# Twin and bilobated chambered Cretaceous planktonic foraminifera: abnormal forms induced by high paleoenvironmental stress?

*Alberto Venturati*

Centro di Ricerca di Micropaleontologia Ambientale, 61100 Pesaro, Italy; E-mail: crma_ps@libero.it

**Key words:** foraminifera, test abnormalities, paleoecology, Cretaceous, Recent

**Abstract.** Several specimens of Cretaceous planktonic foraminifera are characterized by twin or double globular to subglobular chambers in the last whorl. This peculiar shape of the test and/or chambers arrangement, seems to be also a frequent feature of few recent benthic foraminifera living in high polluted transitional marine environments. The occurrence of twin and additional chambers may be attributed to natural and anthropogenic high paleoenvironmental perturbations. Bilobate last chamber planktonic foraminifera are proposed for the first time as possible teratological forms of Cretaceous planktonic foraminifera species. These forms, without any taxonomic value, may be used as potential proxies of paleoenvironmental stress.

## Introduction

The mid-Cretaceous period was a time characterized by the prevailing of greenhouse conditions induced by high concentrations of $pCO_2$ in atmosphere (Caldeira, Rampino, 1993), triggered by the remarkable ocean crust production (Larson, 1991a, b). These extraordinary warm conditions were accompanied by a high sea-level rising (Haq et al., 1987) and a subsequently accelerated hydrological cycle (Weissert et al., 1998). An important feature of the mid-Cretaceous record is the repeated occurrence of world-wide deposition of organic-rich sediments defined as Oceanic Anoxic Events (OAEs of Schalanger and Jenkyns, 1976). OAEs are retained to be geologically short-term paleoenvironmental perturbations that affected severely oceanic plankton communities. Species turnover rates of 25-50% of the total radiolarian assemblages and 20-30% of the planktonic foraminiferal assemblages for the mid-Cretaceous OAEs, have been recently reported respectively by Erbacher and Thurow (1997) and Leckie et al. (2002). Planktonic foraminifera provide useful records for any paleoecological and paleoceanographical changes in surface to subsurface waters during these high stress paleoenvironments. Moreover, planktonic foraminiferal test morphology, shape and chambers arrangement could be excellent tools for (paleo)environmental reconstructions.

The aims of this paper are: (1) to propose planktonic foraminifera with twin final chambers in the last whorl as possible teratological forms of several Cretaceous planktonic foraminifera species, induced by natural stressed conditions, and (2) to value teratological forms as important and potential proxies of paleoenvironmental perturbations.

