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MALACOFAUNA OF THE EEMIAN INTERGLACIAL IN KOCHANÓW (MIDDLE POLAND)

Abstract

The sequence of mollusc assemblages has been found in calcareous sediments of the last interglacial in Kochanów near Łódź. It reflects changes of the climate and the environment during the ascending part of the warm period since the termination of the Wartanian until the climatic optimum of the Eemian. A few phases of the evolution of the ancient melt-lake filled with lacustrine chalk can be distinguished and characterised according to results of malacological analysis. The occurrence of the thermophilous snail *Belgrandia marginata* accompanied by a few other species of limited climatic tolerance is noteworthy. It indicates the warmest episode of the interglacial corresponding with pollen assemblage zones typical of a relatively warm and humid, oceanic climate widespread in Central Europe during the middle part of the Eemian.

INTRODUCTION

Sediments of the Eemian Interglacial occur in several localities situated between Łódź and Warszawa (Fig. 1). They are developed mainly as gyttja, calcareous gyttja, calcareous silt and lacustrine chalk filling melt--depressions such as small lakes and kettle holes, connected with the deglaciation of the Wartanian Glacier. The age of mentioned deposits have been established by several authors according to pollen analysis, listed and interpreted by MAMAKOWA (1989). Mollusc fauna composed almost exclusively of water snails and bivalves were described from the Bobrówka River Valley (KLAJNERT, PIECHOCKI, 1972), from the Wolbórka River Valley in Świątniki (ALEXANDROWICZ, 1988; TURKOWSKA, 1988a, b) and from two outcrops in Warsaw (POLIŃSKI, 1927; URBAŃSKI, 1954; SKOMPSKI, SŁOWAŃSKI, 1961; SKOMPSKI, 1977). They were also mentioned from another outcrop in Warsaw (MORAWSKI, 1975; SKOMPSKI, 1991) and from Żyrardów (KRUPIŃSKI, 1978). A sample of calcareous gyttja with a few specimens of water snails from Rogów was delivered to the author by Prof. KONECKA-BETLEY (Fig. 1).

The site Kochanów is situated 35 km eastward of Łódź. It has been described in detail by MANIKOWSKA (1998). Calcareous sediments

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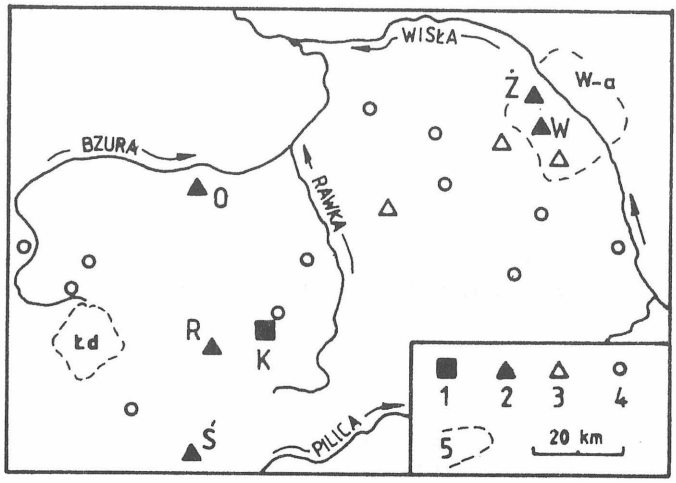

Fig. 1. Main localities of Eemian deposits in Central Poland between Łódź and Warsaw (location map)

1. profile in Kochanów; 2. profiles of mollusc-bearing sediments (the fauna described in detail); 3. profiles of mollusc-bearing sediments (the mollusc fauna mentioned only); 4. other profiles of interglacial deposits; 5. the area of Warsaw and Łódź

Fig. 1. Główne stanowiska osadów interglacjału eemskiego w Środkowej Polsce, między Łodzią a Warszawą (mapka lokalizacyjna)

