

FORAMINIFERAL ASSEMBLAGES AND EARLY MIOCENE PALEOENVIRONMENTS IN THE NW TRANSYLVANIAN BASIN

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Abstract. Foraminifera collected from several sections of the Lower Miocene Hida Formation in the Ilișua Valley were used to interpret the paleoenvironmental setting. Micropaleontological analyses yield highly abundant and diverse assemblages of agglutinated and calcareous benthic foraminifera. "Flysch-type" and slope marl biofacies are dominant among the agglutinated foraminifera assemblages. All subdivisions of the turbiditic depositional environment have been identified, from proximal to distal fan settings with complete Bouma sequences. Besides foraminifera assemblages, the sedimentology indicates a bathyal facies distribution with frequent organic input and bioturbation. All these can be framed into a deep-water marine environment ranging from outer shelf to lower slope, with highly fluctuating sedimentary supply.

Keywords: foraminifera, Lower Miocene, Hida Formation, Transylvanian Basin.

INTRODUCTION

The Lower Miocene Hida Formation (Hofmann, 1879; Koch, 1900) consists of a succession of fine-grained and coarse-grained turbidites. The entire sedimentary succession was deposited during the Early Miocene in a foredeep basin of flexural origin. This basin has experienced subsidence loading (Krézsek & Bally, 2006) and was locally bounded by two well-defined intervals with conglomerates (sequence boundaries). The depositional area, located on the northern margin of the Transylvanian Basin (northern Romania), is at present roughly E-W oriented and positioned in front of the nappes belonging to the Pienidian tectonic units.

Although the Hida Formation was previously considered to be a fluvio-deltaic lithostratigraphic unit with foraminiferal assemblages reducing progressively towards the top (Popescu, 1975), sedimentological studies (Tischler, 2005; Filipescu et al., 2009) together with new data on depositional environments based on foraminiferal assemblages (Filipescu & Beldean, 2008) allowed reconsideration of the depositional setting. Our aim was to separate the diagnostic foraminiferal assemblages and to give new interpretations of the depositional environment based on the identified assemblages.

MATERIAL AND METHODS

Foraminifera were recovered from several sections of the Hida Formation. The representative sections are located in the northwestern part of the Transylvanian Basin (Romania) along Ilișua Valley at Spermezeu 1 (N 47,30658; E 24,16179), Spermezeu 2 (N 47,31991; E 24,16003) and Târlișua (N 47,37984; E 24,17413) (Fig. 1). These sections offer a good exposure across the whole formation.

Thirty samples collected from proximal to distal epiclastic turbidites were analyzed for foraminifera. Sediment samples were processed by standard micropaleontological methods and the foraminifera were recovered from the >63 μm fraction. The identification was done under the stereomicroscope, while several specimens were examined in detail by SEM (JSM-JEOL 5510 LV scanning electron microscope).

The planktonic/benthic ratio was used as a quantitative method that enables the calculation of paleodepth based on the formula of van der Zwaan et al. (1991). The foraminifera assemblages were included into the biofacies model of Kuhnt & Kaminski (1990). Based on the work of Kaminski et al. (2005) agglutinated foraminifera were separated on morphogroups. The lithologic logs were drawn using the StratDraw program (Hoelzel, 2004), and the abundance graphics of GpalWin program (Goery, 1997).

