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A new occurrence of a classic "Árpád-type" mollusc fauna from the Upper Miocene of Kozármisleny, southern Hungary

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ABSTRACT

A classic but very rare "Árpád-type"mollusc assemblage, representing the endemic fauna of the Late Miocene–Early Pliocene Lake Pannon, was discovered in Kozármisleny (near Pécs, southern Hungary). The fossils were collected from silt layers deposited in the shallow sublittoral zone of Lake Pannon, exposed in an 8–10 m high road cut. The assemblage contained some very rare species, including the type species of the genus *Lymnocardium*, *L. haueri* (M. HÖRNES). Palynological investigations from the same layers failed to yield age-diagnostic dinoflagellates, and pointed to a brackish – freshwater depositional environment and warm temperate climate.

Keywords: Pannonian Basin, Lake Pannon, molluscs, palynomorphs, granulometry

1. INTRODUCTION

Much of the sedimentary fill of the Neogene Pannonian Basin System was deposited in the Late Miocene – Early Pliocene Lake Pannon, a large, long-lived, brackish lake populated by a highly endemic "Ponto-Caspian-type" biota. In particular, cardiid bivalves reflect the extraordinary diversity with more than 200 species in the lake (MÜLLER et al., 1999; GEARY et al., 2000). Whereas high diversity in some other groups, such as the gastropods, was achieved by a combined effect of in situ evolution and inheritance from Early – Middle Miocene lakes (HARZHAUSER & MANDIC, 2008), Lake Pannon cardiids probably all originated from ancestors living in the restricted marine environment of the Middle Miocene Sarmatian sea (e.g. VRSALJKO, 1999). Historically, the first significant endemic cockle assemblage from the lake was described by HÖRNES (1862) from the village of Árpád (today part of Pécs), southern Hungary. Later these cardiids played an outstanding role in the classification of Miocene and Pliocene brackish cockles of the entire Paratethyan region. Although similar faunas are well-known from the southern regions of the Pannonian Basin, especially in Croatia (e.g. BRUSINA, 1884; BASCH, 1990), some of the Árpád species are very rare elsewhere. For example, the type species of the genus *Lymnocardium*, *L. haueri*, has not been known to occur in any other locality (reports on *L. haueri* from Serbia (STEVANOVIC, 1951) and Croatia (BASCH, 1990) refer to a morphologically clearly distinct form, probably another species).

