Paleocene Deep-water Agglutinated Foraminifera in the Transylvanian Basin

SORIN FILIPESCU[1] and MICHAEL A. KAMINSKI[2]

1. Department of Geology, Babeş-Bolyai University, str. Kogălniceanu 1, 400084 Cluj-Napoca, Romania
2. Department of Earth Sciences, UCL, Gower Street, London, WC1E 6BT, U.K.

ABSTRACT

A deep-water agglutinated foraminiferal (DWAF) assemblage is described for the first time from Paleocene strata of the substratum of the Transylvanian Basin in Romania. A DWAF assemblage accompanied by early Paleocene planktonic foraminifera was recovered from the Puini borehole, drilled in the Puini Subbasin. The sedimentary fill of the Puini subbasin was formerly regarded to be of Santonian to Maastrichtian age. Our finding of deep marine sediments of early Paleocene age means that marine sedimentation lasted longer in this area than previously thought.

INTRODUCTION

Exploratory drilling by ROMGAZ in the Puini subbasin of the Transylvanian Basin has penetrated the sedimentary cover in a number of boreholes. In the Puini borehole, an interesting and diverse microfaunal assemblage was recovered at a depth of over 1800 m, which sheds new light on the subsurface stratigraphy of Transylvania. A diverse DWAF assemblage accompanied by planktonic foraminifera indicates that marine sedimentation persisted in this area longer than previously thought. According to previously published lithological schemes (Filipescu, 2001; Bally & Krézsek, 2006), the Paleocene of the Transylvanian Basin was believed to be a part of the continental succession deposited between the Maastrichtian and Lutetian.

The recovered assemblage described herein contains both DWAF and planktonic foraminifera that are indicative of an early to mid Paleocene age.

STUDY AREA

The Transylvanian Basin is an intra-Carpathian sedimentary basin that is in fact comprised of a series of superimposed Late Cretaceous to Neogene basinal structures, developed on top of Mid Cretaceous nappes. The current basin has a roughly circular outline, and is a result of late Miocene to Pliocene tectonics. Locally, more than 5000 m of sediments are preserved.

At a larger scale, the basin's fill may be subdivided into four megasequences related to different tectonic settings: Upper Cretaceous, Paleogene, Lower Miocene, and Middle to Upper Miocene. The basin's structure was complicated by several basement-related uplifts (e.g., Pogăceaua), minibasins (e.g., Puini, Târnave, Alămor), and Miocene salt tectonics.

According to Bally & Krézsek (2006), the uppermost Cretaceous sediments of the Transylvanian Basin form a large-scale transgressive-regressive cycle. The Maastrichtian tectonically induced regression initiated the continental sedimentation, but locally deep-marine sediments conformably cover earlier deep-marine successions. The microfaunal assemblages we studied prove that marine settings continued into the Paleocene, at least in the Puini Subbasin.

STRUCTURE OF THE PUINI SUBBASIN

The Puini Subbasin (Fig. 1) is a Santonian-Maastrichtian basin that seals the Aptian to Coniacian Puini thrust of basement origin and its related basin fill with deep-marine deposits of Aptian to Coniacian age (De Broucker, 1998; Ciulavu & Bertotti, 1994). The stratigraphic control was provided by the Puini well (Fig. 2).

MATERIAL AND METHODS

A large subsurface database owned by ROMGAZ S.A. consists of thousands of kilometers of seismic sections, and more than 4000 wells. Micropalaeontological slides from a large number of wells recovered from the former collections of ROMGAZ are now stored in the Department of Geology at Babeş-Bolyai University. The reference well that penetrated the Neogene sedimentary cover of the present-day Transylvanian Basin, provided data on the age and palaeoenvironment of older sediments that comprise the substrate of the basin.

In: Kaminski, M.A. & Coccioni, R. (eds), 2008. Proceedings of the Seventh International Workshop on Agglutinated Foraminifera. *Grzybowski Foundation Special Publication*, **13**, 25-30.

