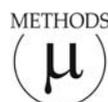


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On the systematics of rugoglobigerinids (planktonic Foraminifera, Late Cretaceous)

(Figs 1–4)

Abstract. A subdivision of the Late Cretaceous planktonic foraminiferal family Rugoglobigerinidae is now proposed according to the nature and patterns in ornamentation as well as the development of peripheral structures. Typical rugoglobigerinids, namely those presenting meridionally arranged pustules, rugosities and costellae are retained within the subfamily Rugoglobigerininae. The subfamily Archaeoglobigerininae is now erected to accommodate taxa presenting chamber ornamentation consisting of not fused pustules, papillae, rugosities, and spines which are not arranged following a meridional pattern. In what concerns the peripheral structures, whose development is regarded as indicative for adaptation to deeper water environments. It is demonstrated that the two subfamilies, Rugoglobigerininae and Archaeoglobigerininae respectively, present quasi-parallel evolutionary strategies. The status of the genus *Rugotruncana* is revised. Transitional specimens between *Archaeoglobigerina blowi* and *Rugotruncana subcircumnodifer* from the Upper Campanian of the New Jersey coastal plain demonstrate that *Rugotruncana* is the only known double-keeled rugoglobigerinid, and is included in the subfamily Archaeoglobigerininae, rather than among the Globotruncanidae.

Key words: Planktonic foraminifera, Late Cretaceous, Rugoglobigerinidae, new subfamily.

INTRODUCTION

Although the “Cretaceous costate globigerinids” have been reported since the beginning of the twentieth century, this group was the subject of detailed studies only in the ‘50s when Brönnimann (1952a, 1952b) and Brönnimann & Brown (1956) erected a number of genera for those forms which mostly present chamber ornamentation with meridional pattern, or at least are strongly ornamented: *Buchnerina*, *Kuglerina*, *Plummerita*, *Rugoglobigerina*, *Rugotruncana*, and *Trinitella*.

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Their distinct systematical status was considered by Subbotina (1959) who included the forms presenting meridionally arranged costellae and rugosities within the subfamily *Rugoglobigerininae*. A substantial advance in our understanding of the Late Cretaceous planktonic foraminifera came with the description of *Archaeoglobigerina* by Pessagno (1967) a genus presenting hispid chamber surface due to the presence of more or less well-developed scattered pustules and an umbilical system composed of portico and tegilla. The presence of two faint keels at the periphery determined its original placement within the family Globotruncanidae. The status of *Archaeoglobigerina* was further discussed by Robaszynski *et al.* (1984). These authors concluded that *Archaeoglobigerina* can be considered a junior synonym of *Rugotruncana* if it can be demonstrated that *Rugotruncana tilevi*, the type species of the latter, does not present pustules and rugosities arranged in a meridional pattern. The holotype of *Rugotruncana tilevi* was neither re-examined recently nor photographed using the SEM technique.

The status of all of the Cretaceous planktonics was thoroughly reviewed by Loeblich & Tappan (1982, 1984, 1988) who validated most of the above mentioned genera and included them within a separate family, the Rugoglobigerinidae. The only exception was *Rugotruncana*, which had been included within the family Globotruncanidae. This systematic framework was subsequently accepted by Huber (1994).

Recently, El-Nakhal (2002) considered the meridional pattern of the ornamentation as the unifying feature of the taxa included in his proposed superfamily Rugoglobigerinacea. Such a classification framework does not take into consideration the iterative evolutionary pattern of the Cretaceous planktonic foraminifers. Meridionally arranged costellae and rugosities independently occurred four times in the Cretaceous planktonics in systematically distant groups: *Hedbergella lybica* (Late Albian–Middle Cenomanian), *Costellagerina* (Santonian–Early Campanian), *Rugoglobigerina* (Late Santonian–Maastrichtian), and *Abathomphalus* (Maastrichtian). Thus, superfamily Rugoglobigerinacea lacks any systematical significance and is considered here *nomen nudum*.

A careful critical reevaluation of the morphological features, stratigraphical distribution and preferences for paleobathymetrical distribution patterns showed that the family Rugoglobigerinidae as it is understood today represents a rather heterogeneous systematic category and it can be further subdivided in two categories of subfamily rank. This subdivision is consistent with both gross test architecture and test surface ultrastructure and ornamentation. Moreover, it translates into systematics the adaptative radiations of the group over approximately 16 My in accordance to their paleobathymetrical affinities resulting in a more natural classification.

