, NA = 1.25). For scanning electron microscope, specimens were sputter coated with gold and examined using JEOL JSM-35C. The results, after counting about 500 specimens of diatoms per sample, are presented in a diatom diagram, which was constructed using the TILIA computer programme.

A system of diatoms proposed by Round *et al.* (1990) has been used in the paper. Taxonomic transformations and data on taxa ecology presented in many monographic reports (Krammer, Lange-Bertalot, 1986, 1988, 1991a, b; Diatomovye…, 1992; Lange-Bertalot, Metzeltin, 1996; Bukhtiyarova, 1999; Lange-Bertalot, 2001) were taken into consideration.

Malakofauna was examined in 30 samples. In each sample from 100 to 300 shells of molluscs were counted. The results obtained are illustrated in a malacological diagram prepared by computer programme TILIA.

## PALYNOSTRATIGRAPHY

The buried lacustrine-boggy deposits studied by pollen analysis in the depth interval of 126-108 m are subdivided into 21 local pollen assemblage zones (K-1 – K-21 L PAZ) (Fig. 1). A brief characteristics of pollen zones is presented in Table 1.

Two cold stages of a glacial rank corresponding to K-1 – K-7 L PAZ and K-17 – K-21 L PAZ, respectively, and one warm stage of an interglacial rank (K-8 – K-16 L PAZ) have been distinguished in the pollen succession.

## THE DEVELOPMENT OF VEGETATION AND CLIMATIC CHANGES

The history of vegetation, preserved in organic deposits of Komorniki, starts back in the period of prevalence of boreal forest communities. Initially, relatively dense pine forests prevailed, with a small admixture of *Picea*, and wet habitats were

Table 1

**Description of the local pollen assemblage zones from the Komorniki site**

| Local pollen assemblage zones | Description of the local pollen assemblage zones |
|---|---|
| K-21 NAP III (108.25-108.0 m) | Maximum values of NAP throughout the profile (80%), domination of Poaceae (42%), *Artemisia* (10%) and Cyperaceae pollen (18%); no upper boundary |
| K-20 *Pinus–Alnus* (108.25–108.65 m) | AP values exceed 60%, especially *Pinus* (27%), *Betula* (26%) and *Alnus* pollen (8%) |
| K-19 NAP II (108.65–109.25 m) | NAP values are again high (71%), particularly Poaceae and *Artemisia* |
| K-18 *Pinus–Picea–Alnus* (109.25–109.65 m) | AP values are high (max. 83%), mainly *Pinus* (34%), *Betula* (45%) and *Alnus* (13%) |
| K-17 NAP I (109.65–109.9 m) | Rapid increase in NAP values to 65%, domination of Poaceae and *Artemisia* pollen |
| K-16 *Betula–Alnus*–NAP (109.9–110.5 m) | Still high AP values, *Betula* (40%) and *Pinus* (33%) prevail |
| K-15 *Pinus–Picea* (110.5–111.0 m) | Domination of *Pinus* pollen (80%), rise in *Picea* (5%) |
| K-14 *Alnus*–NAP (111.0–112.3 m) | *Alnus* pollen values fall to 33%, rises in Poaceae and *Artemisia* pollen values (respectively 28 and 5%) |
| K-13 *Alnus–Carpinus*-NAP (112.3–113.0 m) | High values of *Alnus* (61%), *Carpinus* up to 6% |
| K-12 *Pinus*–Poaceae (113.0–113.85 m) | Domination of *Pinus* (50%) in the lower part of the zone, rise in *Alnus* pollen towards the top |
| K-11 *Ulmus* (113.85–114.05 m) | Rapid increase in *Ulmus* pollen to 22% |
| K-10 *Corylus–Carpinus–Quercus* (114.05–114.55 m) | Abrupt changes in the values of *Corylus* (max. 37%), *Carpinus* (23%) and *Quercus* (18%) |
| K-9 *Quercus–Ulmus–Alnus* (114.55–115.85 m | Maximum values of *Alnus* and *Quercus* pollen (respectively 64 and 20%), *Ulmus* and *Corylus* up to 12%, *Tilia* and *Carpinus* up to 8% |
| K-8 *Betula–Pinus*–NAP (115.85–116.95 m) | Increase in AP, mainly *Betula* (50%) and *Pinus* pollen (44%), still high proportion of *Artemisia* (16%) and Poaceae (12%) |
| K-7 *Artemisia*–Poaceae (116.95–117.6 m) | NAP values exceed 50%, Poaceae (15%) and *Artemisia* (22%) prevail among herbs, which are also characterised by a remarkable variety of taxa |
| K-6 *Pinus–Picea*–NAP (117.6–117.8 m) | AP values persist high (82%), especially *Pinus* (54%), *Betula* (31%) and *Picea* (6%); no lower boundary |
| K-5 *Betula* (118.5–120.35 m) | Increase in AP to 88%, domination of *Betula* (76%); no upper boundary |
| K-4 Poaceae–*Artemisia* (120.35–122.85 m) | NAP values are again high (42%), particularly Poaceae (25%) and *Artemisia* (15%) |
| K-3 *Pinus*–NAP (122.85–124.1 m) | AP values reach 83%, domination of *Pinus* (59%) and *Betula* pollen (23%) |
| K-2 Poaceae–Pinus (124.1–125.05 m) | NAP values up to 42% (mainly Poaceae 25%, Cyperaceae 11% and *Artemisia* 2%). |
| K-1 *Pinus* (125.05–126.0 m) | High AP values (max. 87%), domination of *Pinus* (70%); no lower boundary |

