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LAKE PANNON MOLLUSC FAUNA FROM THE MÓRÁGY HILLS AND ITS FORELAND: A STRATIGRAPHIC, PALEOENVIRONMENTAL AND PALEOGEOGRAPHIC STUDY

THESIS OF THE PhD DISSERTATION

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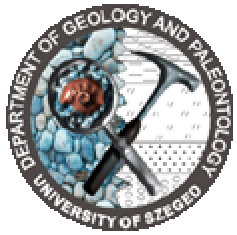

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Background and objectives of the study

At the end of the 1980s, the Mecsek Ore Mining Company (MÉV) conducted an intense exploration program for uranium ore in the young and porous sediments of the shallow subsurface in the Southern and Southeastern foreland of the Mórágy Hills. The drill cores contained an exceptionally diverse and mostly well-preserved Pannonian (Late Neogene) mollusc fauna, including species that had not been previously reported from Hungary.

Following the description of the cores, the material was deposited in the open-air yard of the company's core repository in Kővágószőlős. András Barabás, geologist for MÉV, drew the attention of Miklós Szónoky, professor at the Geological and Paleontological Department of the József Attila University of Szeged, to the exceptional fauna enclosed into the cores. Eventually much of the fossils were collected from the cores by a team of paleontologists (Miklós Szónoky, Pál Müller, Imre Magyar and others) in 1992.

During the systematic investigation of the fauna it became obvious that the fossils represent a variety of depositional environments and geological time intervals within Lake Pannon and within the Pannonian, respectively. The drillings were so closely spaced that the stratigraphic correlation of their sequences was possible through lithological patterns and electric well logs. The whole material thus provided an unparalleled opportunity to test biostratigraphic hypotheses, postulated stratigraphic ranges of species, and environmental and temporal context of various mollusc faunas.

In the spring of 2005 I had the opportunity to collect Pannonian molluscs from outcrops in the Mórágy Hills, where a geological mapping programme associated with the construction of the radioactive waste repository of the Paks Nuclear Power Plant was conducted by the geologists of the Hungarian Geological Institute. This way I was able to extend my study area from the Southeastern foreland of the Mórágy Hills northward into the hills themselves.

The objective of my study was to reconstruct the geological evolution of the study area during the Pannonian Age in as much detail as possible. This reconstruction was based on the determination and biostratigraphic and environmental evaluation of the fossils, stratigraphic correlation of well logs, and field study of outcrops both in the ore exploration area and in the Mórágy Hills. Although my objectives did not include the systematic description and taxonomic revision of the mollusc fauna, the stratigraphic synthesis provided valuable data for the solution of some taxonomic, phylogenetic, and biostratigraphic problems.

The study area

The study area consists of the overlapping areas of two industrial exploration programmes, namely the uranium ore exploration programme of MÉV, and the construction of the radioactive waste repository of Paks NPP. The latter one includes the Mórágy Granite Complex and its immediate foreland, whereas the first one includes the area Southwest of Bátaszék and Southeast of the Mórágy Hills, extending as far as Mohács in the South, Hímesháza in the West, and Báta in the East. Here in the subsurface there are two, several hundred meter deep Neogene basins, such as the Somberek basin (maximum 850 m deep) and its Northeastern projection, the Bátaszék basin (maximum 350 meter deep). The basins are bordered by the Paleozoic Mórágy Granite in the North and Northwest, and by the Máriakéménd-Báta Mesozoic Ridge in the East and South. Towards the West, the basins are connected with the Neogene Ellend basin.

Materials and methods

The materials I used for this study include stratigraphic, sedimentological and geophysical data from the archive of MÉV, and my own observations on core materials, surface outcrops and fossils.

The original description of cores from ore exploration drillings by MÉV included macroscopic observations by the geologists and technicians of the company. The boreholes were drilled with continuous or partial core recovery, or without cores. In the latter case, cuttings were sampled and investigated in 5 m intervals. The stratigraphic columns of the wells were drawn on paper, and contained sedimentological information, the accuracy of which depended on the very person who made the description, or on the requirements of the actual exploration phase. Detailed descriptions are very rare, except for the wells drilled in the initial phase of exploration. Grain size distributions were measured only in one well (Bsz-7, 0-180 m interval).

Based on the available data, I drew the digital stratigraphic column of each selected well. First of all those wells were selected that had been drilled in the initial phase of ore exploration, because these wells provided abundant core material with fossils, and because they had been located to form a network for geological profiles; the subsequent wells were often drilled with less or no core sampling, and their location was inserted between the initial wells. In order to cover the entire study area with stratigraphic correlation, however, I had to involve some drillings that had no available paleontological record. I also digitalized some of the electric well logs, such as gamma ray and resistivity logs.