MORPHOLOGY OF THE RUGOGLOBIGERINIDAE AND ITS RELATIONSHIP WITH PALEOBATHYMETRY

All of the genera included in the family Rugoglobigerinidae have in common the main aperture interiomarginal, umbilical in position and the umbilical system com-

posed of more or less well developed thin and perforated tegilla which leave both proximal and distal apertures.

The group is well polarized with respect to test ornamentation: some of them present scattered, more or less dense pustules but obviously more abundant on the earlier chambers of the last whorl due to the addition of calcitic material during ontogenetical development (e.g., *Archaeoglobigerina*, *Bucherina*, and *Kuglerina*), while in the second group, namely the typical rugoglobigerinids, the rugosities and costellae are arranged following a meridional pattern (e.g., *Plummerita*, *Rugoglobigerina*, and *Trinitella*). The nature of the chamber ornamentation is now regarded as a discriminating feature in the subdivision of the family Rugoglobigerinidae. Accordingly, the former group of genera is included here within the subfamily Archaeoglobigerininae subfam. nov., while the latter within Rugoglobigerininae. Their persistence through time and the lack of transitional morphotypes document the existence of two distinct systematic categories (Fig. 1).

Among the genera included in the two subfamilies *Archaeoglobigerina* and *Rugoglobigerina* respectively present well expressed generalist features, i.e., globular chambered morphotypes, presenting low to medium trochospires, and lacking or presenting weak peripheral structures such as an imperforate peripheral band on the earlier chambers of the final whorl, bordered or not by rows of pustules or faint keels (see Figs 2, 3). Notably, Olsson (1977) regarded these two genera as shallow water inhabitants as they are mostly found in shallower water sediments. This interpretation was subsequently confirmed by Hart (1980), Wonders (1980), Caron (1983), Caron & Homewood (1983) and Georgescu (1997, 2003).

All of the other rugoglobigerinid genera apart from *Archaeoglobigerina* and *Rugoglobigerina* present quite specialized morphological features such as peripheral spines (e.g., *Plummerita*), truncated chambers sometimes presenting a faint keel on the earlier chambers of the final whorl (e.g., *Bucherina* and *Trinitella*), or high to very high trochospires (e.g., *Kuglerina*). These features are considered to be indicative for adaptation to deeper water ecological niches as demonstrated for Cretaceous planktonics by Caron & Homewood (1983) and Georgescu (1997) by extrapolating modern planktonic distribution patterns presented by Bé (1977).

A special case is that of the genus *Rugotruncana* for which a new systematic position is now proposed. Loeblich & Tappan (1988) reviewed the systematical status of *Rugotruncana* stating that it lacks the meridional arrangement of rugosities and costellae as claimed both by the authors of this genus Brönnimann & Brown (1956) and Pessagno (1967) in his proposed revised definition. This interpretation is consistent with the features presented by the holotype-like specimens of *Rugotruncana subcircumnodifer* (Gandolfi) and *R. subpennyi* (Gandolfi) figured by Caron (1985). The general morphology showing globular chambers in the earlier part of the final whorl, subglobular to slightly elongated last-formed chambers, and typical test ornamentation of archaeoglobigerinid type (scattered pustules, occasionally fused, but without meridional pattern) indicate that the genus *Rugotruncana* is a rugoglobigerinid belonging to the Archaeoglobigerininae subfam. nov. rather than a globotruncanid as nowadays considered (see Fig. 4). Such an interpretation is strongly