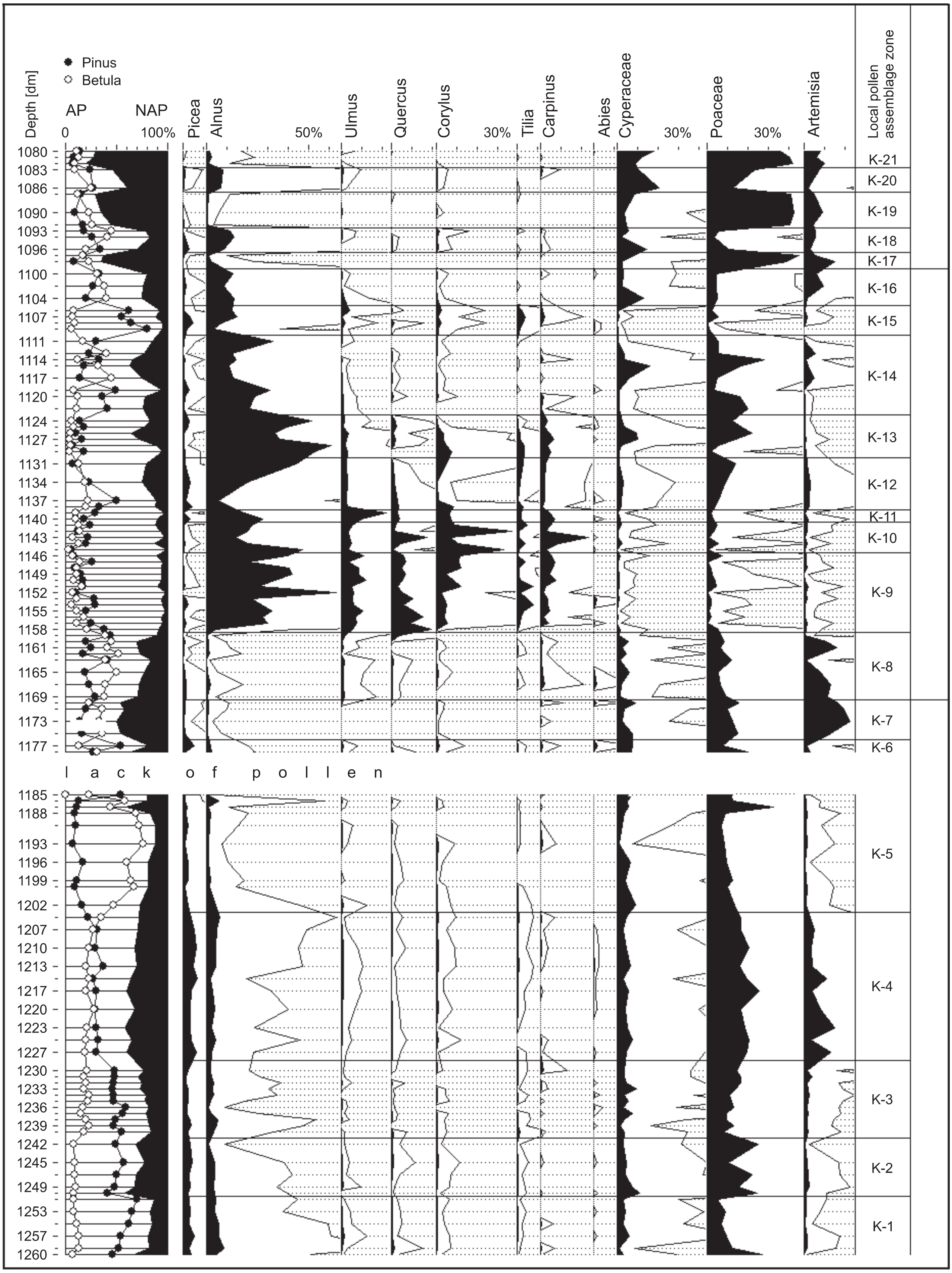


**Fig. 1. Komorniki — simplified pollen diagram**

overgrown with alder communities (K-1). In spectra of pollen zone K-2, the role of communities of herbaceous plants, mainly grassy ones, grew temporarily, which suggests slight decline of climatic conditions. Pine communities, although their role decreased gradually, still dominated, according to pollen spectra of zone K-3. Forests became denser again. Changes in vegetation reflected in spectra of pollen zone K-4 were related to expansion of steppe communities with Poaceae and *Artemisia*, as well as to increasing part of birch trees in forest communities. In spite of declining climate, forests still grew near the ancient lake, although they were no longer dense. The composition of the pollen spectra of zone K-5 indicates the expansion of birch which became the main element of forests communities. After temporary growth of importance of *Pinus* in forests communities (pollen zone K-6), a significant cooling of the climate corresponding to pollen zone K-7 resulted in growth of steppe communities with Poaceae and *Artemisia*, as well as shrub tundra communities with *Betula nana.* According to pollen spectra of zone K-8, gradual recession of open communities, growth of birch forests and, later, of pine forests, are the evidence of the warming of the climate. Pollen spectra of zones K-9, K-10 and K-11 reflect the complete restructurization of forests communities. Habitats left after recessing *Pinus* and *Betula* were occupied by *Quercus*, and later also by *Tilia*, *Carpinus* and *Corylus*. Moist habitats were overgrown by elm-alder communities with a slight admixture of *Fraxinus* spread out over wet habitats. The moderate climate prevailed. Expansion of *Pinus* and recession of thermophilous trees, followed by growth of grass communities (zone K-12) is clear signal of the cooling of the climate. Pollen spectra of zone K-13 indicate the secondary expansion of *Alnus*. Alder communities still remained in the vicinity of the ancint lake, but they gradually lost their significance, according to pollen spectra of zones K-14, K-15 and K-16. Pine and pine-birch communities with an admixture of spruce spread out. Forests were still quite dense. Very distinct cooling of the climate resulted in rapid expansion of steppe-like communities with *Artemisia* (K-17). The landscape was woodless, and was only differentiated with patches of shrub tundra communities with *Betula nana* and *Salix*; the climate was subarctic. The evidence for another warming of the climate (K-18) is expansion of pine and pine--birch communities with addition of spruce, and alder forests in swamp habitats. The improvement of the climatic conditions was probably of short-term nature. Pollen spectra of the next zone (K-19) show that the landscape within the site was woodless again and the cold, subarctic climate prevailed. The changes in vegetation reflected in spectra of two youngest pollen zones give evidence for two more climatic changes, towards warming (K-20) and cooling (K-21).

## DIATOM SUCCESSION AND PALAEOENVIRONMENTAL CHANGES IN THE ANCIENT BASIN

The diatom flora studied from the Komorniki profile consists of 216 species and intraspecific taxa belonging to 54 genera, 25 families, 13 orders, 3 classes. Percentage of different ecological diatom groups (according to habitats type, the halobion spectrum, the pH-requirements, geographical distribution) and species composition change repeatedly from bottom to top along the profile in the depth interval of 114.8–125.6 m. This allowed to distinguish 7 local diatom assemblage zones (L DAZ K-1–K-7) in the diatom diagram (Fig. 2). They reflect the palaeoenvironmental shifts in the ancient basin.

L DAZ K-1 (123.7–125.6 m) is dominated by epiphytic alkaliphilous species (67–73% of the total spectra) represented by *Martyana martyi* (up to 28.4%), *Cocconeis neodiminuta* (14.8%) and *C. placentula* with varieties (21.1%). Among the benthic taxa, alkaliphilous members of *Planothidium lanceolatum* (8.9%) and *Amphora pediculus* (5.5%) were characteristic. This diatom assemblage testifies to a shallow, slightly oligotrophic lake with pH values above 7 on the initial stage of its development.

L DAZ K-2 (122.6–123.7 m) is identified by a sharp increase in the planktonic diatoms content (up to 71% of the total) and a considerable decrease in epiphytic members (up to 21%). The planktonic species are represented by the maximum occurrence of *Stephanodiscus* sp. 1 (to 22.7%) and *Stephanodiscus* sp. 2 (14.2%) characterizing by more or less small size and thin areolation of valves, as well as by small specimens of the halophilous species *Cyclotella meneghiniana* (up to 6.5%), the temperate warm-water alkaliphilous taxa of *Aulacoseira ambigua* (4–11%) and *A. granulata* (3–11%). Among the periphytic diatoms, small specimens of *Staurosirella pinnata* (to 9.6%) were the most often found. The enrichment of the diatom assemblage by virtue of the planktonic members indicates a rise of water level and the amelioration of palaeoecological conditions in the ancient mesotrophic basin at this stage.