All exploration wells in the Somberek basin (named after the villages of Báta, Dunaszekcső, Somberek and Véménd) were drilled with continuous core recovery. I had access to the rich fossil material of wells Dunaszekcső-1 (Dsz-1), Dunaszekcső-2 (Dsz-2), and Báta-4, and to a few samples from Somberek-2 (Smb-2) and Véménd-2 (Vm-2).

MÉV has drilled 78 wells under the name Bátaszék (Bsz-X) in two campaigns. Out of the 78, only 9 was drilled with continuous core recovery, and 30 with occasional core sampling. Of the 39 cored boreholes, I had the opportunity to paleontologically investigate 27. Thus, I examined fossils from 32 wells, and I used the sedimentary column and well logs of 9 additional drillings (spudded with the purpose of either ore exploration or geological mapping) for stratigraphic correlation.

Surface outcrops of Pannonian layers were also involved into the study. In addition to outcrops in the Mórágy Hills, I investigated the abandoned claypit in Somberek with Imre Magyar, and used the results of an earlier study from the Bátaszék brickyard (Lennert et al. 1999).

From the well columns and logs I constructed one major and 11 additional correlation panels, including 3 cross-directed ones. The correlated stratigraphic markers in the well profiles were based on lithology, well log response, and dinoflagellate biostratigraphic data (from Maria Sütő-Szentai 1995, 2000). By means of direct or indirect data, I extended the stratigraphic correlation to the surface outcrops (the two claypits and the four outcrops in the Mórágy Hills) as well. The correlated marker horizons served as a firm basis for paleogeographic reconstructions and for determining the stratigraphic and spatial distribution of various mollusc species and fauna types.

Based on the stratigraphic correlation of wells and outcrops on the one hand, and on the taxonomic evaluation of the mollusc fauna on the other, it was possible to test and re-consider some old hypotheses concerning the phylogenetic relationships within some mollusc groups. Some of the hypotheses are supported, whereas others are rejected by these new data. Especially the long and mostly unbroken Late Miocene sedimentary record of the Somberek basin offered an opportunity to observe evolutionary changes in various lineages. The interpretation of these changes was supported by examples taken from my earlier experience in other subbasins of the Pannonian basin.

Results

1. All the investigated surface outcrops belong to either the *Congeria rhomboidea* sublittoral or the *Prosodacnomya* littoral mollusc zones, pointing to an age of no older than 8 Ma. The dating can be further refined by the occurrences of different *Prosodacnomya* species in the Zsibrik and Bátaszék outcrops. Zsibrik, located at the NE margin of the Mórágy Hills, can be assigned into the *Prosodacnomya dainellii* zone, whereas the claypit of Bátaszék (and probably that of Somberek as

well) belongs to the *Prosodacnomya carbonifera* zone. The age of the studied outcrops is thus estimated to be 8-7.3 Ma.

2. In the Somberek basin, particularly in the Smb-2 well, Sütő-Szentai (1995, 2000) identified all the Pannonian microplankton zones, from the oldest *Mecsekia ultima* zone (<11.6 Ma) to the youngest *Galeacysta etrusca* zone. My oldest correlation horizon in this basin corresponds to the base of the *Spiniferites bentorii pannonicus* zone (~11.4 Ma). The youngest mollusks in this basin indicate the *Congeria rhomboidea* zone. Because specimens of *Prosodacnomya*, usually offering the opportunity for more precise stratigraphic assignement, are not known from this area, the age of the uppermost layers of the Neogene sequence is inferred to be about 7 Ma.

3. In the Bátaszék basin, the oldest, biostratigraphically identified and correlated layers are ~8.5 Ma old, whereas the age of the youngest ones is 7.7-7.3 Ma (based on the occurrence of *Prosodacnomya dainellii*). The macrofossil-free, organic-rich layers in the deepest part of the basin are difficult to date; I hypothesize that they were formed in the late part of the *Spiniferites paradoxus* chron, with a maximum age of 9.5 Ma.

4. 61 bivalve and 44 gastropod species were identified altogether within the Pannonian mollusc record. Based on their distribution, four faunal assemblages (types) were recognized. These represent various lacustrine habitats.