1. profil w Kochanowie; 2. profile osadów zawierających skorupki mięczaków (fauna opracowana i opisana); 3. profile osadów z malakofauną (obecność skorupek mięczaków tylko wzmiankowana); 4. inne profile osadów interglacjalnych; 5. granice miast (Warszawy i Łodzi)

abounding in shells of molluscs were sampled two times in two outcrops localised close to one another in the marginal part of the ancient water body. Three samples had been taken by Prof. MANIKOWSKA in the first outcrop (pit hole 2a) and a few years later thirteen samples were collected by the author in the second outcrop (pit hole 2b). Standard methods of malacological analysis described by LOŻEK (1964) and ALEXANDROWICZ (1987) have been used. The analysed material encloses 3908 specimens representing 29 taxa: 4 species of land snails, 15 species of water snails (4 – *Prosobranchia*, 11 – *Pulmonata*) and 10 taxa of bivalves. Four ecological groups of molluscs and four groups of species characterised by different climatic tolerance have been distinguished. The index **Bi** showing the relation between the number of shells and opercula of *Bithynia tentaculata* was calculated according to the formula described and used by the author (ALEXANDROWICZ, 1987, 1991).

ASSEMBLAGES OF SUBFOSSIL MOLLUSCS

Lacustrine deposits abounding in shells of molluscs were accessible in the trench 2b in Kochanów (MANIKOWSKA, 1998, Fig. 1, 4). Thin-grained

sand alternating with sandy chalk has been distinguished at the bottom of the outcrop. It passes upward into the white and yellowish-white chalk, more or less distinctly bedded, with thin intercalations of whitish-grey silty chalk. Grey and yellowish-grey marly chalk and silty chalk with an admixture of thin-grained sand occurs in the uppermost part of the described sequence. The thickness of the mentioned calcareous deposits is about 1.30 m. Samples taken in the outcrop are numbered in stratigraphic order (1–13). Each one encloses 10 cm of the sediment (Fig. 2 – Lt, Sm).

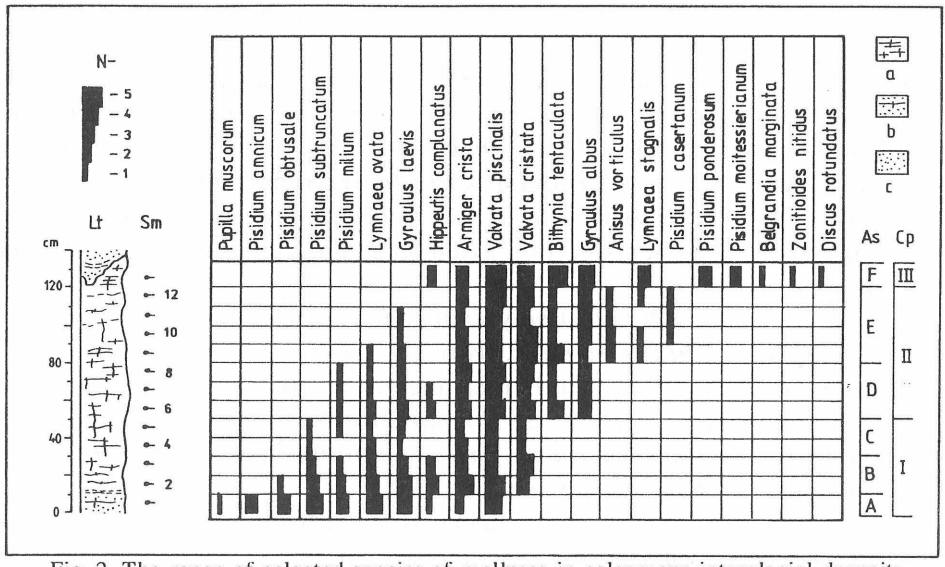

Fig. 2. The range of selected species of molluscs in calcareous interglacial deposits in Kochanów

Lt – lithology: a – lacustrine chalk, b – sand alternated with chalk, c – sand and laomy sand; Sm – samples, N – number of specimens: 1. 1–3; 2. 3–9,3 – 10–31,4 – 32–99,5 – 100–316; As – assemblages of molluscs, Cp – climatic phases distinguished according to results of malacological analysis

Fig. 2. Zasięg wybranych gatunków mięczaków w profilu węglanowych osadów jeziornych w Kochanowie