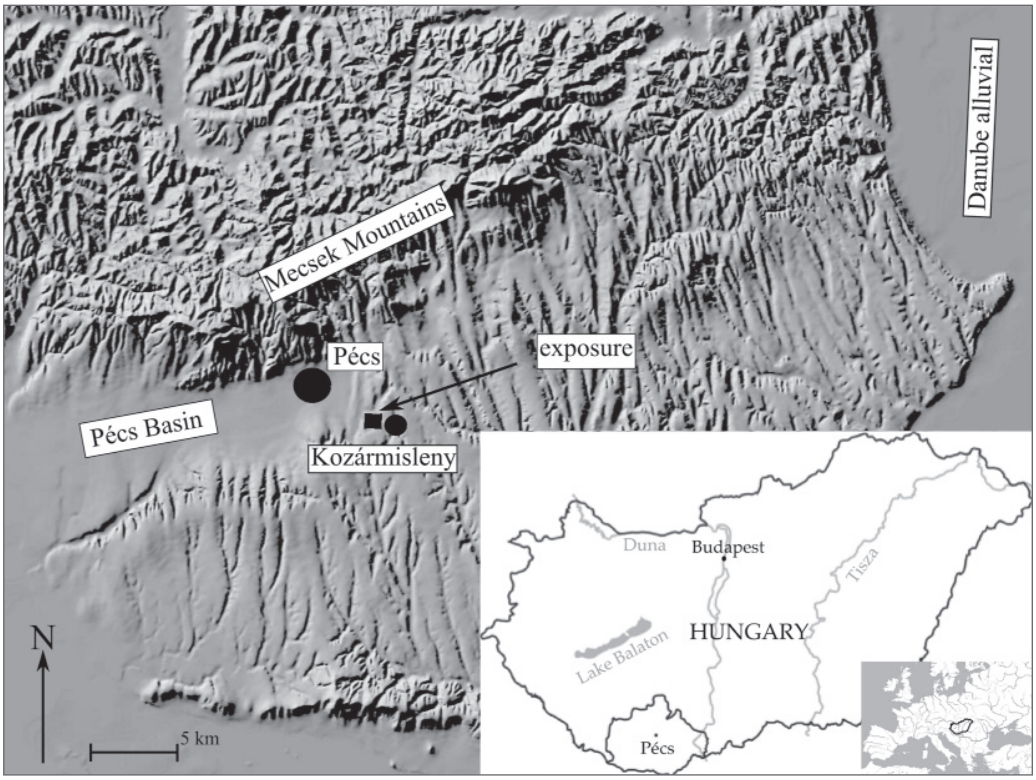

Figure 1: Geographic position of the Kozármisleny profile.

The original descriptions by HÖRNES (1862) were based on donated specimens, and the exact locality where the shells had been collected remained unknown. Recently SZÓNOKY et al., (1999) measured a fossiliferous outcrop located immediately south of Árpád. Some 2.5 km NE of their locality, in the area of the village of Kozármisleny, a road cut was deepened in 2008 as part of the construction of the M6 highway system, exposing fossiliferous silt layers deposited in Lake Pannon. When visiting the outcrop, we were allowed only a restricted time for scanning the sequence and collecting samples. The mollusc fauna of the outcrop, however, proved to be very remarkable. The 10 bivalve (including 8 cardiid) and 4 gastropod species correspond to the classic Árpád fauna, containing the same morphological types and including some of the rarities (*L. haueri*, *L. hungaricum*, *L. arpadense*, *Pteradacna pterophora*). This paper gives a brief account of the outcrop and its mollusc fauna, complete with the results of palynological investigations.

2. THE KOZÁRMISLENY OUTCROP

The excavation site (46°05’N and 18°27’E) is located in the Pécs Basin, between the villages of Kozármisleny and Árpád (Nagyárpád, today part of Pécs) in southern Hungary (Fig. 1), at an elevation of 160 m above sea level. The Pécs Basin is filled with lacustrine, fluvio-lacustrine, and aeolian deposits of Miocene to Pleistocene age. In the southern margin of the basin, the layers dip approximately 1–3° to the south-southeast (SEBE et al., 2008).

The north to south oriented road cut exposed the deposits of Lake Pannon in an 8–10 m thick sequence below a thin Pleistocene loess cover. The section is composed primarily of yellowish-gray, medium- to coarse-grained silt, with 20–30 cm thick intercalations of fine-grained silt. Layers of both the eastern (A) and western (B) walls were numbered from bottom to top.

Layers of wall A (Fig. 2) were continuously sampled at 10–20 cm intervals for laser diffraction grain-size analysis (Fritsch Analysette 22), following the approach of KONERT & VANDENBERGHE (1997) and KOVÁCS (2008). The gray-coloured, fine silt layers were laminated. Between the lamina, magnesium-oxide films occurred. The yellowish-gray, medium- to coarse-grained silt layers showed cross to wavy lamination. The medium- and fine-grained silts were very poorly-sorted, strongly positively skewed, and extremely leptokurtic (Fig. 2, A2, 3, 5, 7, 9). Their grain-size frequency curves were unimodal (Fig. 3.). The coarse silts were also very poorly-sorted, strongly positively skewed, and extremely leptokurtic, but the grain-size frequency distributions tended to exhibit a weakly-developed bimodality (Fig. 2., A1, 4, 6, 8, 10 and Fig. 3.). The grain size parameters and the bimodality of the central parts of the frequency distributions (Fig. 3.) indicate a shallow sublittoral depositional environment with occasionally significant effects of wave action, characteristic of both marine (GOLDBERY, 1980; TAMURA, 2004; BARUSSEAU, 2011) and lacustrine (XIAO et al., 2012) environments.

Most of the layers seemed to be barren of molluscan fossils or contained only shell fragments, but silt layers A1 to A3 and a very-fine, yellow sand layer at the bottom of wall B (B1) contained abundant and well-preserved shells.