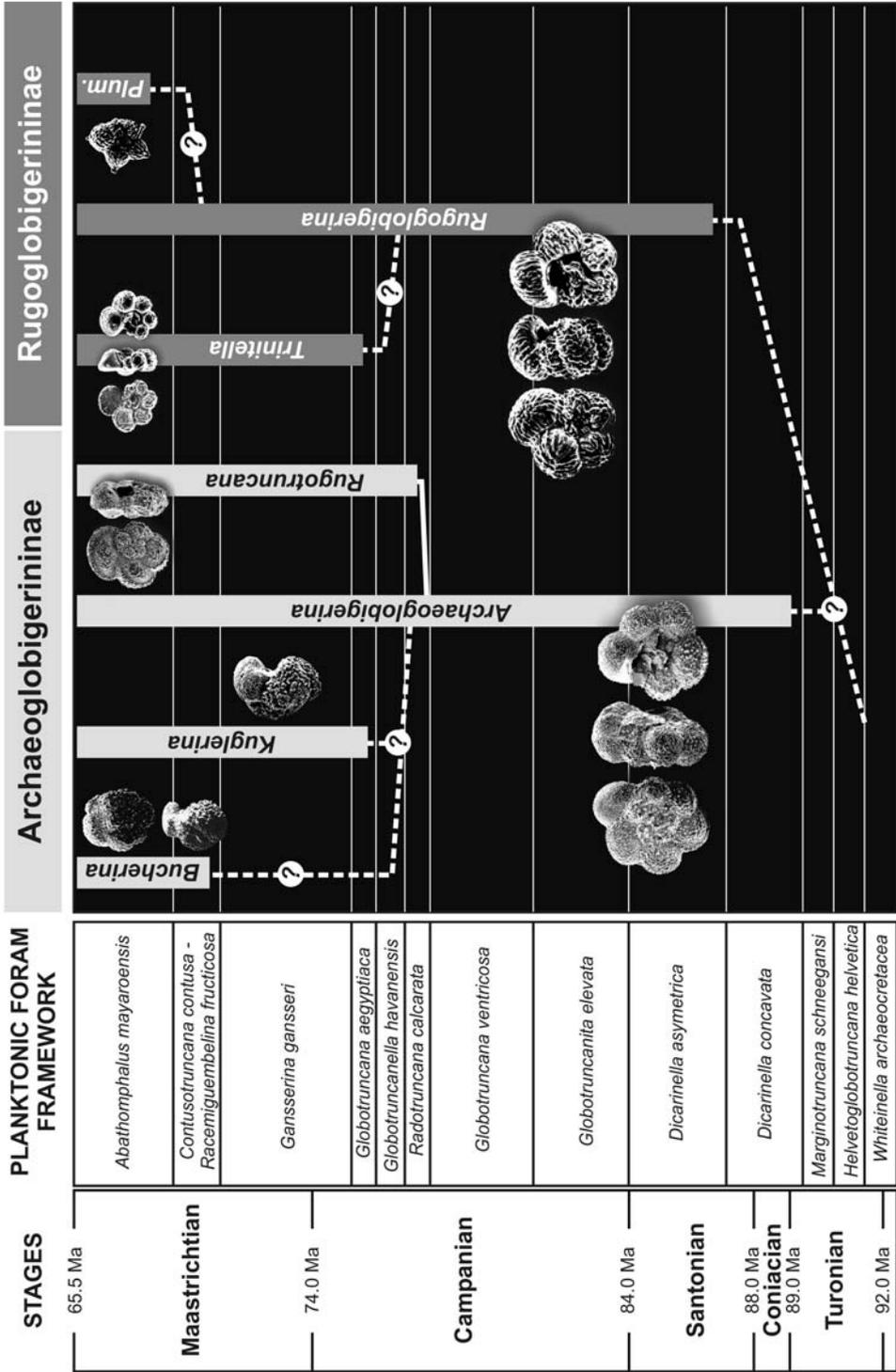


Fig. 1. Stratigraphical distribution and phylogeny of the representatives of the family Rugoglobigerinidae. Numerical ages after Haq *et al.* (1988); this scale is preferred against the more recently released ones due to the opportunities for correlating ages and 3rd order sea-level cycles. Planktonic foraminiferal zonation after Premoli Silva & Sliter (2002). Photograph source: *Bucherina* from Longoria & Gamper (1984, pl. 1, figs 9, 12); *Kuglerina* and *Plummerita* from Robaszynski *et al.* (1984, pl. 50, fig. 2b and 7a respectively); *Trititella* and *Rugoglobigerina* from Caron (1985, figs 8a-c and 10a-c respectively)

supported by the recent discovery of a complete series of transitional specimens between *Archaeoglobigerina blowi* and *Rugotruncana subcircumnodifer* in the Upper Campanian sediments (Marshalltown Formation) of the New Jersey coastal plain (ODP Leg 174AX at the Bass River site). Therefore, *Rugotruncana* represents a direct descendant from *Archaeoglobigerina*, presenting in contrast to the ancestral genus two strong, equally spaced keels at the test periphery. Apparently this feature can be correlated with *Rugotruncana*'s preferences for deeper water sediments. Only further examination of the holotypes of *Rugotruncana tilevi* and *R. subcircumnodifer* can clarify the status of *Rugotruncana*, either a well-defined branch within *Archaeoglobigerina* showing preferences for deeper water paleoenvironments or a distinct genus. The two genera are temporarily retained as valid in accordance to the distinct differences in peripheral structures.

According to the above data, two groups can be recognized among the rugoglobigerinids. The typical rugoglobigerinids (i.e., subfamily Rugoglobigerininae) present meridionally arranged rugosities and pustules initiated their evolution in the late Santonian and underwent a well defined adaptative radiation in Maastrichtian times with the first occurrences of *Plummerita* and *Trititella*. The other group consists of taxa without meridional pattern in their ornamentation and the subfamily Archaeoglobigerininae subfam. nov. is now proposed to include the genera *Archaeoglobigerina*, *Bucherina*, *Kuglerina*, and *Rugotruncana*.