Lt – litologia: a – kreda jeziorna, b – piaski przekładane kredą jeziorną, c – piaski i piaski pylaste; Sm – lokalizacja próbek, N – ilość okazów: 1 – 1–3; 2 – 4–9; 3 – 10–31; 4 – 32–99; 5 – 100–316; As – zespoły mięczaków; Cp – fazy klimatyczne wyróżnione na podstawie wyników analizy malakologicznej

In the lowermost part of the profile (samples 1 and 2) the fauna is relatively rich and differentiated. It contains 12–15 taxa and more than 300–500 specimens in a sample. In the next sample the number of molluscs decrease and the poorest fauna occurs 40–50 cm above the bottom of the outcrop containing 6 or 7 taxa and less than 50 shells in a sample. In the middle and upper part of the sequence assemblages are less differentiated, composed of 9–11 taxa. At the top of the chalk (sample 13) the fauna is very rich again comprising 14 taxa and more than a thousand of specimens (Tab. I, Fig. 3 – N).

The content of specimens representing three taxonomic groups of molluscs: bivalves, prosobranch snails and pulmonate snails is equal only in the lowermost part of the described sequence. In samples 2 and 3 the number of bivalves decrease markedly while the number of snails representing both mentioned groups is nearly the same. In the middle and upper part of the profile shells of snails belonging to *Prosobranchia* are the dominant component of the fauna. The content of pulmonate snails decrease gradually upward and shells of bivalves occur sporadically (Fig. 3, ML).

Six assemblages of molluscs have been distinguished according to the range of particular species (Tab. I, Fig. 2).

A (sample 1) – the fauna characterised by numerous shells of *Pisidium amnicum* – the species living in moving water, mainly in rivers and littoral zones of lakes. Other small bivalves: *Pisidium subtruncatum*, *Pisidium milium* and *Pisidium obtusale* are represented by a considerable number of specimens. Three species of water snails are most important components of this assemblage and the occurrence of land snails is noteworthy.

B (samples 2–3) – the relatively rich fauna dominated by four species of snails: *Valvata piscinalis*, *Valvata cristata*, *Armiger crista* and *Gyraulus laevis*. Three other species are represented by a considerable number of specimens: *Lymnaea ovata*, *Hippeutis complanatus* and *Pisidium subtruncatum*. *Physa fontinalis* and *Anisus contortus* occur only in this assemblage.

C (samples 4–5) – the poor fauna with *Valvata piscinalis*, *Valvata cristata* and *Lymnaea ovata*, composed of a low number of species and specimens. Only a few specimens of bivalves were found.

D (samples 6–8) – the assemblage with numerous specimens of *Valvata piscinalis*, *Valvata cristata*, *Armiger crista*, *Gyraulus laevis* and *Gyraulus albus*. The occurrence of shells and opercula of *Bithynia tentaculata* is noteworthy.

E (samples 9–12) – the fauna with numerous specimens of *Valvata cristata* accompanied by shells of *Valvata piscinalis*, *Gyraulus albus* and *Armiger crista*. Two species of molluscs: *Anisus vorticulus* and *Pisidium casertanum* occur only in this assemblage.

F (sample 13) – the rich fauna dominated by *Bithynia tentaculata* (opercula) and *Valvata piscinalis*. Two species of bivalves represented by a considerable number of shells: *Pisidium moitessierianum* and *Pisidium ponderosum* were found only in this assemblage. The occurrence of *Belgrandia marginata*, the snail connected with a relatively warm, Atlantic climate is particularly worth of noting. *Gyraulus albus*, *Armiger crista* and *Valvata cristata* are another important components of the described fauna. A few shells of land snails have been noted, too.