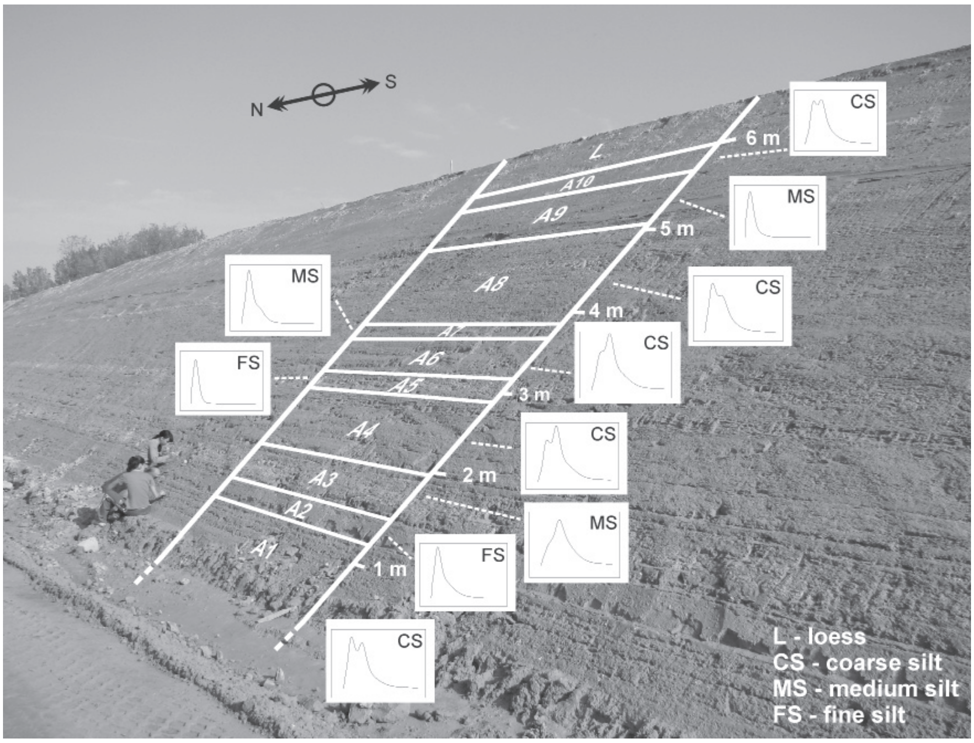

Figure 2: The Kozármisleny road cut (wall A) with grain-size distribution curves of the Upper Miocene layers.

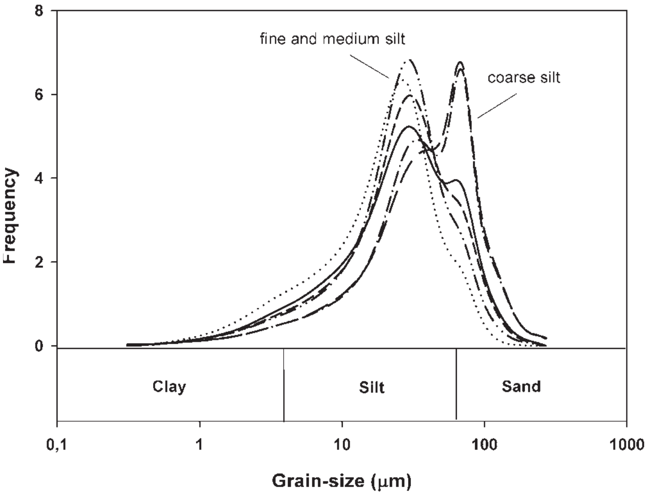

Figure 3: Grain-size spectra of samples from different layers in wall A.

3. MOLLUSCS

Apart from the fossiliferous layers A1 to A3 and B1, mollusc shells were also collected from debris at the foot of the walls. The following forms were identified:

Congeria rhomboidea rhomboidea HÖRNES, 1862 (Fig. 4d). Well-preserved specimens, 5–7 cm in length and 4–5 cm wide, occurred in layers A1 to A3. Several dozen specimens were collected, some with articulated valves, some as single valves.

Dreissenomya unionides FUCHS, 1870 (Fig. 4h). A single specimen was discovered, 4 cm long and 2.5 cm wide.

Lymnocardium arpadense (HÖRNES, 1862) (Fig. 4j). A mass occurrence of single and articulated valves, ca. 3 cm in length and 2 cm in width, occurred in layer B1.

Lymnocardium haueri (HÖRNES, 1862) (Fig. 4i). 3 specimens (length 4–4.5 cm, width 4 cm) were collected from layer B1.

