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THE MALACOFAUNA OF THE HOLOCENE LACUSTRINE SEDIMENTS OF DĄBKI NEAR DARŁOWO

Lacustrine sediments from the archaeological site at Dąbki are represented by detritus gyttja intercalated by shell-gyttja. The thickness of these sediments in the central part of the ancient lake reach over 7 m and in the near-shore part – about 2 m. The described sediments are mainly of Middle Holocene age. All the species of molluscs noted in these sediments are known in the present-day fauna of Poland. The changes of assemblages reflect the evolution of the lake. In its early phase it was a low peat-bog passing into a flat water basin. In the next phase the lake developed and a gyttja with a rich fauna are deposited. During the late phase the basin are filled with sediments and strongly overgrown by reed passing into a peat-bog with small water bodies.

The malacological studies on the lacustrine sediments of the archaeological site at Dąbki were undertaken at the suggestion of late Prof. Dr. T. Wiślański (cf. Ilkiewicz 1989). They have covered two profiles, one of them (P-1) situated in the near-shore and the other (P-2) in the central part of the basin. The studied samples come from cuts and borings made during archaeological and geological-geomorphological works. Doc. Dr. B. Nowaczyk has provided the author with all the samples together with a description of the succession of layers and a geological profile (Fig. 1). The whole material studied comprises 20 samples of profile P-1 and 48 samples of profile P-2. In 29 samples mollusc shells were found, while 24 samples contained only snail opercula referred to as the *Bithynia*-operculum and belonging probably to the species *Bithynia tentaculata* (Linnaeus). No malacofauna was found in the remaining 15 samples.

The described molluscan assemblages contain a total of 29 taxons including 17 freshwater snail species, 8 bivalve species, 1bivalve taxon determined to the familial level, 2 land snail species, and slug shells conventionally determined as *Limacidae* (1 taxon). In both profiles the fauna shows a conspicuous diversity, which enables one to distinguish assemblages that correspond to environmental changes that occurred in the successive phases of the development and decline of the lake. There are also some noteworthy differences between the P-1 and P-2 assemblages. The differences reflect the distinctness of the two sedimentary zones of the lake at the sediments growth.

NEAR-SHORE ZONE PROFILE. The P-1 profile has reached the lacustrine sediments at a depth of 1.30–1.84 m. The sediments are lying on gravels and a peat layer and are covered by peats (Fig. 1, P-1). The lacustrine sediments sequence covers an upper detritus-gyttja (1.30–1.47 m), shell-gyttja (1.47–1.77 m), and lower detritus-gyttja (1.77–1.84 m). These contain rich molluscan assemblages. A diagram of the fauna number has been draw on a basis of 7 representative samples, separately for the number of taxons, the number of snail and bivalve shells, and the number of snail opercula (Fig. 1, P-1, N). In the whole profile the number of opercula of one snail species exceeded the total number of shells representing all the species. In the shell-gyttja layer, its lower part in particular, a very well marked concentration of fauna was found. Each sample of the layer was found to contain more than 10 taxons, several hundreds snail and bivalve shells, and more than 1000 opercula of *Bithynia*.

In the described profile molluscan assemblages associated with particular lithostratigraphic links can be distinguished. The assemblages have been characterized upon a basis of 12 samples numbered consecutively from above (Tab. 1). The upper detritus-gtyttja (GdU, samples 1, 2) contains only snail opercula determined as the *Bithynia*-operculum. Their number may exceed 1000 specimens per sample. Fish remnants are scarcely represented here.