L DAZ K-3 (120.3–122.6 m) is marked by the prevalence of periphytic species (up to 86%) in the diatom composition. Among them, the relatively cold-water species *Staurosirella pinnata* reaches its maximum (as high as 22%). Moreover, three apparently new members of *Staurosirella* sp. 1, *Staurosirella* sp. 2 and *Staurosirella* sp. 3 occur in this zone making up 5–7%, 2–4% and 6–14%, respectively. *Pseudostaurosira* sp. shows rather high values (15–28%). The amount of *Punctastriata ovalis* does not exceed 13.6%. The above data clearly show that the water level became lower in the lake at this stage than in the previous one. The palaeobasin was oligotrophic.

L DAZ K-4 (117.7–120.3 m) is distinguished by the abundance of taxa from the genus *Fragilariforma*. The latter is represented by the cold-water littoral planktonic species *F. heidenii* (up to 29%) preferring the brackish water (Krammer, Lange-Bertalot, 1991), as well as by freshwater periphytic members of *F. hungarica* et var. *tumida* (up to 26%) achieving here the maximum values in the profile. Besides *Staurosirella pinnata* (6–7%) and *Punctastriata ovalis* (up to 11%) regularly occur in this zone. The described diatom assemblage reflects a not deep, oligotrophic type of the ancient basin.

In the sediments corresponding to L DAZ K-5 (117.2–117.7 m) the diatom algae are present in small number. Fossil crysophyte cysts and sponge spicules are the most abundant. It suggests general changes in lacustrine or lacustrine-fluvial biota caused by the environmental shifts in the paleobasin. Sponges species inhabit mainly the littoral zone of lake.

L DAZ K-6 (115.1–117.2 m) is marked by an essential increase in the frequency of diatoms and their taxonomic diver-