- Type 1: It includes profundal and sublittoral species, such as *Lymnocardium "praemajeri"*, *Lymnocardium "praerogenhoferi"*, *Caladacna steindachneri*, *"Pontalmyra" otiophora*, *Congeria czjzeki*, *Valenciennius reussi*, *"Gyraulus"* sp. This assemblage typically occurs in marl (often referred to as "czjzeki marl").
- Type 2: It consists of littoral and subordinately, shallow sublittoral forms: *Lymnocardium hungaricum*, *Lymnocardium "praerogenhoferi"*, *Lymnocardium majeri*, *Lymnocardium "praehaueri"*, *Lymnocardium penslii*, *Lymnocardium diprosopum*, *Lymnocardium proximum*, *Lymnocardium dumicici*, *Lymnocardium scabriusculum*, *Phyllocardium planum*, *Pontalmyra budmani*, *Congeria dubocaensis*, *Congeria markovici*, *Congeria balatonica*, *Dreissena auricularis*. This fauna is found in sandy or silty deposits ("hungaricum sand").
- Type 3: This assemblage is dominated by littoral gastropods, and includes *Valvata*, *"Gyraulus"*, *Micromelania*, *Pseudamnicola*, *Theodoxus*, *Melanopsis*, *Lymnocardium secans*, *Lymnocardium apertum*, *Lymnocardium banaticum*,

Lymnocardium scabriusculum, *Lymnocardium* aff. *trifkovici*, *Pseudocatillus simplex*, *Congeria balatonica*, *Dreissena auricularis*. The fossils are embedded into sand (”small gastropod sand”).

- Type 4: This fauna includes sublittoral species, such as *Lymnocardium majeri*, *Lymnocardium rogenhoferi*, *Lymnocardium hungaricum*, *Lymnocardium diprosopum*, *Lymnocardium schmidti*, *Paradacna okrugici*, *Caladacna steindachneri*, *”Pontalmyra” otiophora*, *Congeria rhomboidea*, *Congeria zagrabiensis*, *Zagrabica maceki*, *Valenciennius reussi*. The enclosing rock is marl (”zagrabiensis marl”).

5. Fauna Type 1 exclusively occured in the Somberek basin, in the lower part of the Pannonian sequence. It is overlain by layers with fauna Type 4. Types 2 and 3 are exclusively known from the lower part of the sequence in the Bátaszék basin. Type 3 in particular was found only in the wells of the easternmost correlation panel (”E”). The thickness of the unit characterized by fauna Type 2 increases towards the East. The uppermost layers, similarly to the Somberek basin, contain Type 4 fauna. This arrangement prooves that Type 2 and Type 3 faunas are coeval; the fauna of the ”hungaricum sand” represents a deeper water counterpart of the so-called ”Radmanest-type” littoral fauna.

6. Based on the complex stratigraphic correlation (including lithology, geophyiscal well logs, and microplankton biostratigraphy) of wells and outcrops, the Pannonian evolution of the area can be reconstructed as follows. The oldest Lake Pannon sediments were deposited in the deepest part of the Somberek basin, in a deep sublittoral environment. The corresponding littoral sediments are missing from the basin margins, probably due to tectonic reasons. In the first part of the Pannonian, up to the end of the *Spiniferites paradoxus* chron, transgression was the dominant process; Lake Pannon gradually flooded the marginal areas, but the Mórágy Granite Complex and much of the Máriakéménd-Báta Mesozoic Ridge remained a dry land.

In the structurally more elevated Bátaszék basin, sedimentation started with organic-rich layers with coarse-grained intercalations, probably deposited during cyclic incursions of lake waters into the basin. The age of these deposits is difficult to determine. The overlying fossiliferous lacustrine deposits are ~8.5 Ma old.

The overall transgressive trend was interrupted two times. The first event is correlated with the boundary of the *Spiniferites paradoxus* and *Spiniferites validus* chrons, i.e. about 9-8.8 Ma. Regression at this time caused a shift of the depositional environments, namely the basinward shift

of the sublittoral zone, giving way to sandy deposits in the formerly pelitic succession (below correlation horizon ”E”). When transgression regained later in the *Spiniferites validus* chron, the uranium ore bearing deposits of the Bátaszék basin were deposited. At this time the lake flooded areas especially towards the South and the West, but also inundated much of the Mesozoic ridge to the East.

The second regressive event in fact consists of minor regressive phases that took place during the *Spiniferites tihanyensis* chron (correlation horizon ”C”) and in the beginning of the *Galeacysta etrusca* chron (correlation horizon ”B”), encompassing the time interval of ca. 8.1 to 7.5 Ma. These phases resulted in minor hiatus in the Bátaszék basin, especially in its Eastern part, and in sandy intercalations in the Somberek basin.

The youngest Pannonian layers in the study area, including parts of the Mórágy Hills, were deposited in a sublittoral environment. This fact indicates that Lake Pannon flooded almost the entire area by 7 Ma. The regressive shallow lacustrine and fluvial deposits that had probably once capped the succession were eroded; the present-day Pannonian stratigraphic sequence is closed by a conspicuous erosional surface.