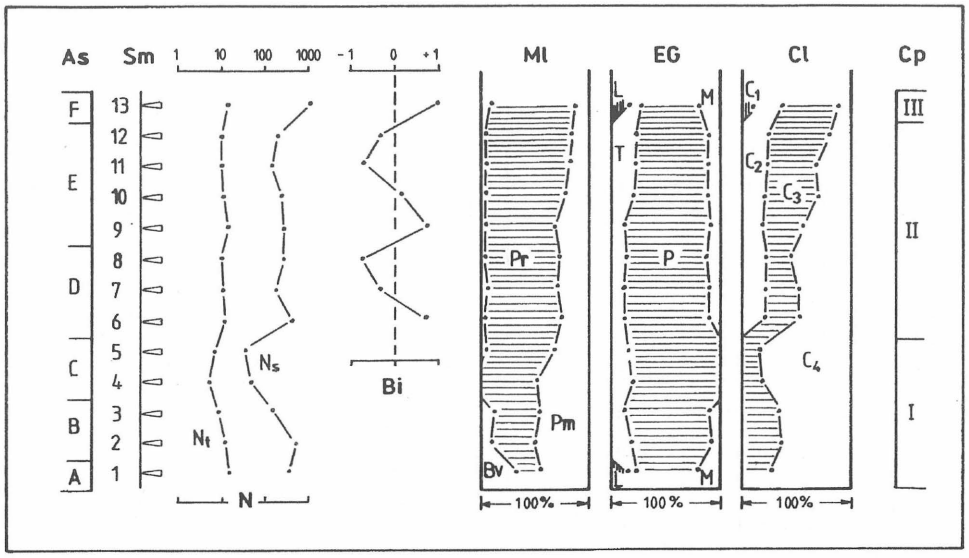

Fig. 3. Features of mollusc assemblages forming the succession of the profile in Kochanów

As – assemblages of molluscs, Sm – samples, N – number of species (Nt) and of specimens (Ns) (in the logarithmic scale), Bi – Bithynia–index, Ml – the content of systematic groups of molluscs: Bv – Bivalvia, Pr – Prosobranchia, Pm – Pulmonata; Eg – the diagram illustrating malacological spectra of species: L – land snails, T – molluscs inhabiting temporary water bodies, P – molluscs of permanent water bodies, M – molluscs preferring moving water; Cl – content of climatic groups of molluscs: Cl – species of warm, oceanic climate, C2 – species of the temperate climatic zone, C3 – molluscs accepting the temperate and the boreal climate, C4 – cold-tolerant species; Cp – climatic phases of the interglacial

Fig. 3. Cechy zespołów mięczaków tworzących sukcesję malakologiczną w profilu osadów interglacjalnych w Kochanowie

As – zespoły mięczaków; Sm – próbki, N – ilość taksonów (Nt) i okazów (Ns) (w skali logarytmicznej); Bi – Bithynia-index, Ml – zmienność udziału grup systematycznych mięczaków: Bv – małże (Bivalvia), Pr – ślimaki skrzelodyszne (Prosobranchia), Pm – ślimaki płucodyszne (Pulmonata); Eg – diagram ilustrujący malakologiczne spektra gatunkowe: L – ślimaki lądowe, T – mięczaki okresowych zbiorników wodnych, P – mięczaki trwałych zbiorników wodnych, M – gatunki reofilne; Cl – zmienność udziału mięczaków o różnej tolerancji klimatycznej: Cl – gatunki typowe dla ciepłego klimatu oceanicznego, C2 – gatunki żyjące w strefie klimatu umiarkowanego, C3 – gatunki akceptujące klimat umiarkowany i borealny, C4 – gatunki o dużej tolerancji klimatycznej; Cp – fazy klimatyczne interglacjału eemskiego.

Four ecological groups of molluscs have been distinguished to characterise changes of the environment: L – land snails, T – molluscs of temporary water bodies, P – species connected with permanent water basins, M – species preferring moving water (Fig. 3, EG). In the described succession of assemblages the number of taxa representing these groups is nearly stable. Land snails occur only in samples 1 and 13 as a secondary component of the fauna (13–14% of species). Molluscs living in water bodies temporary drying up amounts 7–17% (usually 9–14%) in the lower/ /middle part of the sequence and 22–24% in its upper part. Euryecological water molluscs typical of permanent basins are the dominant components of assemblages reaching 60–86 % of taxa. Molluscs connected with moving water (rivers and near-shore zones of lakes) are most numerous only in