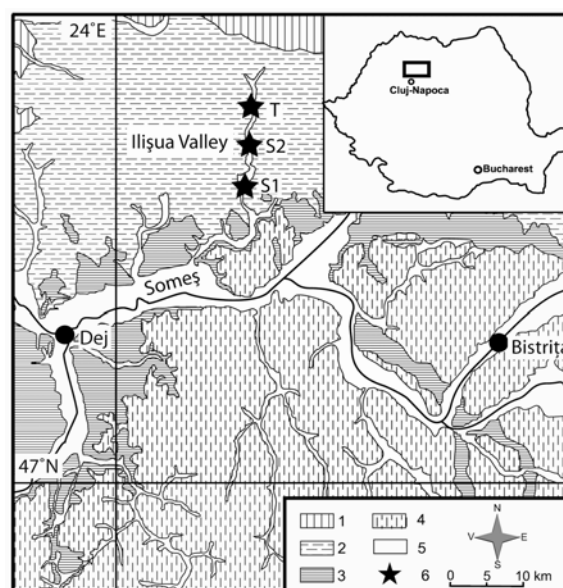


Fig. 1. Location of the investigated sections. 1 – Paleogene, 2 – Lower Miocene (Burdigalian) - Hida Formation, 3 - Badenian, 4 – Sarmatian, 5 – Quaternary, 6 – location of investigated sections.

RESULTS AND DISCUSSION

Spermezeu 1 (S1)

Spermezeu 1 section, positioned in the central part of Hida Formation, consists on sandstone coarse-grained turbidite intervals organized in Ta-e, Tb-e and Tc-e

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Bouma divisions with thin fine-grained beds and conglomeratic channel bodies up to 1.5 m thick and 12 m wide (Fig. 2). The internal fabric of the sandstones suggests an origin from high-density turbidity flows (presence of rip-up clasts, frequent basal scours, plant fragments and vertical burrows) characteristic for a proximal turbidite depositional environment (inner fan facies). Channels are N-S oriented, with lateral migration and consist mostly of clast-supported orthoconglomerates with rounded elements in most of the sandstones, suggesting a sedimentary supply from the Pienidian nappes (Aroldi, 2001).

Foraminiferal assemblages in the finer-grained intercalations from Spermezeu 1 display a very low abundance and diversity. Only few rounded and tubular coarsely agglutinated taxa were identified: *Psammosiphonella cylindrica* (GLAESSNER), *Hyperammia rugosa* VERDENIUS & VAN HINTE, *Bathysiphon filiformis* SARS, *Reticulophragmium rotundidorsatum* (HANTKEN), *Reticulophragmium acutidorsatum* (HANTKEN), and *Cribrostomoides* sp. This type of assemblage with large specimens was observed along the continental margin and in flysch-type basins (Bidgood et al, 2000). No planktonic or calcareous benthic foraminifera have been identified.

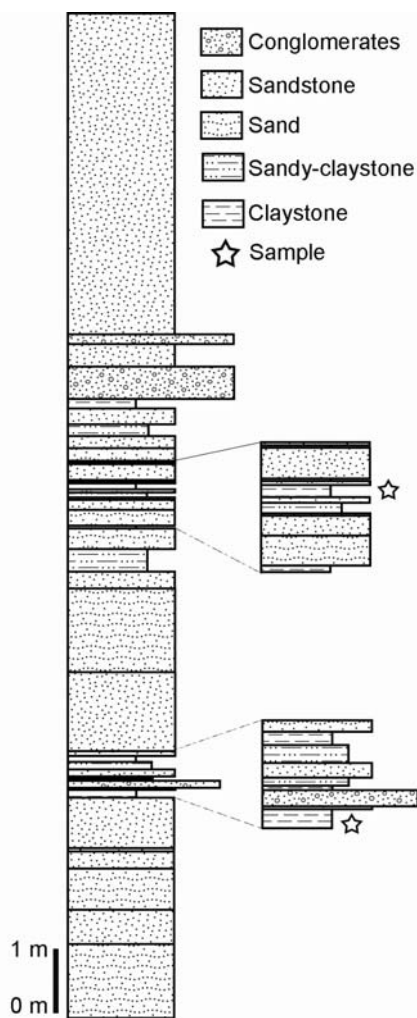


Fig. 2. Sedimentary log for Spermezeu 1 site.

Spermezeu 2 (S2)

Upstream from the previous outcrop, in a lower stratigraphic position, we identified another succession starting with distal turbidites and continuing towards the top with massive middle fan sandstones. The entire succession suggests prograding lobe fringes with a shallowing upward, coarsening upward trend (fig. 3). This facies can be considered in a transitional position between an outer fan and a mid fan, with progressive increasing of sediment supply and turbidity current density with time. The high concentration of plant debris in the uppermost part of the section indicates an active transport from a land area associated with the regressive trend.