Lymnocardium hungaricum (HÖRNES, 1862) (Fig. 4e). Three almost intact specimens and several broken ones and fragments were observed, mostly in layer A3. The valves are 7–9 cm long and 6–7 cm wide.

Lymnocardium majeri (HÖRNES, 1862) (Fig. 4k). A large number of excellently preserved specimens were collected from layers A2 and B1, with an average size of 3 cm length and 2.5 cm width.

Lymnocardium rogenhoferi (BRUSINA, 1884) (Fig. 4m). Four specimens, all belonging to the Árpád morphotype, were recovered from layer A2. None of the valves exceeded 2 cm in length.

Lymnocardium schmidti (HÖRNES, 1862) (Fig. 4f). Three specimens, 3–7 cm in length and 3–6 cm in width, were discovered in layer A3.

Caladacna steindachneri (BRUSINA, 1884) (Fig. 4n). Two internal moulds (steinkern) were collected from layer A2.

Pteradacna pterophora (BRUSINA, 1884) (Fig. 4g). Three partial specimens were collected from debris.

Radix kobelti (BRUSINA, 1884) (Fig. 4a). One specimen was observed in layer A1.

Radix lytostomopsis (BRUSINA, 1902) (Fig. 4b). One specimen occurred in layer A1.

Zagrabica cyclostomopsis BRUSINA, 1884 (Fig. 4c). 3 specimens were discovered, with an average size of 0.9 cm height and 0.6 cm width, in layer A1.

Figure 4: Molluscs from the Kozármisleny profile. a: Radix kobelti, b: Radix lytostomopsis, c: Zagrabica cyclostomopsis, d: Congeria rhomboidea rhomboidea, e: Lymnocardium hungaricum, f: Lymnocardium schmidti, g: Pteradacna pterophora, h: Dreissenomya unionides, i: Lymnocardium haueri, j: Lymnocardium arpadense, k: Lymnocardium majeri, l: Valenciennius reussi, m: Lymnocardium rogenhoferi, n: Caladacna steindachneri. Scale bar: 2 cm for a–c, 1 cm for d–n.

Valenciennius reussi (NEUMAYR, 1875) (Fig. 4l). Two specimens were collected from layer A1.

4. PALYNOLOGICAL INVESTIGATIONS

Three samples from layer A1 were collected for palynological analysis. The objective was to better assess the biodiversity in this environment, and to provide data for biostratigraphic and environmental interpretation.

Palynological samples were prepared using standard processing techniques at the Laboratory of the Hungarian Geological Institute. The samples were treated with HCl (36%) and HF (40%) to remove the mineral fraction, and a heavy liquid ($ZnCl_2$, density 2.2 g/cm^3) was used to separate the organic matter from the undissolved inorganic components. The organic residue was not sieved, and additional oxidation was unnecessary. Organic residue was mounted in glycerine jelly and three slides were investigated. Two dinocyst taxa, three fresh water algae and 18 sporomorph taxa were identified.

4.1. *Dinoflagellates*

The dinoflagellate assemblage consisted of two forms: cf. *Batiacasphaera* sp. DRUGG 1970, 12 specimens (Fig. 5, 4), and Gonyaulacaceae sp. indet. LINDEMANN 1928, only one specimen (Fig. 5, 7).

The *Batiacasphaera*-like dinocyst of layer A1 is poorly preserved. It is similar to those forms that occur elsewhere in the *Galeacysta etrusca* Zone, (younger than 8 Ma) in having an intercalary archeopyle and punctated ornamentation, but differs from them in its habit and glassy appearance. Gonyaulacaceae sp. indet. is well-preserved. A reworked origin for this specimen can be excluded. It resembles some well-known dinoflagellates from the *Galeacysta etrusca* Zone (*Gonyaulax spinifera – G. digitalis*), but its tabulation is not identical with them.

Neither form is suitable for a more precise biostratigraphic evaluation. Their presence indicates a probable brackish environment.

4.2. *Chlorophyta*

The samples contained *Botryococcus braunii* KÜTZING 1849, a green alga common in both brackish and freshwater ecosystems worldwide. *Mougeotia laetevirens* (A. Braun) WITTROCK 1877 and a freshwater *Spirogyra* sp. indicate the presence or proximity of a freshwater environment.