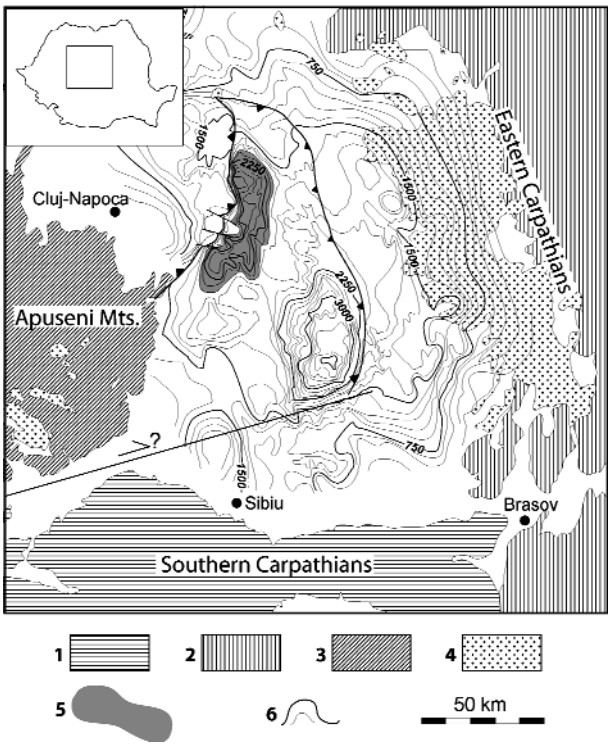

Figure 1. Structure of the Transylvanian Basin and surrounding areas: 1. Southern Carpathians; 2. Eastern Carpathians; 3. Apuseni Mountains; 4. Neogene volcanics; 5. Location of the Puini Subbasin; 6. Basement isochrons (in ms). On top left: position on map of Romania (based on Krézsek & Bally, 2006).

In the Puini borehole, a diverse DWAF assemblage was observed at a depth of over 1800 m. The assemblage was preserved in previously picked assemblage slides, and we can only assume that the samples were processed using industry techniques that were standard at the time. The assemblage was sorted into new cardboard slides in order to facilitate identification, and photographed using light microscopy and in SEM. The assemblage slides are preserved in the BBU and UCL micropalaeontological collections.

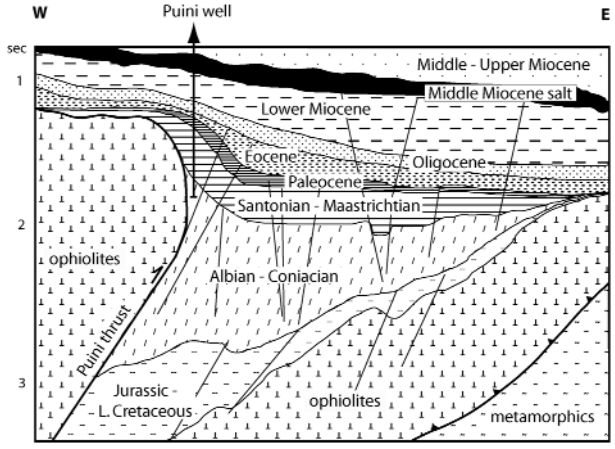

Figure 2. Tectono-stratigraphic structure of the Puini Subbasin (based on the seismic section of Krézsek & Bally, 2006).

RESULTS

The micropalaeontological samples from the Puini well contains a "forgotten" DWAF assemblage that in unpublished Romgaz reports was initially interpreted as Late Cretaceous age (Ciupagea et al., 1970). The assemblage consists of around 15 species of DWAF, and is accomapanied by small-sized planktonic foraminifera, mostly *Eoglobigerina eobulloides*, *Eoglobigerina fringa*, and *Eoglobigerina edita*, indicating an Early Paleocene (Danian) age.

The recovered DWAF assemblage contains a number of species that are known to occur in sediments of Paleocene age in other circum-Atlantic basins, such as *Reticulophragmium* cf. *garcilassoi*, *Reticulophragmium* aff. *vidonioensis*, *Rzehakina minima*, and *Cribrostomoides trinitatensis*.