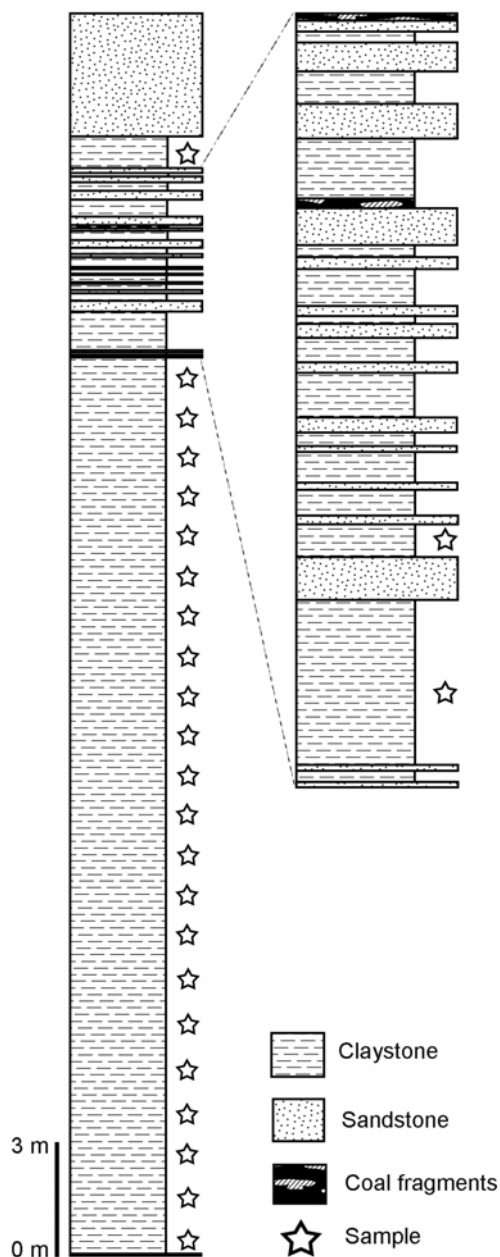


Fig. 3. Sedimentary log for Spermezeu 2 site.