In the shell-gyttja a rich malacofauna occurs. In the upper part of the layer (GsU, samples 3–5) 17 taxons were found. The number of mollusc shells per sample was 300–800, the number of snail opercula exceeding 1000. In the lower part of the layer (GsL, samples 6–9) 22 taxons were found, the fauna being even richer. The main

Table 1. Molluscan Assemblages in Basin Near-Shore Part Profile (P-1)

GdU – upper detritus-gyttja, GsU – upper part of shell-gyttja, GsL – lower part of shell-gyttja, GdL – lower detritus-gyttja, P – peat; symbols of specimen number (after Alexandrowicz 1987): I – 1–3 specimens, II – 4–9 specimens, III – 10–31 specimens, IV – 32–99 specimens, V – 100–316 specimens, VI – 317–999 specimens, VII – more than 1000 specimens

Taxon	Gdu		GsU			GsL				GdL		P
	1	2	3	4	5	6	7	8	9	10	11	12
Limacidae	–	–	–	–	–	–	–	–	–	I	–	–
Vertigo antivertigo	–	–	–	I	–	–	–	–	–	–	–	–
Succinea putris	–	–	–	–	–	–	–	I	–	–	–	–
Valvata cristata	–	–	IV	VI	VI	VI	VI	IV	III	–	I	–
Valvata piscinalis	–	–	II	V	IV	V	V	IV	IV	III	III	–
Bithynia tentaculata	–	–	IV	IV	IV	V	V	IV	IV	IV	II	–
Bithynia-operculum	V	VII	VII	VII	VII	VII	VII	VI	VI	V	V	I
Lymnaea stagnalis	–	–	–	I	II	–	–	I	II	II	I	–
Lymnaea truncatula	–	–	–	–	–	–	–	–	–	–	I	–
Lymnaea auricularia	–	–	–	I	I	I	II	–	–	–	–	–
Lymnaea peregra ovata	–	–	III	III	III	IV	III	III	I	–	–	–
Planorbis planorbis	–	–	–	I	–	–	–	–	–	–	–	–
Anisus vortex	–	–	–	I	I	III	–	–	–	–	–	–
Bathyomphalus contortus	–	–	–	–	–	I	–	I	–	–	–	–
Gyraulus albus	–	–	–	–	–	–	I	I	–	–	–	–
Armiger crista	–	–	–	–	–	–	I	–	–	–	–	–
Hippeutis complanatus	–	–	–	–	–	II	I	–	–	–	–	–
Planorbarius corneus	–	–	–	–	–	I	–	–	–	–	–	–
Acroloxus lacustris	–	–	I	II	I	III	III	II	–	–	–	–
Sphaerium corneum	–	–	II	III	II	III	III	I	I	I	I	–
Pisidium henslovanum	–	–	I	–	–	I	III	II	I	I	I	–
Pisidium milium	–	–	II	IV	IV	IV	IV	II	–	–	–	–
Pisidium subtruncatum	–	–	–	III	II	IV	IV	III	II	II	–	–
Pisidium casertanum	–	–	III	V	V	IV	III	–	–	–	–	–
Pisidium ponderosum	–	–	–	–	–	I	–	–	–	–	–	–
Pisidium moitessierianum	–	–	–	–	I	–	I	I	–	–	–	–
Pisidium nitidum	–	–	–	–	III	IV	III	–	–	–	–	–

element of the shell-gyttja assemblage are the freshwater snails: *Valvata cristata* Müller, *V. piscinalis* (Müller), *Bithynia tentaculata* (Linnaeus), and *Lymnaea peregra ovata* (Draparnaud). The small number of the *Planorbidae* is worth of attention. None of the 7 planorbid taxons found has either reached a high number or showed a continuous distribution range in the profile. Opposite to them the shella of *Acroloxus lacustris* were found quite numerous. An important component of the assemblage are the bivalve shells. This concerns in particular the four species: *Sphaerium corneum* (Linnaeus), *Pisidium milium* Held, *P. subtruncatum* Malm, and *P. casertanum* (Poli). The land snails are represented by entirely hygrophilous species, these being single specimens of *Succinea putris* (Linnaeus) and *Vertigo antivertigo* (Draparnaud). The variability of the molluscan assemblage of the shell-gyttja is insignificant. In the lower part of the layer the fauna is richest while in the upper one the number of both taxons and specimens gets smaller. The malacofauna of the underearth part of the layer is also less rich. In all the samples numerous ostracods and fish remnants occur.