SYSTEMATIC DESCRIPTIONS

Order **Foraminiferida** Eichwald, 1830
 Suborder **Globigerinina** Delage & Hérouard, 1896
 Superfamily **Globotruncanacea** Brotzen, 1942
 Family **Rugoglobigerinidae** Subbotina, 1959
 Subfamily **Archaeoglobigerininae** subfam. nov.

Type genus. *Archaeoglobigerina* Pessagno, 1967, p. 315.

Description. Test trochospiral presenting globular chambers. Periphery broadly rounded with imperforate band, one faint keel, two more or less developed keels, or without any sort of peripheral structures. Main aperture umbilical in position. Umbilical system composed of delicate tegilla leaving proximal and distal accessory apertures. Chamber surface ornamented with scattered pustules, papillae and rugosities, which are never arranged in a meridional pattern.

Stratigraphical range. Coniacian throughout Maastrichtian.

Geographical distribution. Cosmopolitan.

Genera included:

1. *Archaeoglobigerina* Pessagno, 1967, p. 315; type species *Archaeoglobigerina blowi* Pessagno, 1967, p. 316, pl. 59, figs 1-10, pl. 94, figs 2-3.

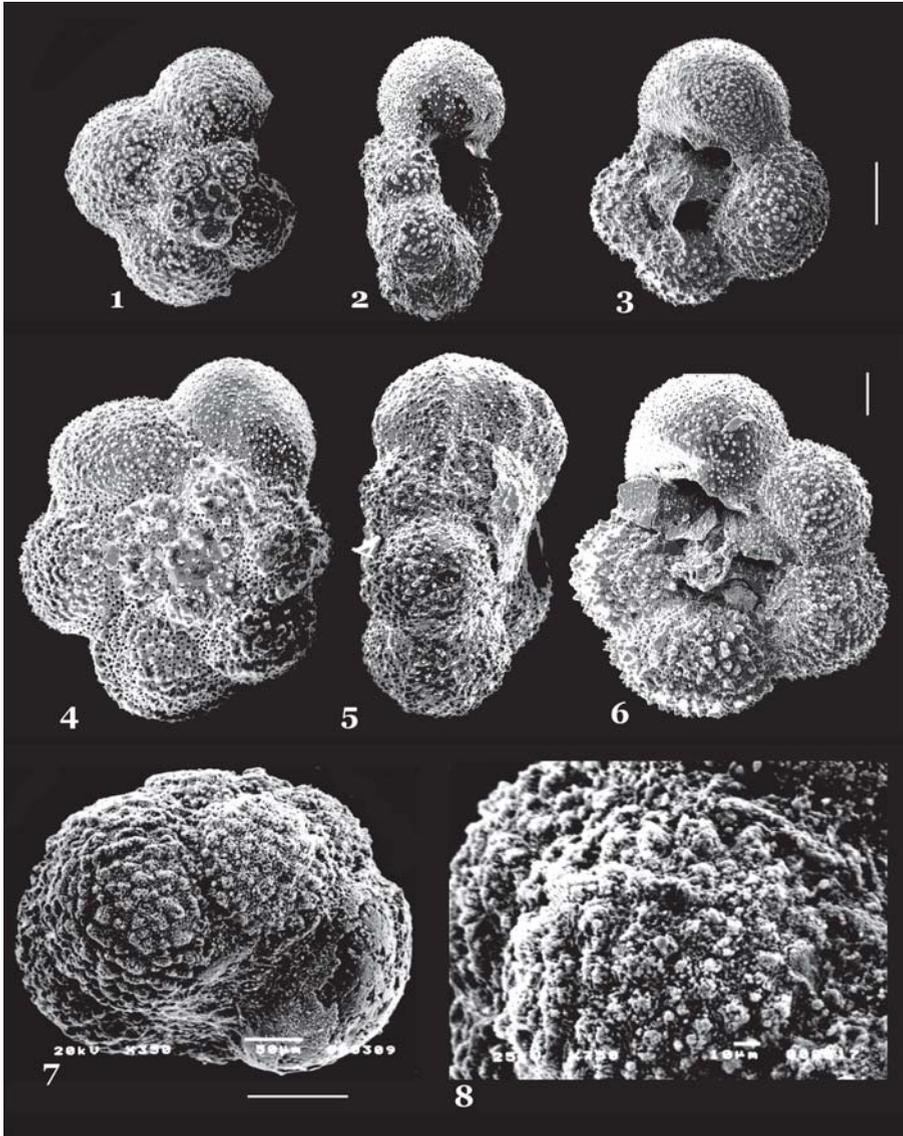


Fig. 2. Representatives of the subfamily Archaeoglobigerinae subfam. nov. *1-3* – *archaeoglobigerina blowi*, three specimens from the Upper Santonian Merchantville Formation of the New Jersey coastal plain subsurface (ODP Leg 174AX at the Bass River site), 1 – RMC-S3/102/505.38–40 m; 2 – RMC-S5/179/501.73–75 m; 3 – RMC-S4/156/497.15–17 m. *4-6* – *Archaeoglobigerina cretacea*, three specimens from the upper Santonian Merchantville Formation (4, 6) and uppermost Campanian Mount Laurel Formation (5) of the New Jersey coastal plain (ODP Leg 174AX at the Bass River site), 4 – RMC-S3/101/505.38–40 m; 5 – RMC-S2/068/399.55–57 m; 6 – RMC-S4/125/494.10–12 m. *7-8* – *Kuglerina rotundata*, specimen from the uppermost Unirea Formation, Lower Maastrichtian of the Romanian Black Sea offshore (PETROMAR well 40 Albatros, sample 40/10/3554–3563 m, specimen PC-ss001-46a (slightly oblique view). The scale bars account for 100 micrometers unless mentioned. Abbreviations: RMC – Rutgers Micropaleontological Collection, PC – PETROMAR Collection