Table 1

Malacofauna of the Eemian lacustrine deposits from Kochanów

Cl	E	Taxon Samples:	1	2	3	4	5	6	7	8	9	10	11	12	13
C2	L	Discus rotundatus (Müller)													1
C4	L	Pupilla muscorum (Linnaeus)	1												
C4	L	Succinea elegans Risso	1												
C3	L	Zontiodes nitidus (Müller)													1
C3	T	Valvata cristata (Müller)		3	4	2	2	4	3	4	5	5	3	4	4
C4	P	Valvata piscinalis (Müller)	4	5	3	3	3	5	4	4	4	4	4	5	5
C1	P	Belgrandia marginata (Michaud)													2
C2	P	Bithynia tentacaulata (Linnacus)						2	2	2	2	2	2	2	3
		Bithynia – operculum						4	1	1	4	2	1	1	5
C3	P	Physa fontinalis (Linnaeus)		1											
C3	P	Lymnaea stagnalis (Linnacus)									1	1		1	3
C4	P	Lymnaea ovata (draparnaud)	4	3	2	2	1	2	1	1	1				
C4	P	Anisus vortex (Linnaeus)	1												
C3	P	Anisus vortculus (Troschel)									2	2	1	1	
C4	P	Anisus contortus (Linnaeus)		2											
C2	P	Gyraulus albus (Müller)						3	3	3	2	3	3	3	4
C4	P	Gyraulus laevis (Alder)	4	4	3	1	2	3	2	2	2	1	1		
C4	P	Armiger crista (Linnaeus)	2	5	3	3	2	4	3	4	3	3	2	3	3
C3	P	Hippeutis complanatus (Linnaeus)	1	3	2			2	1						2
C3	P	Acroloxus lacustris (Linnaeus)									1				
C3	M	Unionidac	1												1
C4	P	Sphaerium corneum (Linnaeus)	1												
C3	M	Pisidium amnicum (Müller)	3												
C4	P	Pisidium milium (Held)	3	2	1		1	1	1	1					
C4	P	Pisidium subtruncatum (Malm)	4	3	2	1	1								
C4	M	Pisidium nitidum (Jenyns)	1	2	2			1	1	1	1	1	1	1	1
C4	T	Pisidium obtusale (Lamarck)	3	1											
C3	T	Pisidium casertanum (Poli)										1	1	1	
C3	M	Pisidium ponderosum (Stelfox)													3
C2	P	Pisidium moitessierianum (Paladlhe)													3

Number of specimens: 1. 1–3; 2. 4–9; 3. 10–31; 4. 32–99; 5. 100–316; Cl – climatic group of molluscs; Cl–C5 (explanations as Fig. 3); E – ecological group of molluscs: L, T, P, M (explanations as in Fig. 3).

the lowermost and in the uppermost part of the profile (20% of taxa) while in the remaining samples they are twice less numerous except of samples 4 and 5, devoid of them (Fig. 3, EG). Differences between assemblages expressed by the content of taxa representing particular ecological groups of molluscs reflect the course of evolution of the interglacial water body in Kochanów, filled gradually with calcareous sediments.

INTERPRETATION

Stratigraphy of the described interglacial deposits can be interpreted according to the range of selected species of molluscs in the presented sequence of assemblages. Three phases of climatic changes can be distinguished on the ground of malacological analysis (Fig. 2, Cp).

I (assemblages A–C). The initial phase is characterised by the fauna with *Gyraulus laevis*. It comprises species of a wide climatic tolerance, living in areas covered with boreal forest. It corresponds either with the final phase of the Late Wartanian or with the first phase of the interglacial defined by MAMAKOWA (1989) as the *Pinus–Betula* Pollen Assemblage Zone of Eemian.

II (assemblages D–E). The second phase begins with the appearance of two species characterised by the limited climatic tolerance: *Bithynia tentaculata* and *Gyraulus albus*. Both are represented by numerous specimens and are important components of assemblages. The mentioned species have been noted as indicators of the temperate climatic zone spread over areas covered with mixed forest (JOHANSEN, 1904; MENZEL, 1910; ALEXANDROWICZ, 1987). This phase can be compared with the *Pinus-Betula-Ulmus* and *Quercus-Fraxinus-Ulmus* Pollen Assemblage Zones (MAMAKOWA 1989).