In the lower detritus-gyttja the molluscan assemblage is poor (GdL, samples 10, 11). Its main components are numerous snail opercula as well as shells of *Valvata piscinalis* (Müller) and *Bithynia tentaculata* (Linnaeus). The remaining snail and bivalve species are represented by single specimens. The molluscs occur along with ostracods and fish remnants. In the peat layer beneath the detritus-gyttja only a few snail opercula were found (P, sample 12).

CENTRAL ZONE PROFILE. The thickness of the lacustrine sediments of the P-2 profile is more than 4 m, their sequence covering the upper detritus-gyttja (2.90–4.50 m), shell-gyttja (4.50–5.30 m), and lower detritus-gyttja (5.30–7.00 m). The floor of the lacustrine sediments has not been reached by boring, and the roof contains peats (Fig. 1, P-2). The corresponding number diagram considers all the 40 samples. The upper boundary of the shell-gyttja is very well marked, while the lower one is less conspicuous (Fig. 1, P-2, N). The composition of the assemblages has been presented upon a basis of selected 12 samples that illustrate changes in shell-gyttja and lower detritus-gyttja fauna (Tab. 2).

In the peats and upper detritus-gyttja only snail opercula were found. In the middle part of the peat layer the occurrence of single specimens of the *Bithynia*-operculum is typical of a thin intercalation of organogenous sediments, whereas the upper detritus-gyttja contains