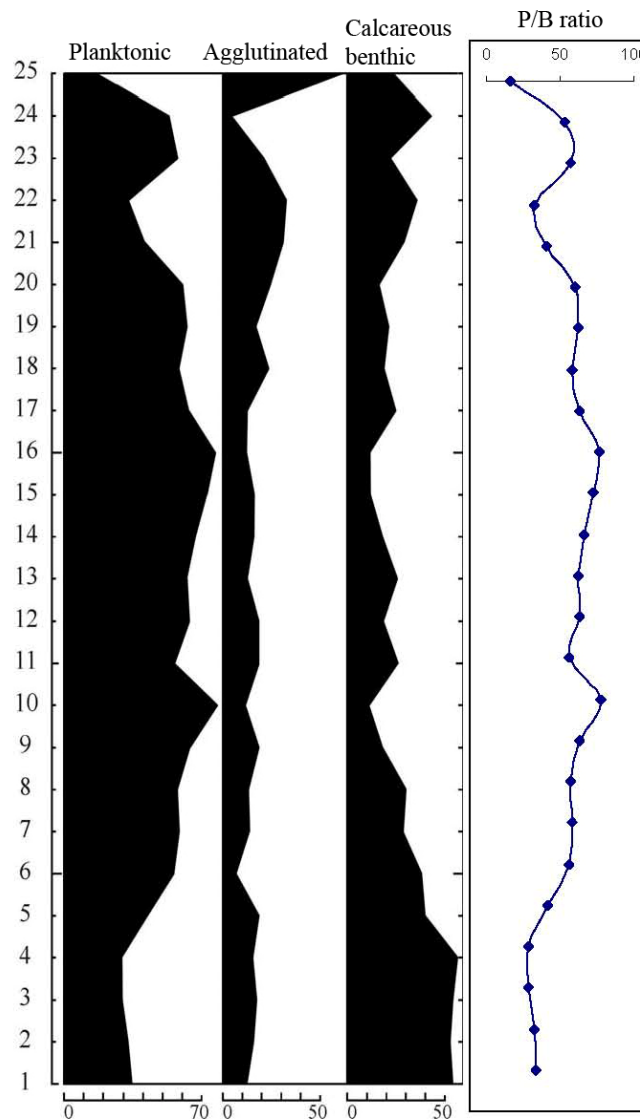


Fig. 4. Planktonic / benthic (agglutinated + calcareous) foraminifera ratio in the studied samples from Spermezeu 2 site.

The foraminiferal assemblages from Spermezeu 2 are mixed, containing both benthic and planktonic taxa (fig. 4). Calcareous benthic foraminifera (> 50 %) dominate in the lower part of succession. The assemblages are characteristic for relatively shallow environments. The increase in abundance of planktonic foraminifera (up to 70 %) proves the presence of deeper environments, which produced a sharp decrease in the level of oxygenation of the substrate. Despite the poor preservation of planktonic foraminifera, some species already known from the Lower Miocene of the Transylvanian Basin have been identified: *Globigerina praebulloides* BLOW, *Globorotalia obesa* BOLLI, *Globigerinoides altiapertura* BOLLI, and *Globigerina ottnangiensis* RÖGL (Popescu, 1975).

A significant decrease in planktonic foraminifera in the upper part of the succession can be observed. The tubular agglutinated foraminifera (*Bathysiphon* sp., *Hyperammia* sp., *Psammosiphonella* sp.) and calcareous benthics (*Siphonina reticulata*, *Valvulinera fabiani*, *Cibicidoides* sp.) are dominant.

Some calcareous benthics are characteristic for shallower (neritic) environments; they were probably redeposited into a deeper environment (*Ammonia beccari*, *Sigmoilina* sp.). Agglutinated foraminifera display a constant abundance along the section, with minor fluctuations (10-20 %). Significant changes can be observed at the top, where agglutinated foraminifera reach up to 50 %.

All morphogroups are present in different proportions except for morphogroup M3b (attached epifaunal forms) (fig. 5). There is a negative correlation between M1 (tubular suspension-feeders) and M4b (deep burrowing infaunal forms with uniserial or multiserial and tapered, elongated, streamlined shape), probably due to different feeding strategies (suspension feeding vs. active deposit feeding) and oxygenation. The morphogroup M4b shows a high abundance in relation to sea level rises, being more tolerant to low-oxygen environments (see Cetean, 2009). A value up to 50 % in morphogroup M1 indicates bathyal environments (Jones & Charnock, 1985); in our samples this group is dominant during relative sea level falls.