4.3. *Sporomorphs*

The following forms were identified:

Abiespollenites latisaccatus (TREVISAN 1967) KRUTZSCH 1971 (Fig.5, 6)

Abiespollenites maximus (KRUTZSCH 1971) NAGY, 1985

Abiespollenites sivaki NAGY, 1985 (Fig.5, 8)

Abietinaepollenites microalatus (R. POTONIÉ, 1932) R. POTONIÉ, 1951

Alnipollenites verus R. POTONIÉ, 1934

Betulaepollenites betuloides (PFLUG, 1953) NAGY, 1969

Cedripites crassiundulicristatus (TREVISAN, 1967) KRUTZSCH, 1971 (Fig.5, 1–3)

Cedripites dacrydioides KRUTZSCH, 1971

Chenopodipollenites multiplex (WEYLAND & PFLUG, 1957) KRUTZSCH, 1960

Ericipites callidus (R. POTONIÉ, 1931) KRUTZSCH, 1970

Hydrosporis levis KRUTZSCH, 1962

Nymphaeaepollenites pannonicus NAGY, 1969

Piceapollenites neogenicus (NAGY, 1969) KRUTZSCH, 1971

Pinuspollenites labdacus (R. POTONIÉ, 1932) R. POTONIÉ, 1958

Plantaginacearumpollenites miocaenicus NAGY, 1963

Polypodiisporites favus (R. POTONIÉ, 1931) R. POTONIÉ, 1933

Tsugaepollenites verrucatus (KRUTZSCH, 1971) NAGY, 1985 (Fig. 5, 5)

Ulmipollenites undulosus WOLFF, 1934

The coniferous species with abundant fir (*Abiespollenites*), pine (*Pinuspollenites*), cedar (*Cedripites*) and less spruce (*Piceapollenites*) reflect the composition of a distant mountainous vegetation. The broad-leaved forms are represented by birch (*Betulapollenites*) and elm (*Ulmipollenites*), the ferns are represented by *Polypodiisporites* and *Laevigatosporites*. Alder (*Alnipollenites*) probably occurred at the lake shore and in marshes. Grasses barely appeared in the samples. The aquatic vegetation is represented by floating ferns (*Hydrosporis*) and water lilies (*Nymphaeaepollenites*).

This pollen spectrum can be readily compared to those of other Late Miocene and Early Pliocene samples from the Transdanubian region of Hungary, such as those in drill cores from Lake Balaton (NAGY-BODOR, 1988) and from the borehole Pula-3 (NAGY, 2005), respectively. In spite of all the similarities, the Kozármisleny samples contain less broad-leaved species and fewer grasses than the two other spectra, and indicate a relatively humid, warm temperate climate.

5. DISCUSSION AND CONCLUSIONS

As indicated by grain size and sedimentary structures, the silt layers of the Kozármisleny outcrop were deposited in the shallow sublittoral zone of Lake Pannon. The ecological demand of molluscs supports this interpretation. *L. majeri*, *L. rogenhoferi*, *Pteradacna pterophora*, and *Valenciennius* are known to have been sublittoral dwellers. *L. arpadense*, similarly to its ancestor *L. diprosopum*, however, usually occurs in littoral sands (GEARY et al., 2010). At the time of deposition, the lake shore was situated a couple of kilometres to the northwest, possibly in the Mecsek Mountains. Recently SEBE et al., (2013) described the occurrence of a wave-cut