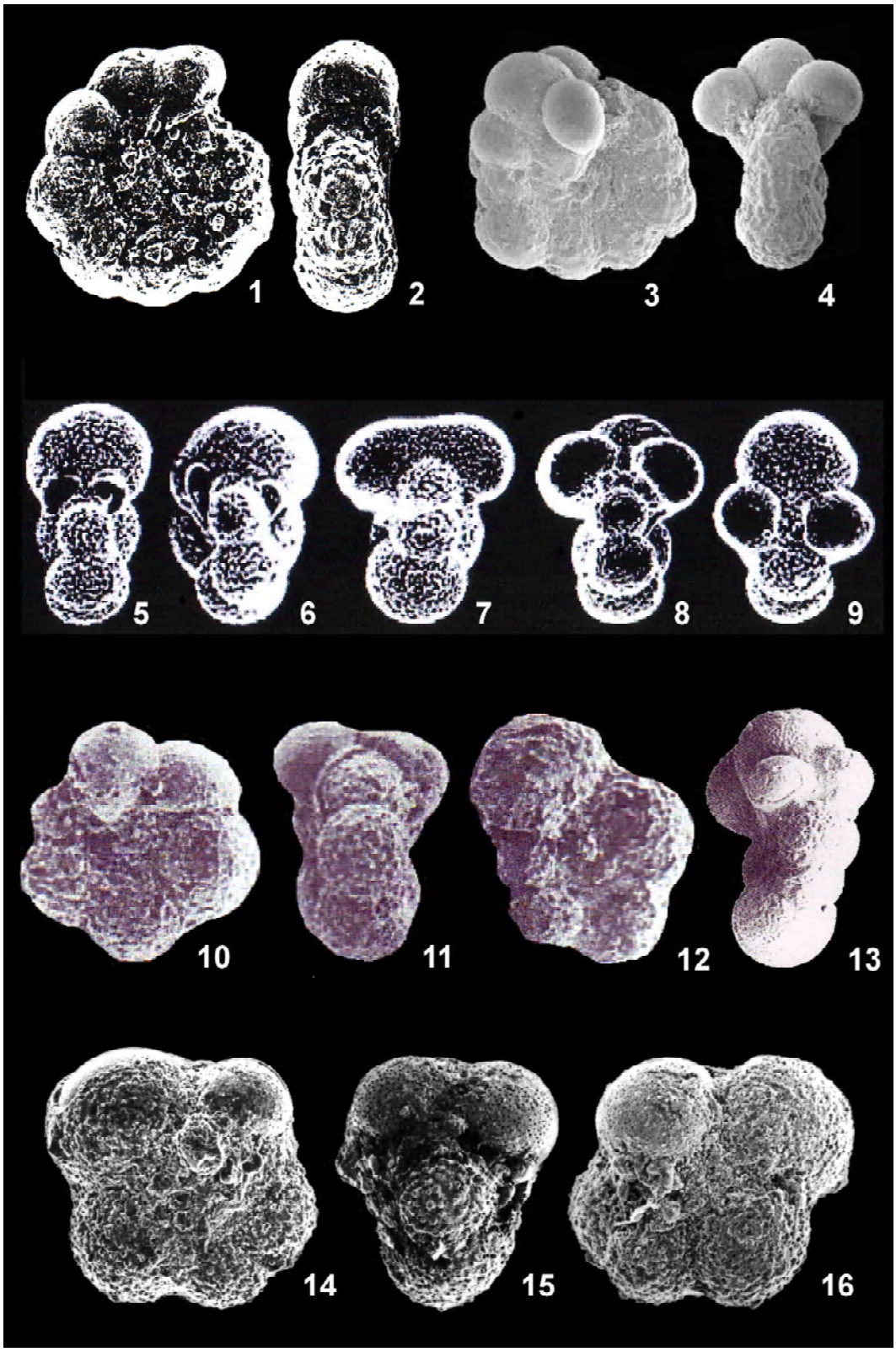
## Cretaceous planktonic foraminiferal species with twin last chambers

Following Moullade et al. (2002) only two species of planktonic foraminifera with twin last chambers are largely accepted: *Globigerinelloides barri* (Bolli et al., 1957) of Aptian age and *G. multispina* (Lalicker, 1948) of upper Santonian to Maastrichtian age. On the contrary, the species *Biglobigerinella algeriana* described by Ten Dam and Sigal (1949) is retained to be a junior synonym of *G. multispina*. On the basis of previous literature data, here I report a list of micropaleontological observations on Cretaceous double-chambered end stage forms. It is well evident that the twin chambered arrangement, seems to be a frequent feature of several mid-Cretaceous planktonic foraminifera species belonging to Aptian-Albian genera as *Globigerinelloides*, *Hedbergella*, *Ticinella* and *Biticinella*.