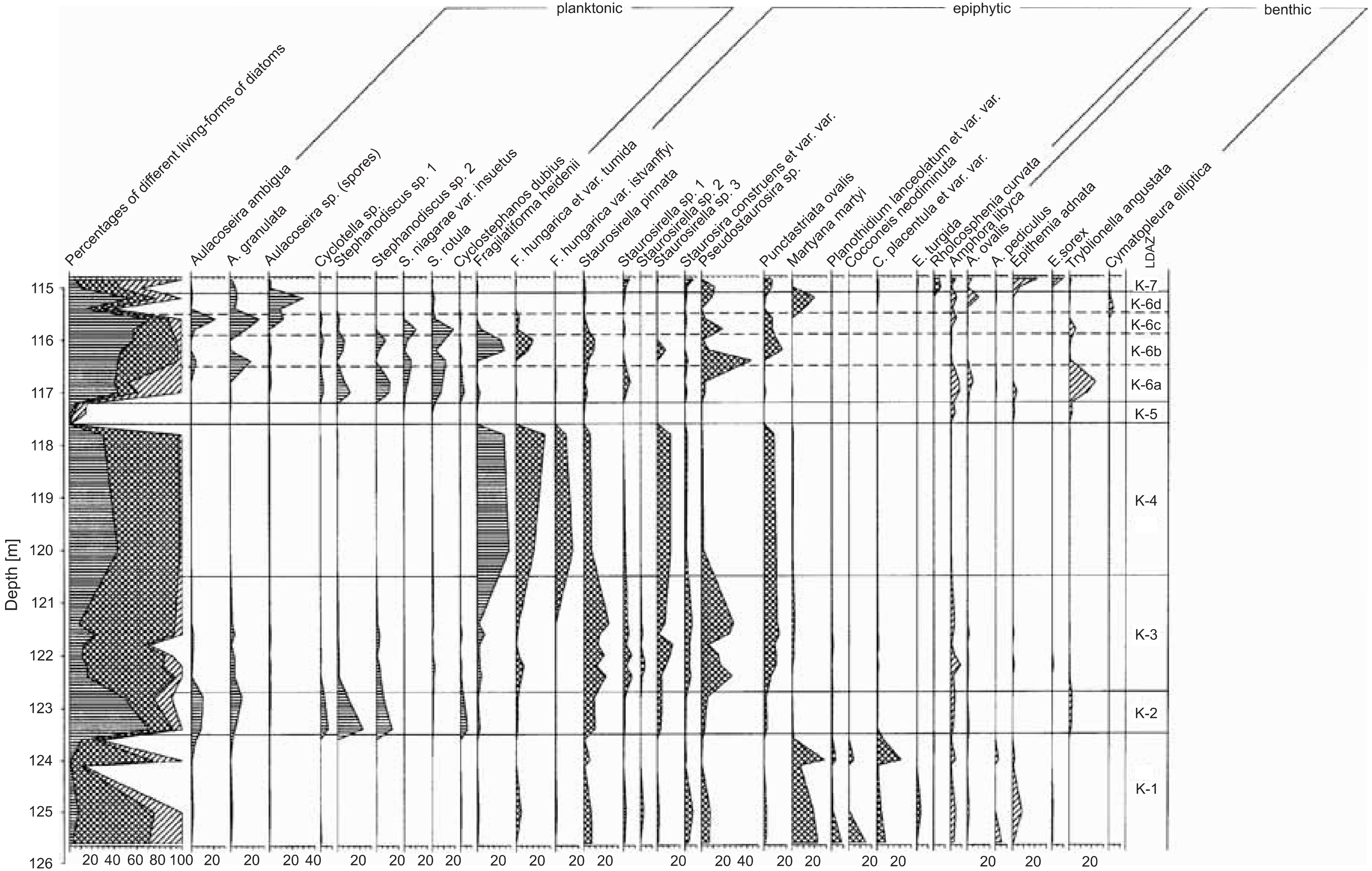


**Fig. 2. Diatom succession in the sedimentary record from the Komorniki profile**

sity. This diatom zone contains four subzones. Subzone K-6a (116.5–117.2 m) is recognized by a considerable content of planktonic small species of *Stephanodiscus* sp. 1 (up to 12.2%) and *Stephanodiscus* sp. 2 (to 12.8%) mentioned above for L DAZ K-2, an appreciable participation of the larger species of *Stephanodiscus* (*S. niagarae* var. *insuetus* and *S. rotula*) which constitute 9–14% of the total spectra, as well as by the maximum values of benthic diatoms of *Triblionella angustata* (up to 22.6%) and *Amphora libyca* (to 7.9%) in the profile.

Subzone K-6b (115.9–116.5 m) is defined by the decrease in the values of benthic taxa and the increase in the proportion of the planktonic members of *Stephanodiscus* (to 30%), *Aulacoseira* (up to 23.2%) and of the littoral planktonic/periphytic representatives of *Fragilariforma, Staurosirella* and *Punctastriata.* The second peak of occurrence of the littoral planktonic species *Fragilariforma heidenii* (to 24.8%) and the maximum amounts of the periphytic members of *Pseudostaurosira* sp. (to 43.5%) and *Punctastriata ovalis* (up to 16.2%) are characteristic of this subzone.

Subzone K-6c (115.5–115.9 m) is dominated by the larger planktonic species of *Stephanodiscus rotula* and *S. niagarae* var. *insuetus* characterizing here by some morphological peculiarities and making up 19.3% and 11.2%, respectively. Moreover, the temperate warm-water taxa of *Aulacoseira granulata* (up to 26%) and *A. ambigua* (up to 21.8%) developing abundantly in the phytoplankton of the eutrophic lakes reach the maximum values in this profile. The number of the periphytic species *Pseudostaurosira* sp. achieves here 18.6%.

Subzone K-6d (115.1–115.5 m) is distinguished by the prevalence of the planktonic members of *Aulacoseira* represented mainly by spores (to 30.4%). Among the epiphytic and benthic diatoms, *Martyana martyi* (to 19.7%) and *Amphora ovalis* (10.1%) belong to dominants, respectively.

The changes noted in the composition of the diatom assemblage of L DAZ K-6 (115.1–117.2 m) suggest that the eutrophication process in the ancient lake had continued throughout the whole time interval corresponding to this zone. The palaeobasin was of medium depth with a tendency to lowering of the water level in it to the end of the characterized interval, when the share of benthic and epiphytic taxa increased in the general composition of diatoms. Besides the abundance of the *Aulacoseira* spores is indicative of the existence of unfavourable conditions for the development of planktonic species in that time (L DAZ K-6d). The predominance of alkaliphilous members in the total spectra testifies to the alkaline reaction of water in the lake.

Lastly L DAZ K-7 (114.8–115.1 m) is identified by the mass occurrence of the alkaliphilous/alkalibiontic widespread benthic and epiphytic species of *Epithemia adnata* (up to 21.5%), *E. sorex* (to 9.3%), *Staurosira construens* (to 7.6%), etc. providing evidence of shallowing and overgrowing of the ancient lake.

Hence, diatom succession revealed in the lacustrine-boggy -fluvial sequence from the profile at Komorniki can be represented as follows: *Martyana, Cocconeis, Planothidium* → *Stephanodiscus, Aulacoseira, Pseudostaurosira, Staurosirella* *Staurosirella, Pseudostaurosira, Punctastriata* *Fragilariforma, Punctastriata, Staurosirella* → a very small number of benthic/epiphytic diatoms → *Stephanodiscus, Tryblionella, Amphora* *Stephanodiscus, Aulacoseira, Fragilariforma, Pseudostaurosira, Punctastriata* *Aulacoseira, Stephanodiscus, Pseudostaurosira* *Aulacoseira, Martyana, Amphora* *Epithemia, Staurosira*. There is a benthic/periphytic → planktonic–benthic/periphytic → periphytic, and generally oligotrophic → meso-eutrophic → eutrophic type of diatom succession reflecting lake changes from a not deep basin (L DAZ K-1) to the lake of medium depth (L DAZ K-2 – L DAZ K-6) and finally to a shallow and overgrown lake (L DAZ K-7).