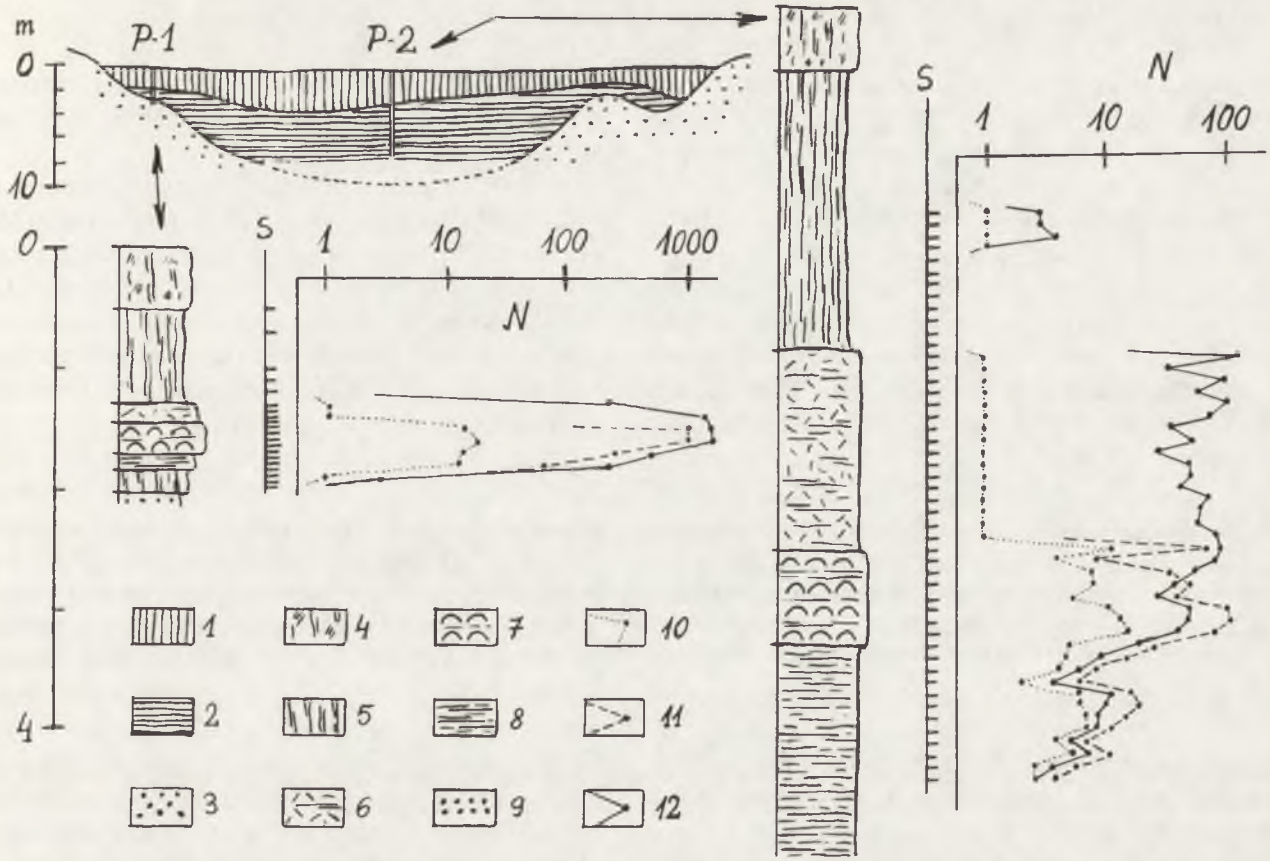

Fig. 1. Profiles of lacustrine sediments at the archaeological station at Dąbki (geological section and sequence of layers after Doc. Dr. B. Nowaczyk)

P-1, P-2 – profiles of near-shore and central parts of the basin. Signatures of geological section: *1* – peat, *2* – lacustrine sediments (gyttja), *3* – sands and gravels; signatures of lithostratigraphic profiles: *4* – peaty and sandy silts, *5* – peat, *6* – upper detritus-gyttja, *7* – shell-gyttja, *8* – lower detritus-gyttja, *9* – sands and gravels; S – sampling-sites, N – diagrams of number of assemblage elements: *10* – taxon number curve, *11* – mollusc shell number curve, *12* – snail operculum number curve

Table 2. Molluscan Assemblages in Basin Central Part Profile (P-2)

For explanations see Table 1

Taxon	P	GdU	GsU		GsL		GdL					
	1	2	3	4	5	6	7	8	9	10	11	12
Succinea putris	–	–	–	–	–	I	–	–	–	–	–	–
Valvata cristata	–	–	II	III	III	III	–	–	–	–	–	–
Valvata piscinalis	–	–	–	I	II	III	III	II	II	II	I	–
Bithynia tentaculata	–	–	III	III	III	III	I	–	I	I	I	–
Bithynia-operculum	I	IV	IV	IV	IV	IV	II	II	III	II	II	II
Marstoniopsis scholtzi	–	–	–	–	III	III	–	–	II	–	–	–
Lymnaea stagnalis	–	–	–	–	–	–	–	–	–	I	–	–
Lymnaea palustris	–	–	–	–	–	I	–	I	–	–	–	–
Lymnaea truncatula	–	–	–	–	–	–	–	–	–	–	–	I
Lymnaea auricularia	–	–	–	–	–	–	–	–	I	–	I	–
Lymnaea peregra ovata	–	–	–	–	–	–	–	–	–	–	I	–
Planorbis planorbis	–	–	–	–	–	–	–	–	–	I	I	–
Bathyomphalus contortus	–	–	–	I	–	–	–	–	–	–	–	–
Gyraulus albus	–	–	–	–	II	I	–	–	–	–	–	–
Armiger crista	–	–	I	I	I	II	I	–	–	–	–	–
Hippeutis complanatus	–	–	–	I	I	–	–	–	–	–	–	–
Acroloxus lacustris	–	–	I	I	III	II	–	–	–	–	–	–
Unionidae	–	–	–	–	–	–	–	–	–	I	–	–
Sphaerium corneum	–	–	I	I	I	I	I	–	–	I	–	I
Pisidium henslovanum	–	–	–	–	–	I	–	–	I	I	–	–
Pisidium milium	–	–	I	I	–	–	–	–	–	–	–	–
Pisidium subtruncatum	–	–	II	III	III	III	II	I	II	–	–	–
Pisidium casertanum	–	–	–	–	–	I	–	–	–	–	I	I
Pisidium ponderosum	–	–	–	–	–	–	–	–	–	I	–	–
Pisidium moitessierianum	–	–	–	–	–	I	–	–	I	I	I	–
Pisidium nitidum	–	–	–	–	–	I	I	–	I	–	–	–

a large number of *Bithynia*-operculum specimens found in all samples (P – sample 1, GdU – sample 2). They are the only component of the assemblage and are accompanied by ostracods and fish remnants.