The occurrence of these species suggests that the Paleocene of the Puini subbasin displays close affinity to some well-known assemblages, such as those found in the Paleocene of eastern Venezuela. The occurrence of primitive species of *Reticulophragmium* (alongside Danian planktonic Foraminifera) is especially diagnostic, as these forms are not known from deposits of Cretaceous age. In Trinidad, the species *Reticulophragmium* cf. *garcilassoi* is known from Danian sediments of the Lizard Springs Formation (Kaminski et al., 1988), while *Reticulophragmium* aff. *vidonioensis* was described from the mid-Paleocene (Zone P3) of eastern Venezuela (Kaminski & Crespo de Cabrera, 1999).

CONCLUSIONS

Paleocene DWAF are reported here for the first time in the substratum of the Transylvanian Basin.

The assemblage displays Atlantic - Tethyan affinities, with primitive *Reticulophragmium*.

Our understanding of the paleogeographic evolution of the Transylvanian Basin is here revised - marine conditions persisted in the area during the Paleocene, at least in the northern part of the basin.

ACKNOWLEDGEMENTS

We thank S.N.G.N. Romgaz S.A. for donating their micropalaeontological collections to BBU. This is contribution nr. 79 of the Deep-Water Agglutinated Foraminiferal Project.

SYSTEMATIC PALAEONTOLOGY

Idendification of the Paleocene DWAF of Transylvania is based mainly on the "Atlas of Paleogene Cosmopolitan Agglutinated Foraminifera" by Kaminski & Gradstein (2005). The suprageneric systematics of the agglutinated foraminifera by Kaminski (2004) is used herein. For the sake of brevity, only primary references are cited.

Bathysiphon sp.
Plate 2, fig. 3

Psammosiphonella sp.
Plate 1, fig. 1; plate 2, figs 1-2

Psammosiphonella discreta (Brady, 1881)
Plate 2, fig. 4
Rhabdammina discreta Brady, 1881, p. 48.- Brady, 1884, p. 268, pl. 22, figs 7-10

Nothia sp.
Plate 1, fig. 2

Placentammina placenta (Grzybowski, 1898)
Plate 2, fig. 7
Reophax placenta Grzybowski, *1898, p. 276-277, pl. 10, figs. 9-10*

Saccammina grzybowskii (Schubert, 1902)
Plate 1, fig. 9, Plate 2, fig. 8
Reophax grzybowskii Schubert, 1902, p. 20, pl. 1, fig. 13

Ammodiscus glabratus Cushman & Jarvis, 1928
Plate 1, fig. 4, Plate 2, fig. 5
Ammodiscus glabratus Cushman & Jarvis, 1928, p. 86, pl. 12, fig. 6

Ammodiscus peruvianus Berry, 1928
Plate 1, fig. 3
Ammodiscus peruvianus Berry, 1928, p. 342, pl. 27

Ammodiscus tenuissimus Grzybowski, 1898
Plate 1, fig. 5
Ammodiscus tenuissimus Grzybowski, 1898, p. 282, pl. 10, fig. 35

Glomospira charoides (Jones & Parker, 1860)
Plate 2, fig. 6
Trochammina squamata Jones & Parker var. *charoides* Jones & Parker, 1860, p. 304.

Rzehakina inclusa (Grzybowski, 1901)
Plate 1, fig. 7
Spiroloculina inclusa Grzybowski, 1901, p. 260, pl. 7, fig. 20.

Rzehakina minima Cushman & Renz, 1946
Plate 1, fig. 6
Rzehakina epigona (Rzehak) var. *minima* Cushman & Renz, 1946, p. 24, pl. 3, fig. 5.

Subreophax scalaris (Grzybowski, 1896)
Plate 1, fig. 8
Reophax guttifera Brady var. *scalaria* Grzybowski, 1896, p. 277, pl. 8, fig. 26

Haplophragmoides stomatus (Grzybowski, 1898)
Plate 1, fig. 13
Trochammina stomata Grzybowski, 1898, p. 290, pl. 11, figs 26-27.