## MALACOLOGICAL INVESTIGATIONS

Malacofauna occurred in the profile at Komorniki consists of 30 (3 land and 27 freshwater) taxa. Results of malacological analysis allowed to identify 6 malacological zones in the depth interval of 108–126 m (Fig. 3). Among them, the malacological zones K-1 (125.1–126.0 m) is dominated by the extinct reophilous molluscs of *Fagotia wuesti*, *Lithoglyphus jahni* and *Sphaerium* cf. *rivicola*. This suggests the existence of a drainage paleolake. In the next zone K-2 (123.8–125.1 m) only the extinct species of *Sphaerium* cf. *rivicola* remained the leading position (up to 32%). The malacological zone K-3 (120.5–123.8 m) is defined by the abundant peaks of the stagnophilous species *Valvata piscinalis* (up to 65%) and the reophilous member *Valvata naticina* (to 10%). The next zone K-4 (116.8–120.5 m) is distinguished by a high occurrence of many stagnophilous and reophilous molluscs indicating the mobility of the water environment. The malacological zone K-5 (114.0–116.8 m) is characterized by the diverse composition and the abundance of the temperate warm-water molluscs (*Uniaceae* gen., *Valvata naticina*, *Lithoglyphus jahni*, *Viviparus* sp., *Neumayria* (*Parafossarulus*) *crassitesta*) that corresponds to the interglacial conditions of palaeoenvironment. The prevalence of *Bithynia leachi trosheli* in the common composition of the malacofauna of the malacological zone K-6 (at the level of 108 m) testifies to an essential shallowing and even the disappearance of the paleolake.

## DISCUSSION

The characteristic feature of the pollen sequence which represents the warm period in the diagram from Komorniki is appearance of thermophilous deciduous tree pollen, that is *Quercus, Ulmus, Tilia, Carpinus* and *Alnus*, as well as *Corylus*, almost at the same time. Such a composition of pollen spectra, as well as almost simultaneous occurrence of the aforementioned tree and shrub pollen, is typical of the second warm period of the Augustovian and the Ferdynandovian Interglacials. In the Komorniki diagram, as well as in diagrams of the Augustovian Interglacial from Szczebra (Janczyk-Kopikowa, 1996)