III (assemblage F). The third phase is documented by the occurrence of *Belgrandia marginata*, accompanied by *Pisidium moitessierianum*, *Gyraulus albus* and *Bithynia tentaculata*. The first mentioned species is a warm-loving one, connected with the mild, Atlantic climate. It characterises the climatic optimum of the last interglacial but is unknown in sediments of the Holocene Climatic Optimum in Central Europe. Shells of *Belgrandia marginata* were reported from a few localities of the Eemian interglacial in Poland, namely in Poznań (the outcrop Szeląg), Brachlewo, Żmigród, Ruszkówek and Świątniki (LUBICZ–NIEZABITOWSKI, 1929; BRODNIEWICZ, 1965; SKOMPSKI, 1983, 1991; ALEXANDROWICZ, 1985; KOZYDRA, SKOMPSKI, 1995). The mentioned phase corresponds with the *Corylus-Quercus-Tilia* Pollen Assemblage Zone, described by MAMAKOWA (1989).

The evolution of the climate during the deposition of calcareous lacustrine sediments in Kochanów can be characterised using the method described by Sparks (1964). Four groups of species tolerating different climatic conditions have been distinguished (C1–C4). Their content changes within the described mollusc succession from the bottom upward (Fig. 3, Cl). Cold-tolerant molluscs (C4) accompanied by species connected with the boreal-temperate zone (C3) prevail in the lower part of the sequence. Species spread over areas covered with mixed and deciduous forest (C2) occur beside taxa of the two previously mentioned groups in the middle and the upper part of the sequence. The occurrence of warm-demanding molluscs (C1) is the characteristic feature of the last episode of the succession, distinguished at the top of the profile (Fig. 3, Cl, Cp I–III).

Relations between the content of species representing different ecological groups of molluscs reflect changes of the environment and sedimentary conditions (Fig. 3, EG). The main type of the fauna occurs in almost all samples (2–12) excluding the lowermost and the uppermost ones. It is an assemblage typical of a shallow permanent lake with a rich vegetation, offering the ecological environment favourable for snails and bivalves. An episode of impoverishment is noted by the deterioration of the fauna in samples 4 and 5. The lake was isolated from surrounding area and was gradually filled with calcareous sediment nearly completely devoid of terrigenous material. Ecological conditions were still the same in spite of the warming of the climate, indicated by a few species coming at first in the middle part of the sequence (since the sample 6).

The fauna from the first and the last sample is somewhat different. The assemblage beginning the succession (sample 1) contains an admixture of land snails living in open and in humid habitats (*Pupilla muscorum*, *Succinea elegans*) as well as of molluscs preferring moving water, even rivers (*Pisidium amnicum*). It suggests, that in the initial phase the described sedimentary basin was developed as a small water body, inducted into a flow system. Shells of land snails were washed from surrounding habitats. The mollusc assemblage closing the succession (sample 13) encloses snails connected with shady places and with marches (*Discus rotundatus*, *Zonitioides nitidus*). The admixture of species typical of moving water (*Pisidium ponderosum*) increases again (Fig. 3, EG).

The Bithynia index calculated in samples from the upper part of the profile (samples 6–13) vary from −0.75 to +0.98 (Fig. 3, Bi). It indicates, that during the deposition of calcareous sediments the lake was more or less overgrown with reeds. Three episodes of the increasing development of vegetation belts can be distinguished (samples 6, 9, 13).

The described succession of mollusc assemblages seems to be quite complete. It begins with the formation of the melt-water body at the Early Eemian or even at the termination of Late Wartanian. The lake developed

during the ascending phase of the interglacial till the its climatic optimum. It was gradually filled with calcareous sediments, overgrown and finally covered with terrigenous deposits, washed mainly from surrounding slopes (MANIKOWSKA 1998).

The quite similar history of an interglacial water basin was described by CHACHAJ, KRZYSZKOWSKI (1994), ALEXANDROWICZ (1994) and KUSZEL (1994) from the Great Polish Lowland. Lacustrine deposits with a sequence of relatively rich mollusc assemblages filling a small melt-lake were found in Rogaczewo near Czempiń (Fig. 1). The succession corresponds with the developments of a melt-depression during the ascending phase of Eemian. At the beginning of the climatic optimum the water basin was transformed into a swamp and a peat bog. Another similar succession of mollusc assemblages in known from the profile in the Bobrówka River Valley near Łowicz (KLAJNERT, PIECHOCKI 1972). In sediments of both mentioned Eemian lakes the fauna typical of the climatic optimum was not noted. It indicates, that these lakes were being completely filled and overgrown earlier then the lake in Kochanów.

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