Recurvoides sp.
Plate 2, fig. 11

Cribrostomoides trinitatensis Cushman & Jarvis, 1928
Plate 2, figs 12, 13
Cribrostomoides trinitatensis Cushman & Jarvis, 1928, p. 21, pl. 12, figs. 12a-b

Spiroplectammina excolata (Cushman, 1926)
Plate 1, fig. 11
Textularia excolata Cushman, 1926, p. 585, pl. 15, fig. 9a-b.

Reticulophragmium* cf *garcilassoi (Frizzel, 1943)
Plate 2, fig. 10
Cyclammina cf. *garcilassoi* Frizzel.- Cushman & Renz, 1946, p. 19, pl. 2, fig. 11.
Reticulophragmium cf *garcilassoi* (Frizzel, 1943).- Kaminski *et al.*, 1988, p. 192, pl. 7, figs 3-5b; pl. 10, fig. 5.
Remarks. This is the smaller, more compressed (Danian) morphotype of the species, not the large lenticular (Late Paleocene) form illustrated by Kaminski & Gradstein (2005).

Reticulophragmium* aff. *vidonioensis Kaminski & Crespo de Cabrera, 1999
Plate 1, figs 16, 17
aff. *Reticulophragmium vidonioensis* Kaminski & Crespo de Cabrera, 1999, p. 190, fig. 2 (1a-4d).
Remarks. The specimens from Puini have the same number of chambers and rounded periphery as the Venezuelan type specimens, but they display a somewhat more advanced alveolar inner structure.

Clavulinoides sp.
Plate 1, fig. 10

REFERENCES

Berry, E.W. 1928. The smaller foraminifera of the middle Lobitos shales of northwestern Peru. *Eclogae Geologae Helvetiae*, **21**, 390-405.

Brady, H.B. 1881. Notes on some of the reticularian Rhizopoda on the "CHALLENGER " Expedition; Part III. *Quarterly Journal of Microscopical Sciences*, **21**, 31-71.

Brady, H.B. (1884). Report on the foraminifera dredged by H.M.S. CHALLENGER during the years 1873-1876. *In:* Murray, J. (Ed.), *Reports of the scientific results of the voyage of the H.M.S. Challenger. Zoology*, **9**, 1-814.

Ciulavu, D. & Bertotti, G. 1994. The Transylvanian Basin and its Upper Cretaceous substratum. *Romanian Journal of Tectonics*, **75** (2), 59-64 (Bucharest).

Ciupagea, D., Pauca, M. & Ichim, T. 1970. *Geologia Depresiunii Transilvaniei*. Editura Academiei, Bucuresti, 256 pp.

Cushman, J.A. 1926. The foraminifera of the Velasco Shale of the Tampico Embayment. *American Association of Petroleum Geologists Bulletin*, **10**, 581- 612.

Cushman, J.A. & Jarvis, P.W. 1928. Cretaceous foraminifera from Trinidad. *Contributions from the Cushman Laboratory for Foraminiferal Research*, **4**, 85-103.

Cushman, J.A. & Renz, H.H. 1946. The foraminiferal fauna of the Lizard Springs Formation of Trinidad, British West Indies. *Cushman Laboratory for Foraminiferal Research Special Publication*, **18**, 1-48

De Broucker, G., Mellin, A. & Duindam, P. 1998. Tectono-Stratigraphic evolution of the Transylvanian Basin, pre-salt sequence, Romania. *In:* Dinu, C., & Mocanu, V. (eds), *Geological and Hydrocarbon Potential of the Romanian areas*, Bucharest Geosciences Forum, **1**, 36-70.

Filipescu, S. 2001. Cenozoic Lithostratigraphic units in Transylvania. *In:* Bucur, I.I., Filipescu, S., & Sasaran, E. (eds.) *Algae and carbonate platforms in western part of Romania*. 4th Regional Meeting of IFAA Cluj-Napoca 2001 - Field Trip Guidebook, Cluj University Press, 75-92.