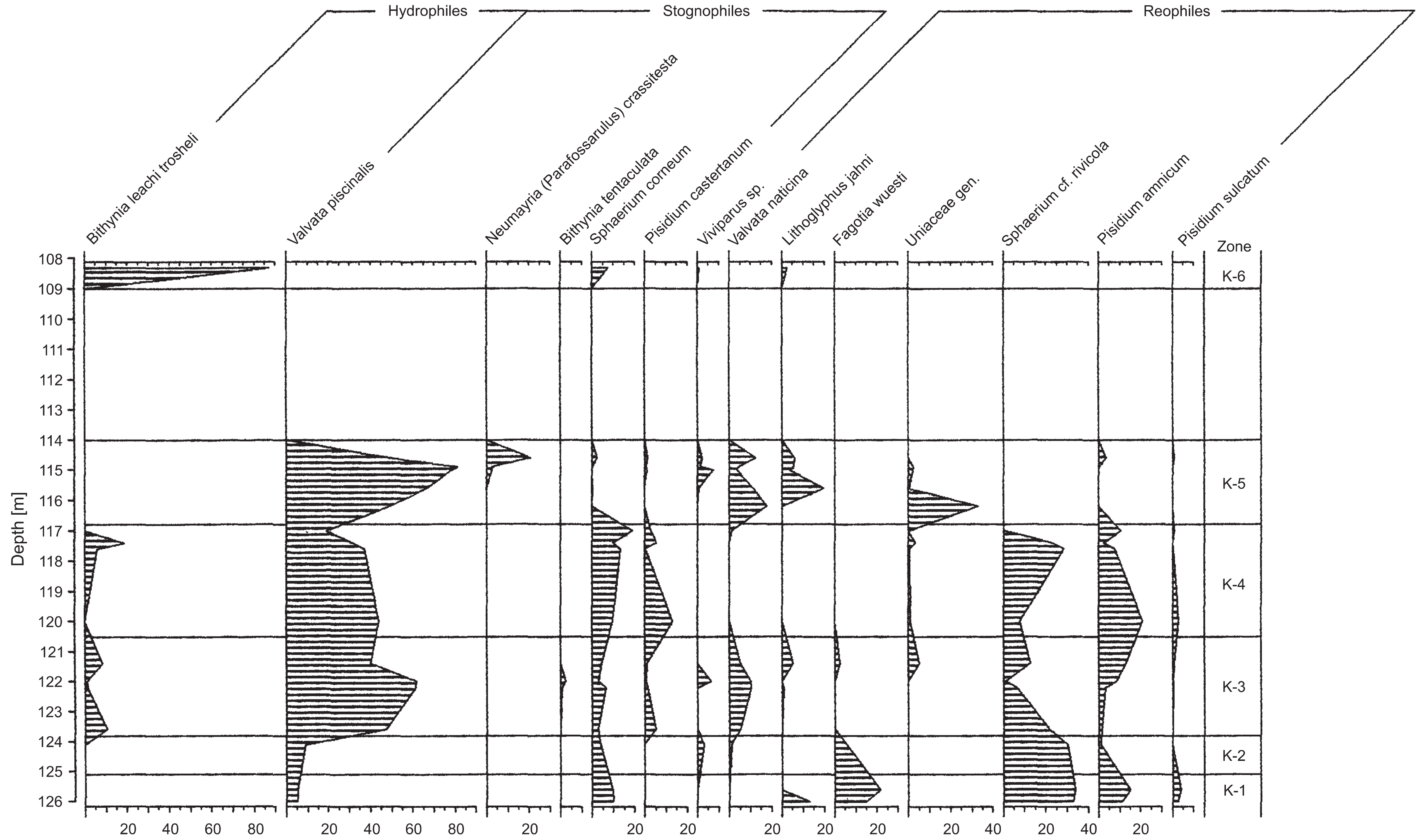


**Fig. 3. Malacological diagram of the profile at Komorniki (after A. Sanko)**

and Czarnucha (Winter, 1999) and of the Ferdynandovian Interglacial from Zdany (Pidek, 2003), *Quercus* and *Ulmus* occur slightly earlier than other thermophilous trees and hazel.

Comparison of the interglacial pollen sequence from Komorniki and pollen successions of the second warm period of the Augustovian and the Ferdynandovian Interglacials results in a conclusion that it shows more similarities to successions regarded as Augustovian. In the Komorniki diagram, as well as in the parts of the Szczebra (Janczyk-Kopikowa, 1996), Czarnucha (Winter, 1999) and Kalejty (Winter, 2001) diagrams which represent the second warm period of the Augustovian Interglacial, 10% or higher values of *Ulmus* pollen is reported. High pollen values of this tree are characteristic of the first climatic optimum of the Ferdynandovian Interglacial, whereas its abundance in pollen spectra of the second warm period of that interglacial is much lower. In the younger part of the interglacial in Komorniki (K-13), very high abundance of *Alnus* pollen can be seen. Relatively high values, at about 20%, of alder pollen also occur in the younger part of the second warm period in Szczebra (Janczyk-Kopikowa, 1996), Czarnucha (Winter, 1999) and Kalejty (Winter, 2001). In the Ferdynandów (Janczyk-Kopikowa, 1975) and Zdany (Pidek, 2003) diagrams, such increase in *Alnus* values after the climatic optimum is not reported. However, because both high values of *Ulmus* and increase in *Alnus* may be a result of local environmental conditions, one should be careful so as to not overestimate their diagnostic importance.

In the Komorniki pollen succession, two cool periods occur in addition to the warm unit. The older period (K-1 – K-7) may be correlated with the cold period distinguished within the Augustovian Interglacial in Szczebra (Janczyk-Kopikowa, 1996), Czarnucha (Winter, 1999) and Kalejty (Winter, 2001). However, pollen spectra in zone K-7 *Artemisia*–Poaceae, with over 50% abundance of herbaceous plants and occurrence of *Betula nana*, suggest a woodless landscape with patches of shrub tundra, typical of glacial periods. The younger cool period (K-17 – K-21) is correlated with the Nidanian Glaciation.

According to the palaeomagnetic data obtained by Nawrocki (Ber, 2000), the sediments of the Augustovian Interglacial laying in the Czarnucha section below 112.8 m belong to the Matuyama chron. The occurrence of *Eucommia* pollen in the Czarnucha profile testifies to the correlation of the Augustovian Interglacial apparently with the Cromerian I Interglacial (Kacprzak *et al.*, 2002).

Generally, diatom succession from the Komorniki profile is correlated with that from the Czarnucha section (Marciniak, 2004). Nevertheless diatom succession from the Komorniki site is more complete (see above).

The diatom flora found in the deposits corresponding to the older cold stage (L PAZ K-1 – K-7) is similar in some its aspects with that from the Nizhninian cold period (minor Glaciation) known from the profile at Krasnaya Dubrova (the borehole 55B) within Belarus (Khursevich, Loginova, 1986; Khursevich *et al.*, 1990). Both diatom floras are dominated by benthic/periphytic members of *Martyana martyi* and *Fragilaria s.l.* However, if the diatom community from the Krasnaya Dubrova profile contains a lot of *Amphora pediculus*, *Staurosira* (= *Fragilaria*) *construens* with varieties and *Pseudostaurosira* (= *Fragilaria*) *brevistriata*, then *Fragilariforma heidenii*, *F. hungarica* with varieties, the various species of *Staurosirella* (including three unidentified, apparently new taxa), *Pseudostaurosira* sp. and *Punctastriata ovalis* occur in a high number in the Komorniki profile. Besides some unidentified, small planktonic species of *Stephanodiscus* are marked in the depth interval of 122.6–123.7 m reflecting apparently the improvement of palaeoecological conditions in the ancient basin at that short time.