The malacofauna of the shell-gyttja is rich and diversified. In the upper part of the layer 10 taxons (GsU, samples 3, 4) and in the lower one 16 taxons (GsL, samples 5, 6) were found. The numbers of the snail opercula and mollusc shells were approximately balanced, the latter prevailing in the lower part of the layer. The main components of the assemblage are: *Bithynia tentaculata* (Linnaeus), *Valvata cristata* Müller, and *Pisidium subtruncatum* Malm, and in the lower part of the layer also *Marstoniopsis scholtzi* (Schmidt) and *Valvata piscinalis* (Müller). A continuous distribution range is shown by *Acroloxus lacustris* (Linnaeus) and *Sphaerium corneum* (Linnaeus). The share of the *Planorbidae* shells represented by 4 taxons, *Armiger crista* (Linnaeus) in particular, is considerable, while the *Lymnaeidae* are an accessory component of the fauna. Only one sample was found to contain a shell of a land snail – *Succinea putris* (Linnaeus), all samples containing ostracods, gyrogonites of the *Charophyta*, and fish remnants.

The lower detritus-gyttja contains a poor malacofauna-assemblage (GdL, samples 7–12). In all the samples the number of the mollusc shells is slightly higher than that of the opercula. The most numerously represented is *Valvata piscinalis* (Müller), and in the upper part of the layer also *Pisidium subtruncatum* Malm. The presence of typical species of temporary water bodies, these being *Lymnaea truncatula* (Müller) and *Planorbis planorbis* (Linnaeus), is noteworthy. The planorbid shells occur sporadically, while the family *Lymnaeidae* is represented by several taxons. In certain samples there have been found fish remnants and ostracods. In the lowest part of the profile the assemblage comprises only four taxons, the specimen number being small.

MALACOFAUNA CHARACTERISTICS. The Holocene sediments of the lake basin at Dąbki contain mollusc species that are associated with various types of environment. The land fauna is represented by three taxons belonging to two ecological groups, the freshwater one comprising 26 taxons divided into three groups. The evaluation of the ecological valence of particular taxons is based on papers of Ehrmann (1937), Ložek (1964), Piechocki (1969; 1979), and the author (Alexandrowicz 1987).

1. Mesophilous land snails – these are only two small slug species (*Limacidae*) found in the P-1 profile of the lower detritus-gyttja that can be included to the group. They belong probably to a species prefering humid meadows and shrubs of a various degree of shading.

2. Hygrophilous snails – these are two species: *Vertigo antivertigo* (Draparnaud) and *Succinea putris* (Linnaeus). Both live chiefly in humid and water-logged meadows and shrubs, as well as in peat-bog habitats by river banks and lake shores.

3. Snails of temporary water-bodies – the group comprises amphibiotic species as *Lymnaea truncatula* (Müller), species living in temporary water-bodies, e.g. *Lymnaea palustris* (Müller) and *Planorbis planorbis* (Linnaeus), and molluscs that occur mainly in much overgrown water-bodies, being much resistant to desiccation: *Valvata cristata* Müller, *Bithynia tentaculata* (Linnaeus), and *Planorbarius corneus* (Linnaeus).