Grzybowski, J. 1896. Otwornice czerwonych iłów z Wadowic. *Rozprawy Wydziału Matematyczno-Przyrodniczego, Akademia Umiejętności w Krakowie, serya 2*, **30**, 261-308.

Grzybowski, J. 1898. Otwornice pokładów naftonosnych okolicy Krosna. *Rozprawy Wydziału Matematyczno-Przyrodniczego, Akademia Umiejętności w Krakowie, serya 2*, **33**, 257-305.

Grzybowski, J. 1901. Otwornice warstw inoceramowych okolicy Gorlic. *Rozprawy Wydziału Matematyczno-Przyrodniczego, Akademia Umiejętności w Krakowie, serya 2*, **41**, 219-286.

Jones, T.R. & Parker, W.K. 1860. On the Rhizopodal fauna of the Mediterranean compared with that of the Italian and some other Tertiary deposits. *Quarterly Journal of the Geological Society of London*, **16**, 292-307.

Kaminski, M.A. 2004. The Year 2000 classification of agglutinated foraminifera. *In:* Bubik, M., & Kaminski, M.A. (eds), *Proceedings of the Sixth International Workshop on Agglutinated Foraminifera*. Grzybowski Foundation Special Publication, **8**, 237-255.

Kaminski, M.A. & Crespo de Cabrera, S. 1999. A new species of primitive *Reticulophragmium* (Foraminifera) from the Paleocene Vidoño Formation of northeastern Venezuela. *Annales Societatis Geologorum Poloniae*, **69** (4), 189-193.

Kaminski, M.A. & Gradstein, F.M. 2005. *Cenozoic cosmopolitan deep-water agglutinated foraminifera*. Grzybowski Foundation Special Publication, **10**, 547 pp.

Kaminski, M.A., Gradstein, F.M., Berggren, W.A., Geroch, S. and Beckmann, J.-P. 1988. Flysch-type agglutinated foraminiferal assemblages from Trinidad: Taxonomy, Stratigraphy and Paleobathymetry. *Abhandlungen der geologischen Bundesanstalt, Wien*, **41**, 155-227.

Krézsek, C. & Bally, A. 2006. The Transylvanian Basin (Romania) and its relation to the Carpathian fold and thrust belt: Insights in gravitational salt tectonics. *Marine and Petroleum Geology*, **23**, 405-442.

Schubert, R.J. 1902. Neue und interessante Foraminiferen aus dem südtiroler Altteriär. *Beiträge zur Paläontologie und Geologie Österreich-Ungarns und des Orients*, **14**, 9-26. Wien.