The composition of dominant diatoms revealed in the sediments corresponding to the beginning and the first half of the climatic optimum of the interglacial stage (L PAZ K-8 – K-9) is similar in the abundance of planktonic members of *Stephanodiscus* and *Aulacoseira* with that found in the deposits of the Mogilevian Interglacial from the Krasnaya Dubrova profile (the borehole 13B) in Belarus (Khursevich, Loginova, 1986; Khursevich *et al.*, 1990). Nevertheless the interglacial diatom flora from the Komorniki section is distinguished by the presence in its composition of small unidentified species of *Stephanodiscus*, marked in the sedimentary record of the older cold stage, as well as by the considerable participation of the larger species of *S. niagarae* var. *insuetus* and *S. rotula* (with some morphological peculiarities). For instance, many found specimens of *S. rotula* are characterized by the availability of only one valve face fultoportula with two satellite pores near the centre and a relatively high valve mantle. Certain specimens of *S. niagarae* var. *insuetus* are distinguished by the various shapes of areolae; an irregular location of valve face fultoportulae (near the centre, on the boundary of uniseriate and biseriate striae, within biseriate striae), and the absence of conspicuous hyaline strips on the valve mantle. *S. niagarae* var. *insuetus* is the Pleistocene extinct taxon known from the Belovezhian, Mogilevian and Alexandrian interglacials of Belarus (Khursevich, Loginova, 1986; Khursevich *et al.*, 1990; Velichkevich *et al.*, 1997; Khursevich, Fedenya, 1998), from the Muchkapian Interglacial within the central regions of Russia (Antsiferova, 1991), from the Ferdynandovian (Khursevich *et al.*, 1990; Marciniak, Lindner, 2003) and Augustovian (Marciniak, 2004) interglacials in Poland. *Stephanodiscus rotula* is a widespread species with the age range from Pliocene to present. The benthic/periphytic diatoms in the interglacial diatom flora from the profile at Komorniki are represented by the same taxa from the family Fragilariaceae that were typical for the cold stage, as well as by various species of *Hippodonta*, *Navicula*, *Amphora*, *Tryblionella*, *Epithemia*, etc.

Thus, diatom succession from the Komorniki profile, including certain unidentified, apparently new dominant species of *Stephanodiscus*, *Staurosirella* and *Pseudostaurosira*, has no complete analogs among all other known continental diatom records of the middle Pleistocene in Europe. The further detailed study of diatom succession in the profile at Komorniki and another coeval sections of the northeastern Poland, the descriptions of new species, the clarification of an evolutionary trend within the *Stephanodiscus* group of diatoms, as well as the comparison of results of diatom investigations with materials of other palaeontological methods and geological data allow to give apparently some more palaeobotanical evidence for the stratigraphic position of the Augustovian Interglacial in the Pleistocene sequence of Poland.

Among the extinct species of molluscs, *Fagotia wuesti* and *Neumayria* (*Parafossarulus*) *crassitesta* are marked in the Pleistocene of Poland at the first time. *Fagotia wuesti* was first described by Meijer (1989) from the Kedichem Formation of the Bavel Interglacial in the Netherlands. Besides this species listed as *Fagotia acicularis* by Zeissler (1971) and Mania (1973) is known from Thuringia (Germany) only in deposits assigned to either the Borntal or Artern interglacials. According to palaeomagnetic research, sediments of the Artern Interglacial have reversed polarity and occur apparently in the upper part of the Matuyama epoch (Menning, Wiegank, 1982; Wiegank, 1987). *Neumayria* (*Parafossarulus*) *crassitesta* is present in the sediments of the Leerdam, Borntal, Artern and Holsteinian interglacials of the Western Europe (Meijer, Preece, 1996). Mass occurrence of *Neumayria* (*Parafossarulus*) *crassitesta*, represented by thick-walled *operculata* with an eccentric nucleus and diagnosed as *Bithinia labiata*, was found in the deposits of the Korchevian Interglacial within Belarus (Sanko, 1999). The extinct fluvial species of *Lithoglyphus jahni* is characterized by wider geological distribution. This mollusc is commonly known from the Tiglian, Waalian and Bavelian sediments in the Netherlands (Meijer, Preece, 1996), present in most Thuringinian localities assigned to the Borntal and Artern interglacials in Germany (Mania, 1973) and occurs in the Mazovian Interglacial deposits in Poland (Skompski, 1982).

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