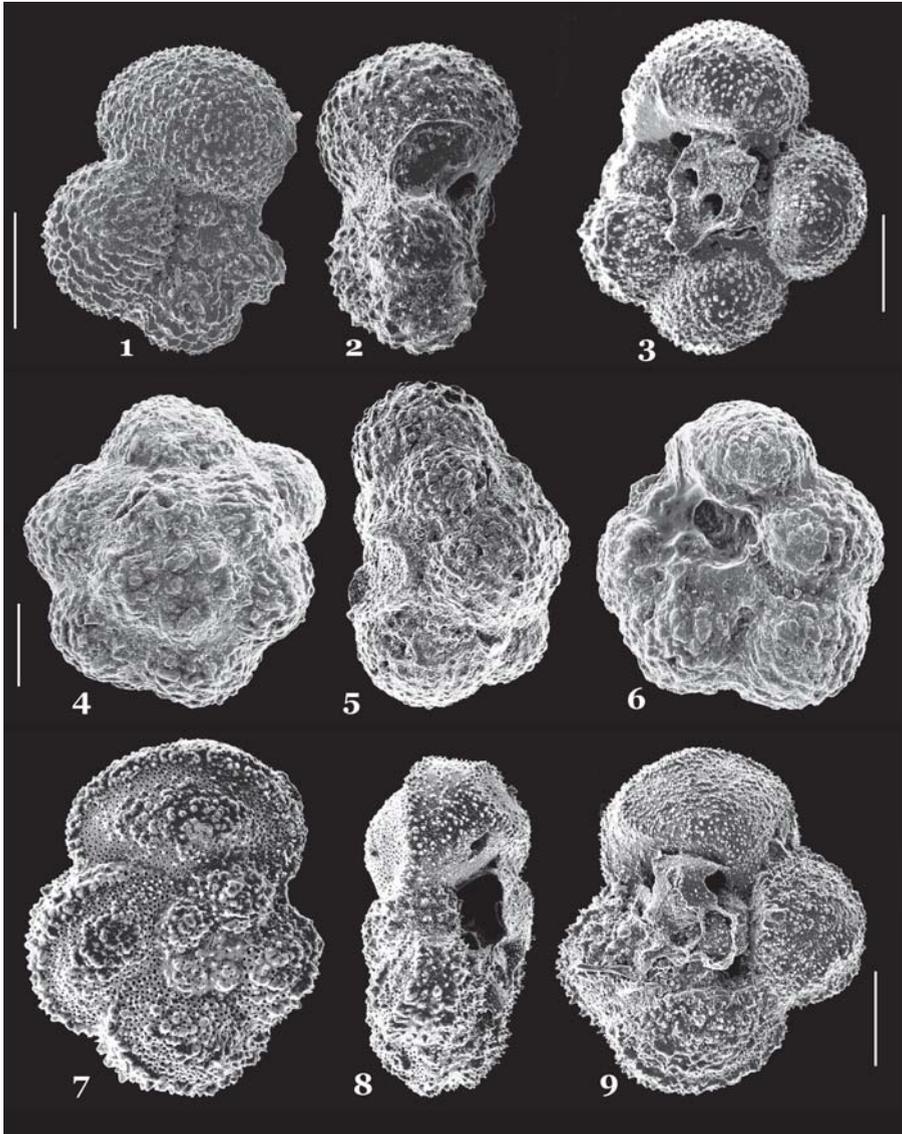


Fig. 3. Representatives of the subfamilies Rugoglobigerinae (1–6) and Archaeoglobigerinae subfam. nov. (7–9). **1, 2** – *Rugoglobigerina macrocephala*, two specimens from the Middle Maastrichtian Navesink Formation of the New Jersey coastal plain (RMC – Olsson collection). **3** – *Rugoglobigerina rugosa*, specimen from the lowermost Campanian Woodbury Clays of the New Jersey coastal plain subsurface (ODP Leg 174AX at the Bass River site), RMC-S10/061/435.84–86 m. **4–6** – *Rugoglobigerina pennyi*, three specimens from the uppermost Unirea Formation, Lower Maastrichtian of the Romanian Black Sea offshore (PETROMAR well 40 Albatros, sample 40/10/3554–3563 m, specimens PC-ss001-59b, c, d). **7–9** – *Rugotruncana subcircumnodifer*, three specimens from the Upper Campanian Marshalltown Formation of the New Jersey coastal plain (ODP Leg 174AX at Bass River site), **7** – RMC-S10/054/435.84–86 m; **8** – RMC-S10/053/435.84–86 m; **9** – RMC-S10/052/435.92–94 m. Scale bars account for 100 micrometers unless mentioned. Abbreviations: RMC – Rutgers Micropaleontological Collection, PC – PETROMAR Collection

2. *Bucherina* Brönnimann & Brown, 1956, p. 557; type species *Bucherina sandidgei* Brönnimann & Brown, 1956, p. 557, pl. 21, fig. 19, pl. 2, figs 19-21.

3. *Kuglerina* Brönnimann & Brown, 1956, p. 557; type species *Rugoglobigerina (Rugoglobigerina) rugosa rotundata* Brönnimann, 1952a, p. 34, pl. 4, figs 7-9.

4. *Rugotruncana* Brönnimann & Brown, 1956, p. 546; type species *Rugotruncana tilevi*, Brönnimann & Brown, 1956, p. 547, pl. 22, figs 1-3, junior synonym of *Globotruncana (Rugoglobigerina) circumnodifer subcircumnodifer* Gandolfi, 1955, p. 44, pl. 2, fig. 8.