4. Molluscs of stable stagnant water-bodies – the group comprises most taxons that show quite varied ecological preferences. Here can be included eurytopic species, as for instance *Pisidium casertanum* (Poli), *P. milium* Held, and *P. subtruncatum* Malm, as well as those prefering shallow water-bodies with a rich vegetation, such as small lakes, ponds, old river beds and meanders of slowly-flowing rivers: *Lymnaea peregra ovata* (Draparnaud), *Anisus vortex* (Linnaeus), *Batyomphalus contortus* (Linnaeus), *Armiger crista* (Linnaeus), *Hippeutis complanatus* (Linnaeus), and *Acroloxus lacustris* (Linnaeus). The list is completed with two taxons of higher ecological preferences: *Marstonopsis scholtzi* (Schmidt) and *Pisidium moitessierianum* Paladilhe.

5. Molluscs prefering mobile water – these are taxons chiefly connected with slowly flowing rivers, the near-shore zones of lakes, and flow reservoirs. The said group comprises two snail species: *Lymnaea auricularia* (Linnaeus) and *Gyraulus albus* (Müller), and four bivalve species: *Sphaerium corneum* (Linnaeus), *Pisidium henslovanum* (Sheppard), *P. ponderosum* Stelfox, and *P. nitidum* Jenyns. Big bivalves of the family *Unionidae*, whose undetermined shell fragments were found in one sample, can probably be included here, too.

The molluscan assemblages of the two profiles conspicuously differ between each other (Tab. 3). In the P-1 profile the fauna is rather uniform. The greatest share have the molluscs of ecologic Group 3, while those of Group 5 having the smallest, the share of Group 4 being intermediate. This corresponds with the situation of the profile in the near-shore of the water-body. In the P-2 profile the molluscs of Group 4 are most important, predominating in the lower detritus-gyttja and the lower part of the shell-gyttja. In the upper part of the shell-gyttja the share of the snails of Group 3 increases considerably. The land snails are an accessory component of all the molluscan assemblages distinguished.

INTERPRETATION AND CONCLUSIONS. The lacustrine sediments of the site at Dąbki were radiocarbon dated by Doc. Dr. M. F. Pazdur (1992). The age of the shell-gyttja of the near-shore part of the basin was estimated at 6230±60 years BP and 5700±80 years BP. The lower detritus-gyttja probably represents the older part

Table 3. Ecological Characteristics of Molluscan Assemblages

E – ecological groups (1–5) described in text – percent shares of components, BI – *Bithynia* index, values. For other symbols see Fig. 1 and Tab. 1

E	P-1			P-2		
	GdL	GsL	GsU	GdL	GsL	GsU
1-2	1	1	0	0	1	0
3	58	60	58	11	24	64
4	37	34	39	76	65	32
5	4	5	3	13	10	4
BI	0.87	0.93	0.96	0.88	0.76	0.75

of the Atlantic phase and the Boreal phase of the Holocene, the upper detritus-gyttja representing the younger part of the climate optimum.

The conclusions that stem from the malacological analysis are in accordance with the dating results. All the mollusc species occurring in the gyttjas are connected with the mezoclimate zone and belong to the recent fauna of Poland. On the other hand, neither the taxons that are found entirely in the Glacial or Late Glacial sediments (*Pisidium obtusale lapponicum* Clessin) nor the ones that prefer the boreal climate but can now be found also in Poland, e.g. *Gyraulus laevis* (Alder) and *Pisidium lillieborgi* Clessin, occur in the gyttjas. A malacofauna like this is typical of the Holocene sediments, the middle part in particular.

One of the characteristic features of the molluscan assemblage of Dąbki is the presence of numerous snail opercula. The concentration of the opercula is connected with specific sedimentation conditions (Steenberg 1917; Wasmund 1926; Alexandrowicz 1987). In the shallow part of the lake, being overgrown by reed and bulrush, after a snail of the genus *Bithynia* has died, the operculum is rapidly falling on the bottom while the empty shell can be floating on the surface for loang and is being slowly transported by waving toward the shore. The relation between the number of opercula and the one of shells is expressed by the BI index (*Bithynia* index) whose value is 1 when a sample contains only opercula, 0 when there are equal numbers of opercula and shells, and −1 when there are only *Bithynia* shells in a sample (other taxons being not considered). As a result, the said character of a subfossil-fauna assemblage can be interpreted in the following way:

1. The number of shells is approximately equal to the number of opercula: the fauna indicates a water body or part of it free of reed.

