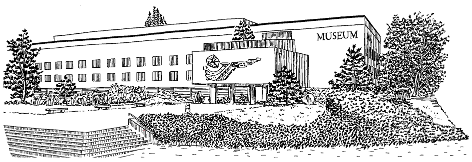
REVUE DE
PALÉOBIOLOGIE

ISSN 1661-5468

VOL. 31, N° 2, 2012



Muséum d'Histoire Naturelle • Ville de Genève • Suisse

Revue de Paléobiologie, *Genève* (décembre 2012) 31 (2): 303-312 ISSN 0253-6730

Biostratigraphy and stepwise extinctions of the larger foraminifera during Cenomanian (Upper Cretaceous) of Gebel Um Horeiba (Mittla Pass), west-central Sinai, Egypt

Orabi H.Orabi[1], Reefat A. Osman[2], Gamal M. El Qot[2] & Adel M. Afify[2]

Abstract

Ten benthic larger foraminifera species *Cisalveolina* cf. *lehneri* (Reichel, 1941), *C. frassi* (Gűmbel, 1872), *Sellialveolina viallii* Colalongo, 1963, *Reticulinella reicheli* (Cuvillier *et al*., 1969), *Orbitolina* (*Mesorbitolina*) *texana* (Roemer, 1849), *Spiroloculina cenomana* Chiocchini, 2008, *Spirosigmoilina* sp*.*, *Cuneolina cylindrica* Henson, *Palaeosigmoilopsis apenninica* Chiocchini, 2008, and *Praechrysalidina infracretacea* Luperto Sinni, 1979 have been recorded from the Cenomanian sediments of west-central Sinai for the first time. Due to the scarcity of index fossils such as ammonites and planktonic foraminifera and the high-diversity of the larger foraminifera species, three biozones have been recorded during Cenomanian based on larger foraminifera. In addition, two step patterns extinctions of larger foraminifera have been observed in the Late Cenomanian shallow-water carbonates of the studied area. The first step (E1) occurs at the middle part of the larger foraminifera *Praealveolina cretacea* Zone and the second one (E2) occurs near the top of the same latter zone with low-diversity of miliolids and textularids. The latter two extinction events (E1 & E2) are correlated with the record of sea-level change of eustatic curve of Haq *et al*. (1988).

Keywords

Larger Foraminifera, Cenomanian, Biostratigraphy, Palaeoecology, Sinai, Egypt.

1. INTRODUCTION

Despite the high-diversity of larger foraminifera in the Middle East and Egypt during Cenomanian, few publications were carried out (e.g., Orabi, 1992; El Sheikh & Hewaidy, 1998; Shahin & El Baz, 2010). The larger benthic foraminifera show rapid diversification and abrupt extinctions in the shallow water carbonate platform (Gräfe, 2005). Therefore it is possible to use this group of fauna as index fossils in biostratigraphy. In addition and according to Parente *et al*., (2008), two step patterns of extinction of larger foraminifers during the Cenomanian are documented and these events were probably due to changes in nutrient availability during OAE2.

The aim of the present study is to identify the benthic larger foraminifera during Cenomanian of Gebel Um Horeiba (Mittla Pass), west-central Sinai. In addition, the biostratigraphy based on larger foraminifera during that time is also discussed and compared with other countries of the Mediterranean region.

The studied section (Mittla Pass) is located in the west-central part of the Sinai Peninsula, Egypt. It is bounded between Lat. 30° 1'N and Long. 32° 53' E. The studied section is far away about 50 km of Suez and surrounded by Sadr El Heitan- El Hassana road to the East, El Giddi pass and Gebel Um Minsherah to the North (Fig. 1).

2. GEOLOGICAL SETTING

According to Kuss & Bachmann (1996) and Bauer *et al*. (2003) the most important Mesozoic-Early Tertiary tectonic events recorded in northeast Africa are: (1) Late Triassic-Early Jurassic E-W directed rifting and opening of the Neo-Tethyan Ocean, which is evident from major subsurface graben and basin structures of the unstable shelf. They were proven along the NE-SW trending Trans-Africa Lineament, and were followed by a period of relative tectonic quiescence (Aptian-Turonian). (2) NW-SE convergence of the Afro-Arabian and Eurasian plates resulting in transgressive inversion along the pre-existing ENE-trending half graben structures from the Turonian onwards, and involving several phases of lateral strike-slip faulting and gentle folding (Guiraud, 1998), referred to as the Syrian Arc System (Krenkel, 1924). The ENE-WSW trending domal anticlines in northern Sinai are part of this intraplate fold belt, which extends from the Sinai Negev Fold Belt in northern Egypt and Israel to the Palmyride Fold Belt of Syria. The area under