Remarks. The subfamily *Helvetiellinae* was proposed to accommodate two alleged valid genera, *Helvetiella* and *Kuglerina* (Fig. 2: 7–8), being based mainly on the presence of “spinosopapillate ornamentation, consisting of massive papillae becoming axially elongated to form spines arranged in parallel rows latitudinally oriented, giving tests a roughened appearance” (Longoria & Gamper, 1984, p. 172). The systematic unit proposed by Longoria & Gamper (*op. cit.*) cannot be accepted for at least two reasons: (i) it encompasses only a part of the rather homogeneous group of the rugoglobigerinids without ornamental elements arranged following a meridional pattern (namely those with papillae), being thus of limited systematic significance, and (ii) the type genus is invalid, *Helvetiella* being regarded as a junior synonym of *Kuglerina* by Loeblich & Tappan (1988) and Georgescu (1996).

Subfamily *Rugoglobigerininae* Subbotina, 1959

Original description. *Rugoglobigerininae* Subbotina in Rauzer-Chernousova & Fursenko (1959, p. 303).

Type genus. *Rugoglobigerina* Brönnimann, 1952a, p. 16.

Description. Test very low, nearly flat to high trochospiral. Chamber surface strongly ornamented with pustules, rugosities and costellae following a meridional pattern. Periphery broadly rounded with incipient imperforate peripheral band, faint keel, spines, or lacking any sort of peripheral structures. Main aperture interiomarginal, umbilical in position. Umbilical system composed of delicate tegilla leaving both proximal and distal accessory apertures.

Stratigraphical range. Late Santonian through Maastrichtian.

Geographical range. Cosmopolitan.

Genera included:

1. *Plummerita* Brönnimann, 1952b, p. 146; type species *Rugoglobigerina (Plummerella) hantkeninoides hantkeninoides* Brönnimann, 1952a, p. 37, pl. 3, figs 1–3.

2. *Rugoglobigerina* Brönnimann, 1952a, p. 16; type species *Globigerina rugosa* Plummer, 1927, p. 38, pl. 2, fig. 10.