## Aptian forms

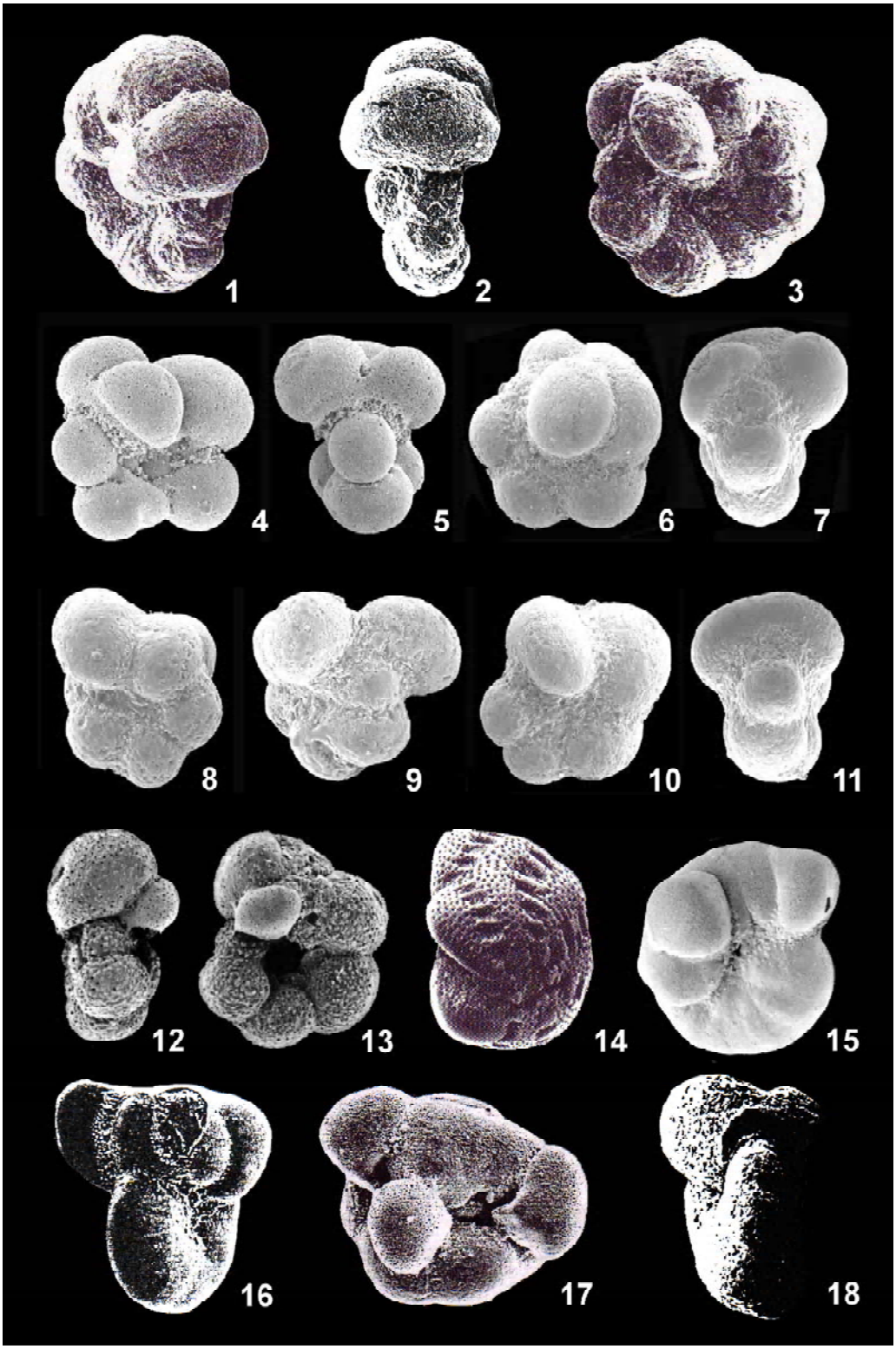
*Biglobigerinella sigali* was described by Chevalier (1961) as a form very similar to *Globigerinelloides ferreolensis*, but possessing bilobate final chambers.