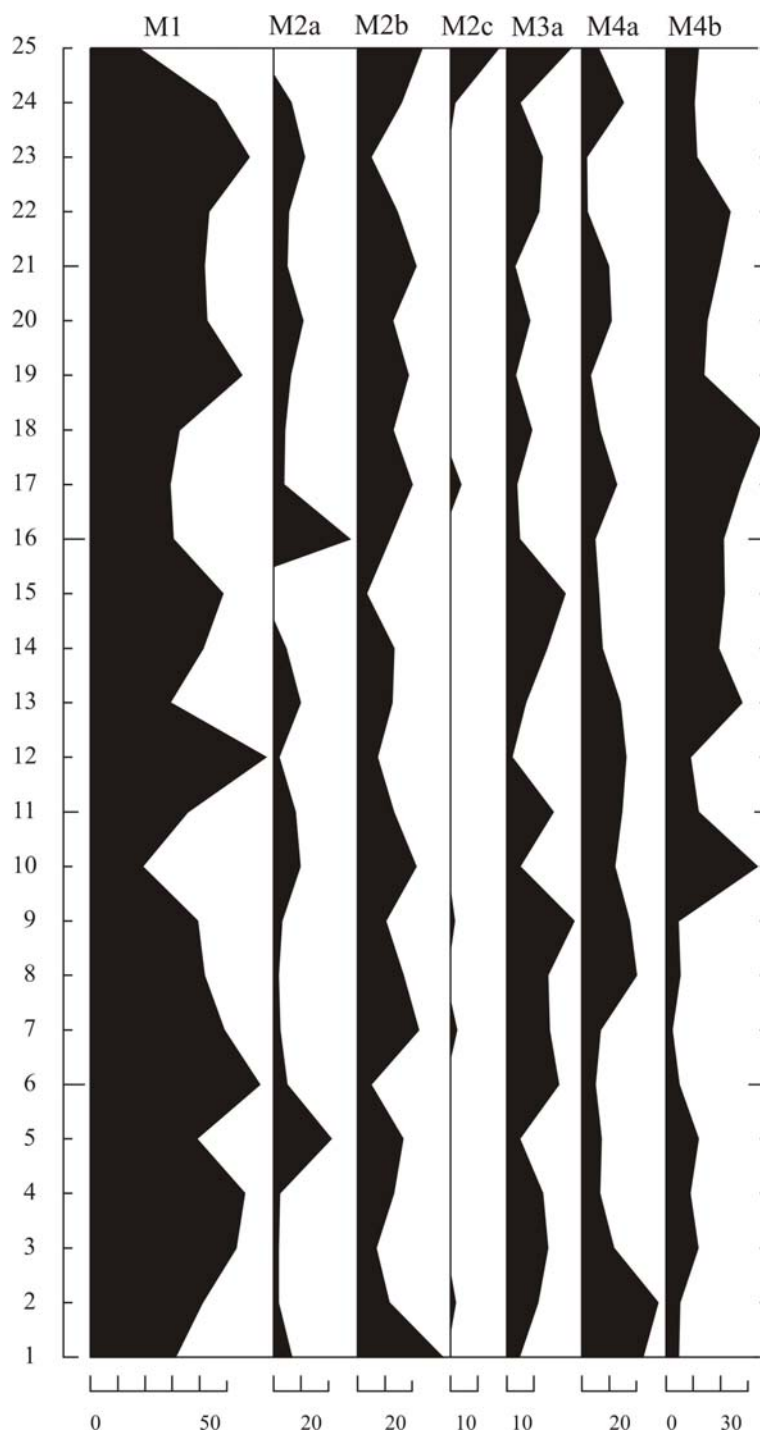


Fig. 5. Proportions of the main agglutinated morphogroups from Spermezeu 2 site.

Morphogroup M2c (epifaunal detritivores, keeled forms with mixed coiling modes such as *Spiroplectammia*) reaches maximum values (15 %) at the top of the succession. Together with high proportions of morphogroups M2b (active deposit feeding, trochospiral and streptospiral coiled) and M3a (flattened planspial and streptospial epiphytal forms) it probably points out to shallowing of the environment.

The following biofacies of agglutinated foraminifera are dominant in the studied section from Spermezeu 2 (based on classification of Kuhnt & Kaminski, 1990):

- "fysch-type" agglutinated foraminifera biofacies with *Bathysiphon*, *Nothia*, *Rhizammina*, *Hyperammia*, characteristic of bathyal slope environments to distal turbiditic environments or areas influenced by contour currents (Kuhnt & Kaminski, 1990; Koutsoukos, 2000).

- slope marl biofacies is dominated by tubular forms with subdominant ammodiscids, haplophragmiids and loftusiids. This biofacies is characterized by varying admixture of calcareous benthic and planktonic foraminifera belonging to outer neritic to upper bathyal environments (Kaminski et al., 2005).

Târlișua (T)

Târlișua succession, also located in the central part of the Hida Formation, consists of thin-bedded sandstones intercalated with hemiplegic mudstones. An internal organization into Td-e Bouma divisions (thin-bedded turbidites of transitional outer fan - basin plain depositional facies) can be observed.