3. *Trititella* Brönnimann, 1952a, p. 56; type species *Trititella scotti* Brönnimann, 1952a, p. 57, pl. 4, figs 4–6.

CONCLUSIONS

Systematic revision of the family *Rugoglobigerinidae* by means of test morphology, stratigraphical and paleobathymetrical distribution revealed the fact that two lineages can be recognized within this group. Both of them originated in the shallow water globular morphotypes *Archaeoglobigerina* and *Rugoglobigerina*, the first evolutionary appearances of which are dated as Coniacian and Late Santonian respectively. The first lineage having *Archaeoglobigerina* as ancestral genus initiated an adaptative radiation in Late Campanian–Maastrichtian times. The *Rugoglobigerina* adaptative radiation is dated as latest Campanian–Maastrichtian. The two lineages are now conferred subfamily status. Apart from the morphological, stratigraphical and paleobathymetrical data, this interpretation seems to be supported by the lack of transitional specimens between taxa presenting a meridional arrangement of the ornamental elements and those lacking it.

Archaeoglobigerininae

(test ornamentation without meridional pattern)

Archaeoglobigerina

TH: nearly flat to low.

O: pustulose to costellate.

P & PS: broadly rounded presenting imperforate peripheral band bordered or not by two weak keels.

US: tegilla.



Bucherina

TH: low to moderately high.

O: papillose, rarely hispid.

P & PS: truncated presenting a faint keel or row of pustules in the earlier chambers of the final whorl.

US: tegilla.



Kuglerina

TH: high to very high.

O: pustulose to rugose.

P & PS: broadly rounded, without peripheral structures.

US: tegilla.



Rugotruncana

TH: low.

O: pustulose to rugose.

P & PS: truncated with imperforate band bordered by two equally developed keels throughout the final whorl.

US: portici then tegilla when adult.



Rugoglobigerininae

(ornamentation shows meridional arrangement)

Plummerita

TH: nearly flat to low.

O: rugose to costellate.

P & PS: rounded to compressed, spinose.

US: tegilla.



Rugoglobigerina

TH: nearly flat to high.

O: costellate, rarely rugose.

P & PS: broadly rounded, occasionally with imperforate peripheral band.

US: tegilla.



Trititella

TH: nearly flat to low.

O: costellate, rarely rugose.

P & PS: rounded to truncated with faint carinal band.

US: tegilla.



Fig. 4. Genera of the family Rugoglobigerinidae and their key features. Abbreviations as follows: TH – trochospire height, O – ornamentation, P & PS – periphery and peripheral structures, and US – umbilical system. Photograph sources other than the present article figures: *Bucherina* from Longoria & Gamber (1984, pl. 1, fig. 9), *Kuglerina* from Longoria & Gamber (1984, pl. 1, fig. 2), *Plummerita* from Robaszynski *et al.* (1984, pl. 50, fig. 7a), *Rugoglobigerina* from Robaszynski *et al.* (1984, pl. 50, fig. 3b), and *Trititella* from Robaszynski *et al.* (1984, pl. 50, fig. 4b). No scale implied.