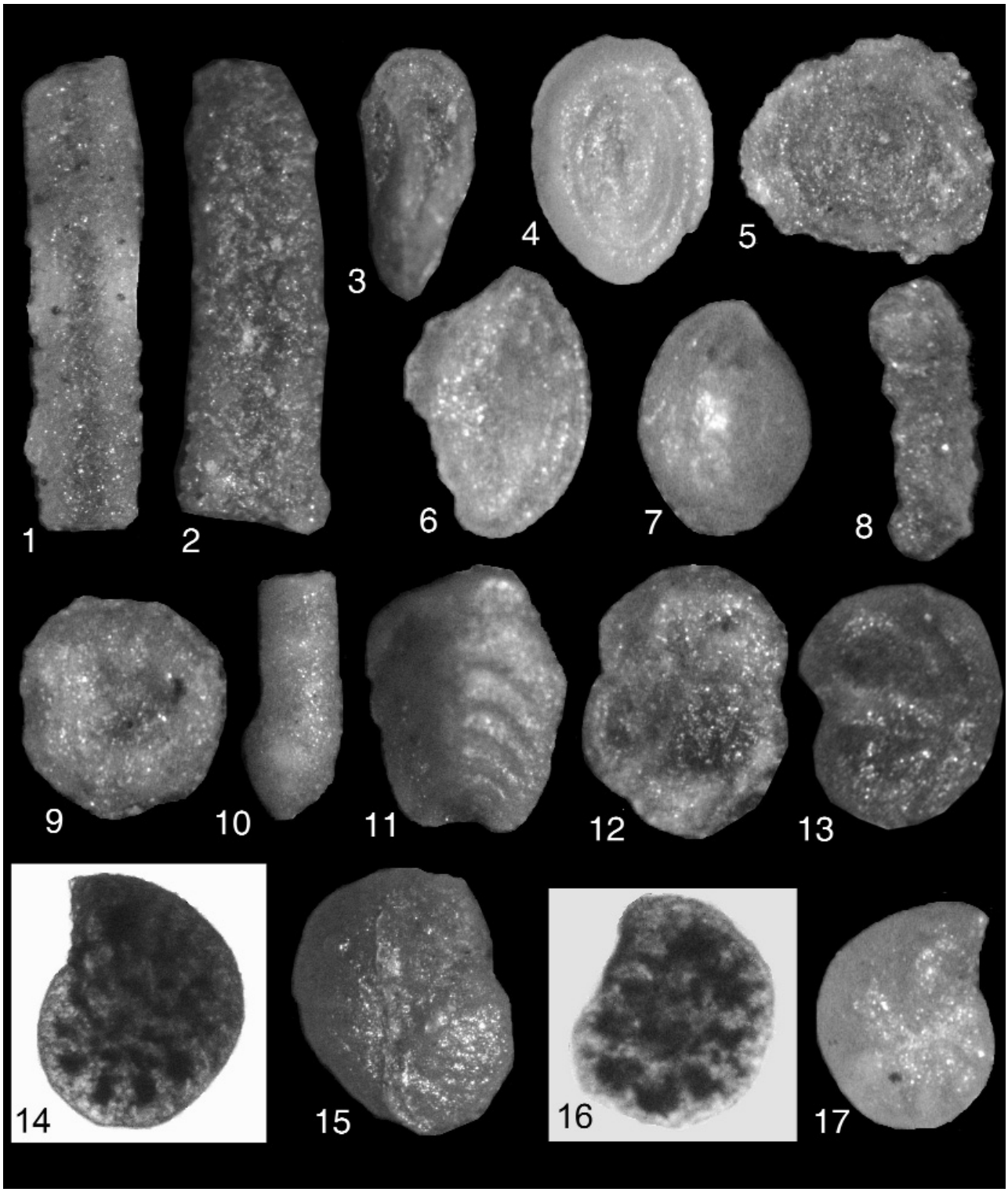

Plate 1. Light Microscope images
1. *Psammosiphonella* sp.; 2. *Nothia* sp.; 3. *Ammodiscus peruvianus*; 4 *Ammodiscus glabratus*; 5. *Ammodiscus tenuissimus*; 6. *Rzehakina minima*; 7. *Rzehakina inclusa*; 8. *Subreophax scalaris*; 9. *Saccammina grzybowskii*; 10. *Clavulinoides paleocenicus*; 11. *Spiroplectammina excolata*; 12. *Trochammina* sp.; 13. *Haplophragmoides stomatus*; 14,15. *Reticulophragmium* cf. *garcilassoi*; 16,17. *Reticulophragmium* aff. *vidonioensis*.