The foraminifera are very rare. Only some fragments of planktonic and calcareous benthic foraminifera have been found, hardly identifiable at species level. The very rare and poorly-preserved foraminifera are probably a consequence of the high sedimentary input.

CONCLUSIONS

The sections of the Hida Formation cropping out along the Ilișua Valley were deposited in a deep-water turbiditic environment that progressively experienced variations both in depth and morphology. This is documented by large variations in the turbidite facies, from channelled deposits of the proximal inner fan (Spermezeu 1) to thin-bedded turbidites of the distal outer fan (Spermezeu 2 and *Târlișua*), and by fluctuations in the foraminiferal assemblages. The uplifted Pienidian nappes (Eocene-Oligocene in age) could be considered as potential - but not unique - source area for both the conglomerates and the finer-grained sediments of the Hida Formation.

The planktonic/benthic (P/B) ratio recorded some fluctuations in the samples from Spermezeu 2 probably as a consequence of relative sea-level changes. The high abundance of plankton in some samples can be correlated to relative sea-level rise, continued with diversification of the benthos.

All agglutinated morphogroups are present in different proportions except for morphogroup M3b. The morphogroups' distribution shows minor fluctuations with an increase of M2c toward the top of Spermezeu 2 succession, suggesting relatively shallower environments. Based on planktonic/benthic ratio, agglutinated morphogroup distribution and sedimentological features a clear transition from a deep marine (bathyal) environment to a shallower (outer shelf) environment can be observed.

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PLATES

Plate I

Foraminiferal assemblages from Spermezeu (SEM). 1- *Vulvulina pennatula* (BATSCH); 2- *Saccamina grzybowskii* (SCHUBERT); 3- *Hormosinelloides guttifer* (BRADY); 4- *Reophax pilulifer* BRADY; 5- *Karrerella chilostoma* (REUSS); 6- *Saccamina* sp.; 7- *Reophax subfusiformis* EARLAND; 8- *Reophax globosus* SLITER; 9- *Karrerulina* sp.; 10- *Gaudrynopsis bregoviensis* (VENGLINSKIY); 11- *Lenticulina subpapillosa* (NUTTALL); 12- *Elphidium reussi* MARKS; 13; 14- *Cibicidoides pseudoungerianus* (CUSHMAN); 15- *Gobigerinoides* cf. *primordius* BANNER & BLOW; 16; 17- *Globigerina ottnangienis* RÖGL; 18- *Globigerina praebulloides* BLOW.

Plate II

Foraminiferal assemblages from Spermezeu (stereomicroscope – scale = 500µm). 1- *Hyperammia rugosa* VERDENIUS & VAN HINTE; 2- *Protobotellina vermiculata* ŁUCZKOWSKA; 3; 4- *Bathysiphon* sp.; 5; 6- *Psammosiphonella cylindrica* (GLAESSNER); 7- *Karrerulina* sp.; 8; 9- *Reophax subfusiformis* EARLAND; 10- *Reophax* sp.; 11- *Hormosinelloides guttifer* (BRADY); 12- *Rhabdammina linearis* BRADY; 13- *Dorothia* sp.; 14- *Gaudrynopsis bregoviensis* (VENGLINSKIY); 15- *Vulvulina pennatula* (BATSCH); 16- *Ammodiscus miocenicus* KARRER; 17- *Reticulophragmium acutidorsatum* (HANTKEN); 18- *Crbrostomoides subglobosus* (CUSHMAN); 19- *Ammodiscus* sp.; 20- *Reticulophragmium rotundidorsatum* (HANTKEN); 21- *Dentalina acuta* D'ORBIGNY; 22- *Planularia galea* (FICHEL & MOLL); 23- *Nodosaria pyrula* D'ORBIGNY; 24- *Amphicoryna armata* (NEUGEBOREN); 25- *Siphonina reticulata* (CZJZEK); 26- *Lenticulina inornata* (D'ORBIGNY).