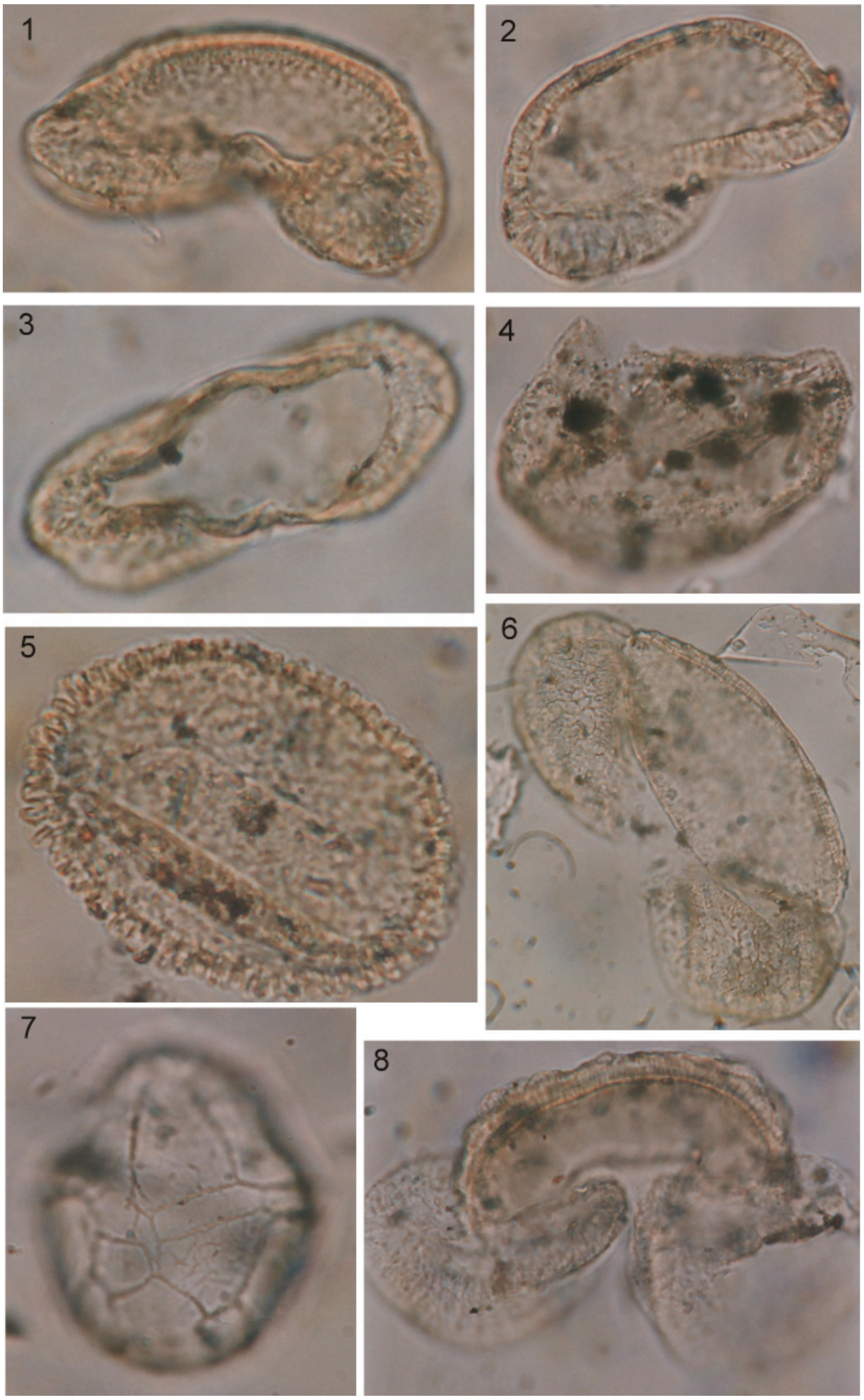

Figure 5: Pollen and algae from layer A1. 1–3: Cedripites crassiundulicristatus (TREVISAN, 1967) KRUTZSCH, 1971 (55–56 µm); 4: cf. Batiacasphaera sp. (DRUGG, 1970) (56 µm); 5: Tsugaepollenites verrucatus (KRUTZSCH, 1971) NAGY, 1985 (54 µm); 6: Abiespollenites latisaccatus (TREVISAN, 1967) KRUTZSCH, 1971 (133 µm); 7: Gonyaulacaceae sp. LINDEMANN, 1928 (46×39 µm); 8: Abiespollenites sivaki NAGY, 1985 (94 µm).

platform, together with the mollusc *Dreissenomya unioides*, a burrowing dreissenid (also present in the Kozármisleny fauna), from the southern slope of the Mecsek Mountains, at 380 m above sea level.

The diverse cardiid assemblage seems to indicate brackish water, whereas the algae and sporomorphs argue for a brackish to freshwater environment. Spores and pollen indicate a warm temperate climate.

The palynological investigations failed to identify age-diagnostic dinoflagellates. The great similarity of the mollusc fauna to the classic Árpád one however, allows inference of the *Prosodacnomya vutskitsi* Zone (7–5 Ma). Although the Árpád outcrop displays more sand layers, the close proximity and identical fauna suggests that the two outcrops, Árpád and Kozármisleny, expose the same sedimentary rock body.

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