7. The Somberek basin record supports the hypothesis that *Congeria zagrabiensis* evolved from *Congeria czjzeki*. The stratigraphic and temporal range of each morphological state was established: the youngest occurrences of *Congeria czjzeki* are in the upper part of the *Spiniferites paradoxus* zone (up to 8.9 Ma), whereas the oldest specimens of *Congeria zagrabiensis* were found in the lower part of the *Spiniferites tihanyensis* zone (down to 8.1 Ma). In between the two dates, during the *Spiniferites validus* chron, a transitional form lived; temporarily it is called *Congeria ”praezagrabiensis”*, and it will be introduced as a new chronospecies in a scientific journal.

8. The hypothetic evolutionary lineage of *Congeria rhomboidea* was also corroborated. The chronostratigraphic distribution of each morphological stage was explored. *Congeria praerhomboidea* occurs up to the top of *Spiniferites paradoxus* zone (8.9 Ma); *Congeria dubocaensis* lived in the *Spiniferites validus* chron (8.9 to 8 Ma); typical *Congeria rhomboidea* appears in the bottom of *Galeacysta etrusca* zone (from 8 Ma). The nomenclatural inconsistencies, hindering the correct taxonomic and evolutionary interpretation of some forms (*Congeria praerhomboidea*, *Congeria dubocaensis*) were clarified.

9. I recognized a new chronospecies, preliminarily referred to as *Lymnocardium ”praerogenhoferi”*, in the lower part of the Pannonian sequence. This form also occurs in other

subbasins of the Pannonian basin, such as the Kisalföld basin, and it can be regarded as an early morphological phase of *Lymnocardium rogenhoferi*. The boundary between their stratigraphic ranges corresponds to the boundary between the *Spiniferites validus* and *Spiniferites tihanyensis* zones (~8.1 Ma).

10. The evolutionary lineage leading to *Lymnocardium majeri* also includes an early chronospecies (named *Lymnocardium "praemajeri"* until its formal description). The boundary between the stratigraphic spans of the two chronospecies corresponds to the bottom of the *Spiniferites paradoxus* zone (10.6 Ma).

11. I established that the species *Lymnocardium secans* first appeared in the *Spiniferites validus* chron (8.9-8 Ma) through branching from *Lymnocardium apertum*, and can be traced in the stratigraphic record until the top of the *Spiniferites tihanyensis* zone (7.9 Ma). I corroborated the phylogenetic relationship between *Lymnocardium haueri* and *Lymnocardium apertum*, and determined the chronostratigraphic distribution of each morphological phase in the lineage: *Lymnocardium apertum*, early form: *Spiniferites paradoxus* zone (up to 8.9 Ma); *Lymnocardium apertum* (typical, late form): *Spiniferites validus* zone (8.9-8.1 Ma); *Lymnocardium "praehaueri"* (a preliminary name): *Spiniferites tihanyensis* zone (8.1-7.9 Ma); *Lymnocardium haueri*: *Galeacysta etrusca* zone (from 7.9 Ma).

12. The postulated anagenetic nature of the *Lymnocardium penslii – Lymnocardium schmidti* lineage should be rejected, because the stratigraphic ranges of the two species overlap. *Lymnocardium penslii* occurs in the stratigraphic record up to the top of *Spiniferites tihanyensis* zone (~7.9 Ma), whereas the early form of *Lymnocardium schmidti* appears within the same zone. Typical (late) form of *Lymncoardium schmidti* lived in the *Galeacysta etrusca* chron.

13. The widely accepted anagenetic evolutionary model of large *Melanopsis* should also be rejected, at least starting from the *Spiniferites paradoxus* chron, because some species that had been considered to live at different times were now found in the same layer or stratigraphic interval.

14. The biostratigraphic positions of different members of the *Congeria partschi – Congeria markovici* lineage and two other lineages of small *Melanopsis* (*Melanopsis pygmaea-bouéi – Melanopsis decollata-defensa*) were explored. In all the three cases the boundary between the stratigraphic spans of the older and younger chronospecies pairs is within the *Spiniferites validus*

zone, but in the first case it is close to the bottom of the zone (~9-8.9 Ma), whereas in the case of *Melanopsis* it is well within the zone (8.5-8.3 Ma).

15. I claim that taking into consideration the high intraspecific morphological variability characteristic of endemic species flocks in general and displayed by my material in particular, the taxonomic diversity of Lake Pannon *Valvata*, *"Gyraulus*", and *Theodoxus* should be significantly reduced by a thorough taxonomic revision.

16. I give a description and rich photographic representation of well-preserved specimens of *Lymnocardium dumicici* and *Pontalmyra budmani* for the first time from the area of Hungary.

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