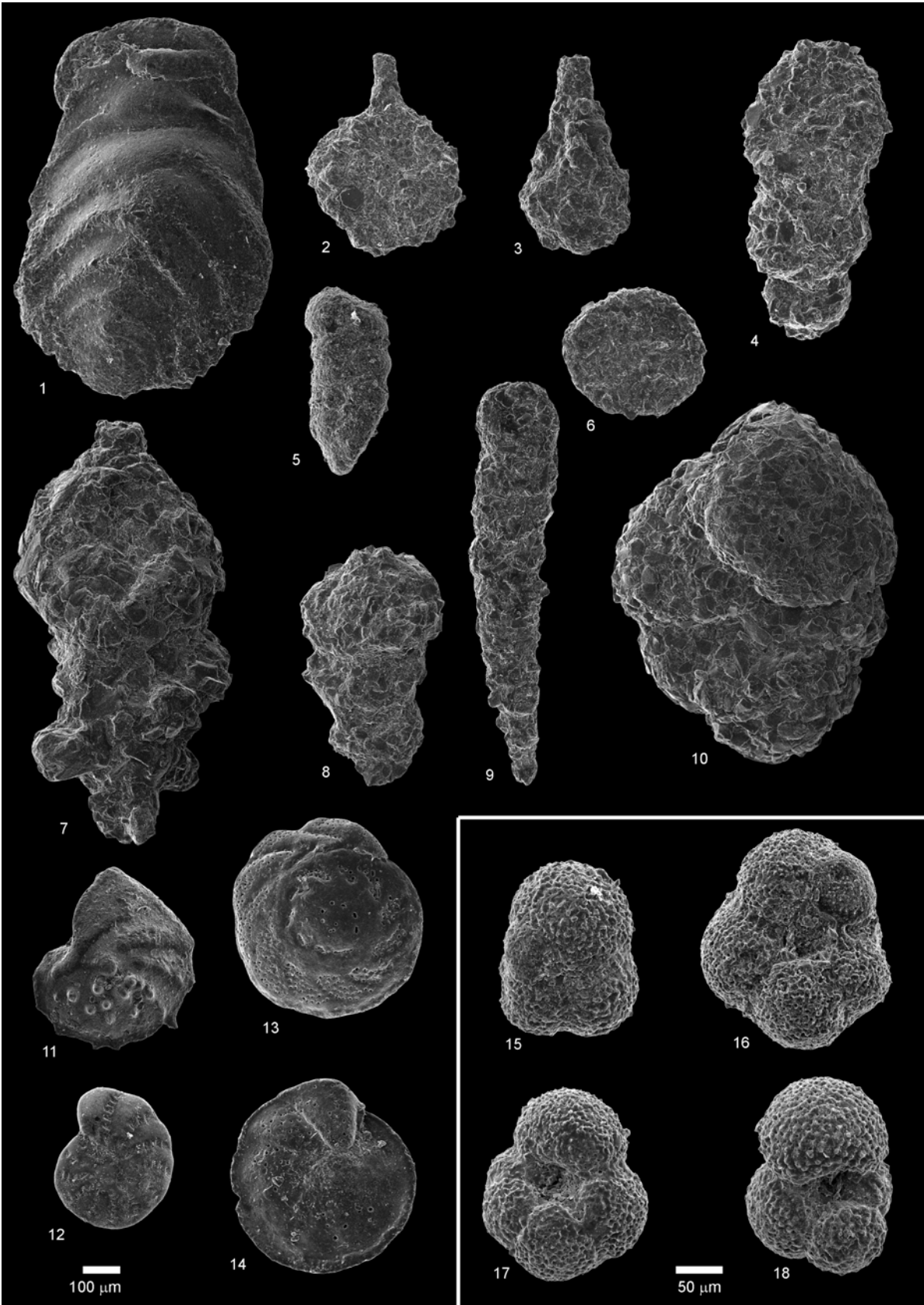


PLATE II