REFERENCES

- Bé, A. W. H., 1977. An ecological, zoogeographic and taxonomic review of Recent planktonic foraminifera. In: Ramsay, A. T. S. (ed.), *Ocean Micropaleontology*. London Academic Press, 1: 1–100.
- Brönnimann, P., 1952a. Globigerinidae from the Upper Cretaceous (Cenomanian–Maastrichtian) of Trinidad, B. W. I. *Bulletin of American Paleontology*, 34 (140): 1–70.
- Brönnimann, P., 1952b. *Plummerita* new name for *Plumerella* Brönnimann, 1952 (not *Plummerella* De Long, 1942). *Contribution from the Cushman Foundation for Foraminiferal Research*, 3: 1–146.
- Brönnimann, P. & Brown, N. K., 1956. Taxonomy of the Globotruncanidae. *Eclogae Geologicae Helvetiae*, 48: 503–562.
- Caron, M., 1983. La spéciation chez les Foraminifères planctiques: une réponse adaptée aux contraintes de l'environnement. *Zitteliana*, 10: 671–676.
- Caron, M., 1985. Cretaceous planktic foraminifera. In: Bolli, H. M., Saunders, J. B. & Perch-Nielsen, K. (eds), *Plankton stratigraphy*. Cambridge University Press: 17–86.
- Caron, M. & Homewood, P., 1983. Evolution of the early planktic foraminifera. *Marine Micropaleontology*, 7: 453–462.
- El-Nakhal, H. A., 2002. Classification of the meridionally costellate Cretaceous planktonic foraminifera. *Journal of Micropaleontology*, 21: 1–8.
- Gandolfi, F., 1955. The genus *Globotruncana* in northeastern Colombia. *Bulletin of American Paleontology*, 36 (155): 1–118.
- Georgescu, M. D., 1996. Santonian–Maastrichtian planktonic foraminifers (Globigerinelloididae, Hedbergellidae, Globotruncanidae and Rugoglobigerinidae) in the Romanian Western Black Sea offshore. *Micropaleontology*, 42: 305–333.
- Georgescu, M. D., 1997. Upper Jurassic–Cretaceous planktonic foraminiferal succession and evolution of the Western Black Sea. In: Robinson, A. G. (ed.), *Regional and petroleum geology of the Black Sea and surrounding regions*. *American Association of Petroleum Geologists, Memoir*, 67: 169–182.
- Georgescu, M. D., 2003. Microfaunal abundance fluctuations in the Black Sea (Romanian offshore, Cretaceous to Pliocene). In: Leckie, M.R. & Olson, H. (eds), *Micropaleontologic proxies for sea-level change and stratigraphic discontinuities*. Society of Economic Paleontologists and Mineralogists, Special publication 75: 301–315.
- Haq, B. U., Hardenbol, J. & Vail, P. R., 1988. Mesozoic and Cenozoic chronostratigraphy and cycles of sea-level change. In: Wilgus, C. K., Hastings, B. S., Ross, C. A., Posamentier, H. W., Van Wagoner, J. C. & Kendall, C. G. St. C. (eds), *Sea-level changes: an integrated approach*. *Society of Economic Paleontologists and Mineralogists, Special Publication*, 42: 71–108.
- Hart, M. B., 1980. A water depth model for the evolution of the planktonic foraminifera. *Nature*, 286: 252–254.
- Huber, B. T., 1994. Ontogenetic morphometrics of some late Cretaceous trochospiral planktonic foraminifera from the Austral Realm. *Smithsonian Contributions to Paleobiology*, 77: 1–85.
- Loeblich, A. R. jr. & Tappan, H., 1982. Classification of the Foraminiferida. In: Broadhead, T. W. (ed.), *Foraminifera, notes for a short course*. University of Tennessee, Department of Geological Sciences, Studies in Geology, 6: 22–36.
- Loeblich, A. R. jr. & Tappan, H., 1984. Suprageneric classification of the Foraminiferida (Protozoa). *Micropaleontology*, 30: 1–70.
- Loeblich, A. R. jr. & Tappan, H., 1988. *Foraminiferal genera and their classification*. Van Nostrand Reinhold Company, New York, 1–970.
- Longoria, J. F. & Gamper, M. A., 1984. Subfamily Helvetiellinae, a new group of Late Cretaceous (Maastrichtian) planktonic foraminifera. *Micropaleontology*, 30: 171–179.
- Olsson, R. K., 1977. Mesozoic foraminifera – Western Atlantic. In: Swain, F. M. (ed), *Stratigraphic micropaleontology of Atlantic basin and borderlands*. Elsevier, Amsterdam: 205–230.

- Pessagno, E. A. jr., 1967. Upper Cretaceous planktonic foraminifera from the western Gulf Coastal Plain. *Palaeontographica Americana*, 5 (37): 243–445.
- Plummer, H. J., 1927. Foraminifera from the Midway Formation in Texas. *Bulletin, University of Texas Bureau of Economic Geology and Technology*, 2644: 1–206.
- Premoli Silva, I. & Sliter, W. V., 2002. *Practical manual of Cretaceous planktonic foraminifera*. International School on Planktonic Foraminifera, 1st course: Cretaceous, Perugia 18–22 February 2002, 1–462.
- Rauzer-Chernousova, D. M. & Fursenko, A. V. (eds), 1959. *Principles of Palaeontology*, part 1, Protozoa (in Russian). Akademia Nauk SSSR: 1–482, Moscow.
- Robaszynski, F., Caron, M., Gonzalez Donoso, J. M., Wonders, A. H. & The European Working Group on Planktonic Foraminifera, 1984. Atlas of late Cretaceous globotruncanids. *Revue de Micropaléontologie*, 26: 145–305.
- Subbotina, N. N., 1959. Planktonic foraminifera. In: Rauzer-Chernousova, D. M. & Fursenko, A. V. (eds), *Principles of paleontology*, part 1, Protozoa (in Russian). Moscow, Akademia Nauk SSSR: 1–368.
- Wonders, A. A. H., 1980. Middle and late Cretaceous planktonic foraminifera of the Western Mediterranean area. *Utrecht Micropaleontological Bulletin*, 24: 1–157.