2. The opercula significantly outnumber the shells or even the former are the only component of an assemblage: the fauna indicates a lake zone overgrown by reed and bulrush.

3. The shells significantly outnumber the opercula: the fauna comes from a lake near-shore zone situated inside or in the vicinity of a reed zone.

A relative *Bithynia*-operculum richness may also be due to a sediment type, since at a low pH the snail shell is dissolved more rapidly than the operculum (Alexandrowicz 1987).

In profile P-1, in the lower detritus- and shell-gyttjas the number of the *Bithynia*-operculum is much bigger not only than that of the taxon shells but also than the total number of the mollusc shells. The BI index ranges from 0.87 in the lower detritus-gyttja to 0.96 in the upper part of the shell-gyttja. In P-2 profile the proportions between the elements in question are more balanced, which concerns in particular the shell-gyttja where BI = 0.75–0.76 (Tab. 3). The difference corresponds with the situation of the profiles and indicates the existence of reed zones or belts in the near-shore part of the lake.

The sequence of the molluscan assemblages in both profiles reflects changes in sedimentary environment in the successive phases of the evolution of the lake. The initial phase correspond to the development of a low peat-bog within which small and much overgrown water-bodies existed. The peats that were formed then (the lower peat intercalation of profile P-1) contain scarce specimens of the *Bithynia*-operculum. In the next phase the peat-bog was deluged and transformed into a vast and shallow water-body or bay of a big lake. The assemblage that occurs in the lower detritus-gyttja indicates that it was a stable water-body subject to overgrowing. Its considerable part was covered by reed, which is indicated by the high and balanced BI index value in both profiles. During the sedimentation of the shell-gyttja the environmental conditions were especially favourable for molluscs to develop. The lake had probably rendered extended, there being separated the littoral and sublittoral zones, which is marked in the molluscan assemblages. At the end of the shell-gyttja sedimentation the environmental conditions were worsening step by step. In the next phase of the evolution of the lake, which corresponds to the sedimentation of the upper detritus-gyttja, the environment was visibly changed. In a short time the malacofauna became impoverished so that the only element left were snail opercula (*Bithynia*-operculum). The water-body rendered shallower and became a vast zone of reed and bulrush, having a labile water-level and framed by bogs and water-logged meadows. The last phase of the evolution was the complete overgrowing of the lake or its bay and the creation of a peat-bog. In the central part of peat-bog there were small, temporary puddles inhabited by snails of the genus *Bithynia*.

The Holocene lake at Dąbki was situated near seashore. However, the molluscan assemblages found in its sediments contain no Baltic species that are typical of brackish water. This evidences that the sea did not have any direct effect on the lake evolution, which concerns also the so called littorinid transgression that occurred at the climate optimum of the postglacial period.

In the Central Pomerania area, in the vicinity of Koszalin, Darłowo, Słupsk, and Bytów, there are numerous known localities of Holocene lacustrine sediments. These are marls and calcareous gyttjas that fill melt-lake basins of various size (Alexandrowicz, Tchórzewska 1981; Alexandrowicz et al. 1990). The sediments contain rich molluscan assemblages that comprise certain species found at Dąbki as: *Valvata cristata* Müller, *V. piscinalis* (Müller), *Bithynia tentaculata* (Linnaeus), *Armiger crista* (Linnaeus), *Pisidium subtruncatum* Malm, as well as numerous snail opercula. A typical character of the majority of the assemblages is also the presence of typical snails of the boreal climate: *Vertigo geyeri* Lindholm, *Gyraulus laevis* (Alder), and *G. acronicus* (Ferussac). This indicates the lower Holocene age of the sediments, which for some profiles has been proved by radiocarbon dating. The evolution of the said water-bodies went similarly as the development of the lake at Dąbki, and in the last phases of their existence they were completely overgrown and changed into peat-bogs.

Translated by Magdalena Szarowska

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