**PLATE I**




1-2. Globigerinelloides barri (normal shape); 3-4. Globigerinelloides barri (bilobated shape); 5-9. Globigerinelloides multispina (from Lalicker, 1948); 10-12. Globigerinelloides multispina (from Petrizzo, 2000); 13. Hedbergella subcretacea (from Lipson-Benitah and Almogi-Labin, 2000); 14-16. Biticinella sp. (from Bellier, 1998)

**PLATE II**




1-3. Globigerinelloides ferreolensis stade “Biglobigerinella” (from Moullade et al., 1998); 4-11. Globigerinelloides blowi (from Verga, Premoli Silva, 2003a); 12-13. Ticinella cf. roberti (from Bellier, 1998); 14. Cribroelphidium gunteri (from Coccioni, 2000); 15. Haynesina paucilocula (from Venturati, 2003); 16. Haynesina germanica (from Sharifi et al., 1991); 17. Ammonia beccarii (from Almogi-Labim et al., 1992); 18. Cribrostomoides kosterensis (from Alve, 1991)

Specimens of *G. ferreolensis* stade "*Biglobigerinella*" with reniform and twin final chambers was reported by Moullade et al. (1998). Verga and Premoli Silva (2003) well illustrated some specimens of *G. blowi* possessing one or more final twin chambers.

## Albian forms

Atypical specimens of planktonic foraminifera with additional final chamber and bilobate final chambers are respectively referred by Bellier (1998) to *Ticinella* cf. *roberti* and *Biticinella* sp. Uncommon specimen of *Hedbergella subcretacea* showing twin last chambers is illustrated by Lipson-Benitah and Almogi-Labin (2000).

## Discussion

As reported above, several forms of mid-Cretaceous planktonic foraminifera are characterized by bilobate-twin last chambers and additional final chamber. Speculating on this peculiar shape of the test and/or chambers arrangement, I can suppose a parallelism among modern benthic foraminifera and Cretaceous planktonic foraminifera. In fact recent investigations focused on high stressed transitional marine environments, have permitted to detect that bilobation seems to be also a common and noticeable feature of recent teratological benthic foraminifera. The development of additional and double last chambers is retained to be a test abnormality which is induced by different kinds of marine pollution or extreme natural environmental conditions. Remarkable high percentages of benthic foraminifera with twin or additional last chambers are usually found in marine environments, exposed to elevated heavy metal concentrations (e.g.; Alve, 1991; Sharifi et al., 1991; Coccioni, 2000; Venturati, 2003) or recognized in unpolluted habitat, but characterized by strong variations of chemical and physical parameters of the water masses (e.g.; Almogi-Labin et al., 1992).

## Conclusions

Several specimens of planktonic foraminifera with twin last chambers are wide distributed in the Aptian-Albian time. Successively, only the species *G. multispina* that usually displays bilobation in the final chambers is reported from Santonian to Maastrichtian (e.g.; Petrizzo, 2000). The occurrence of bilobated forms during the Cretaceous time could be related to the world-wide distribution of OAEs and/or global climatic variations. In fact, the increase in primary productivity, the drastic change of the food supply and the onset oxygen depleted paleoenvironments may induced the development of additional final chambers and bilobation. Therefore, I retain planktonic foraminifera with twin and bilobated final chambers as teratological forms without any taxonomic value, that may be used as potential proxies of paleoenvironmental stress.

## References


Almogi-Labin, A., L. Perelis-Grossovicz, M. Raab. 1992. Living *Ammonia* from hypersaline inland pool, Dead Sea area, Israel. — *Journal of Foraminiferal Research, 22,* 257—266.

Alve, E. 1991. Benthic foraminifera in sediment cores reflecting heavy metal pollution in Sorfjord, western Norway. — *Journal of Foraminiferal Research, 21,* 1—19.

Bellier, J.-P. 1998. Cretaceous planktonic foraminifers, eastern equatorial Atlantic. — In: Mascle, J., G. P. Lohmann, M. Moullade (Eds.). *Proceedings of the Ocean Drilling Program, Scientific Results, 159,* 335—345.

Bolli, H. M., A. R. Loeblich, H. Tappan. 1957. Planktonic foraminiferal families *Hantkeninidae*, *Orbulinidae*, *Globorotaliidae*, and *Globotruncanidae*. — *U.S. Natural Museum Bulletin, 215,* 3—50.