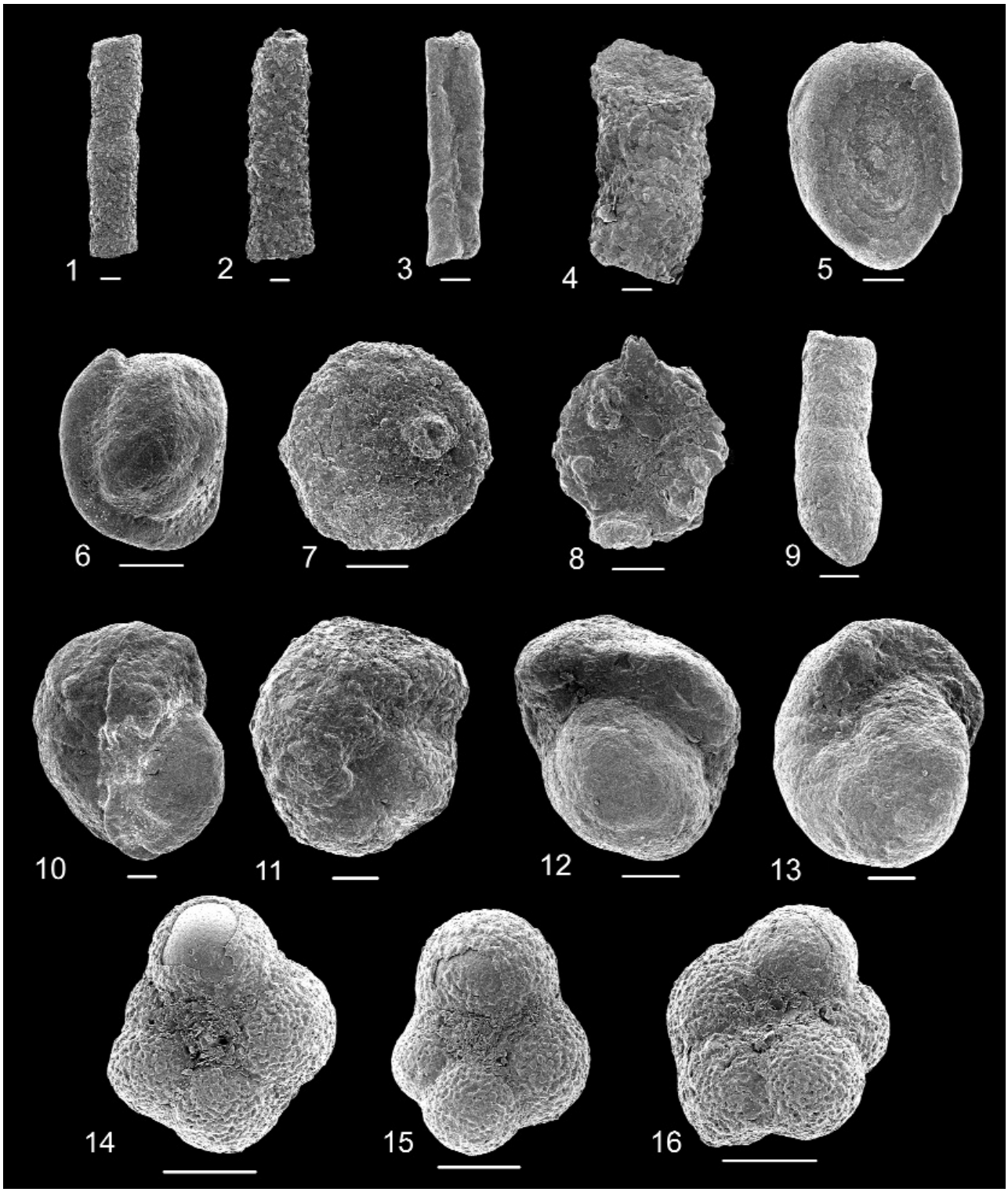

Plate 2. SEM images

1-13. Agglutinated foraminifera: 1. *Psammosiphonella* sp.; 2. *Psammosiphonella* sp.; 3. *Bathysiphon* sp.; 4. *Psammosiphonella discreta*; 5. *Ammodiscus glabratus*; 6. *Glomospira charoides*; 7. *Placentammina placenta*; 8. *Saccammina grzybowskii*; 9. *Clavulinoides paleocenicus*; 10. *Reticulophragmium garcilassoi*; 11. *Recurvoides* sp.; 12,13. *Cribrostomoides trinitatensis*; 14-16 Planktonic foraminifera - Zone P1 (Danian): 14. *Eoglobigerina eobulloides*; 15. *Eoglobigerina fringa*; 16. *Eoglobigerina edita*.