Caldeira, K., M. R. Rampino. 1993. Aftermath of the end-Cretaceous mass-extinction. Possible stabilization of the carbon cycle and climate. — *Paleoceanography, 8,* 515—525.

Chevalier, J. 1961. Quelques nouvelles espèces dans le Crétacé inférieur méditerranéen. — *Revue de Micropaleontologie, 4,* 30—36.

Coccioni, R. 2000. I foraminiferi bentonici della Sacca di Goro (Italia) e la loro possibile utilizzazione come bioindicatori dell'inquinamento da metalli pesanti. — *Studi Costieri, 2,* 199—215.

Erbacher, J., J. Thurow. 1997. Influence of oceanic anoxic events on the evolution of mid-Cretaceous radiolaria in the North Atlantic and western Tethys. — *Marine Micropaleontology, 29,* 139—158.

Haq, B. U., J. Hardenbol, P. R. Vail. 1987. Chronology of fluctuating sea levels since the Triassic. — *Science, 23,* 1156—1167.

Lalicker, C. G. 1948. A new genus of foraminifera from the Upper Cretaceous. — *Journal of Paleontology, 22,* 624.

Larson, R. L. 1991a. Latest pulse of Earth: evidence from a mid-Cretaceous superplume. — *Geology, 19,* 547—550.

Larson, R. L. 1991b. Geological consequences of superplumes. — *Geology, 19,* 963—966.

Leckie, M. R., T. J. Bralower, R. Cashman. 2002. Oceanic anoxic events and plankton evolution: Biotic response to tectonic forcing during the mid-Cretaceous. — *Paleoceanography, 17,* 1041, doi: 10.1029/2001PA000623

Lipson-Benitah, S., A. Almogi-Labin. 2000. Albian planktonic foraminifera from Israel. — *Geological Survey of Israel Bulletin, 86,* 1—50.

Moullade, M., G. Tronchetti, W. Kuhnt, J.-P. Masse. 1998. Les foraminiferès benthiques et planctoniques de la séries du Stratotype Historique de l'Aptien inférieur dans la rérion de Cassis — La Bédoule (SE France). — *Géol. Méditerranéenne, 25,* 187—225.

Moullade, M., J.-P. Bellier, G. Tronchetti. 2002. Hierarchy of criteria, evolutionary processes and taxonomic simplification in the classification of Lower Cretaceous planktonic foraminifera. — *Cretaceous Research, 23,* 111—148.

Petrizzo, M. R. 2000. Upper Turonian-lower Campanian planktonic foraminifera from southern mid-high latitudes (Exmouth Plateau, NW Australia): biostratigraphy and taxonomic notes. — *Cretaceous Research, 21,* 479—505.

Schalanger, S. P., H. C. Jenkyns. 1976. Cretaceous oceanic anoxic events: causes and consequences. — *Geologie en Mijnbouw, 55,* 179—184.

Sharifi, A. R., L. W. Croudace, R. L. Austin. 1991, Benthic foraminiferids as pollution indicators in Southampton Water, southern England, U.K. — *Journal of Micropaleontology, 10,* 109—113.

Ten Dam, A., J. Sigal. 1949. Sur une espèce du genre de Foraminifères *Biglobigerinella* Lalicker, 1948. — *Compte Rendu Sommaire des Séances de la Société Géologique de France, 11,* 234—235.

Venturati, A. 2003. *Foraminiferi e stress ambientale: casi studio nel Cretacico e nel Recente.* Unpublished Ph. D. Thesis, Universita di Urbino, Urbino, Italy, 1—179.

Verga, D., I. Premoli Silva. 2003. Early Cretaceous planktonic foraminifera from the Tethys: the large, many-chambered representative of the genus *Globigerinelloides*. — *Cretaceous Research, 24,* 305—334.

Weissert, H., A. Lini, K. B. Föllmi, O. Kuhn. 1998. Correlation of Early Cretaceous carbon isotope stratigraphy and platform drowning events. — *Palaeogeog., Palaeoclim., Palaeoecol., 137,* 189—203.