[1] *Menoufia University, Faculty of Science, Geology Department, Shiben El Kom, Egypt. E-mail: oraby1952@yahoo.com*

[2] *Banha University, Faculty of Science, Geology Department, Banha city, Egypt. E-mail: g_elqot@yahoo.com*

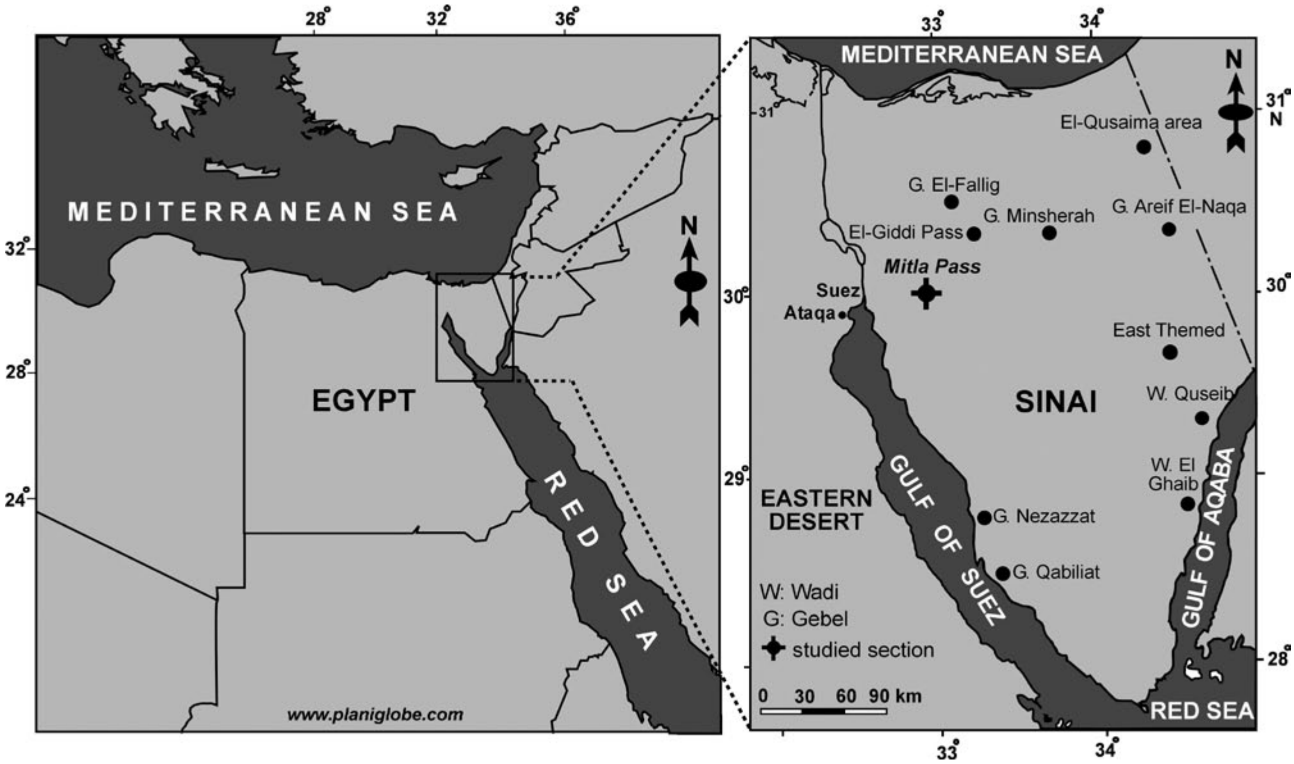


Fig. 1: Locality map.

investigation (Mitla Pass) is related to the tectonics of the Syrian arc system that extends through the northern part of Sinai and forms a series of fold belts such as Gebel Halal, Gebel Maghara, Gebel Yelleg, Gebel Minsherah and Gebel Um Horeiba.

3. STRATIGRAPHY

3.1. Galala Formation (Cenomanian)

The term Galala Formation was preferred to describe the Cenomanian rocks of the studied section. This Formation attains about 305 m thick at Gebel Um Horeiba and is composed of mixed siliciclastics and carbonate rocks (Fig. 2). It consists of limestone and dolomitic limestone with shales, clays and fossiliferous marl interbeds. The Galala Formation has been subdivided into two informal members; the lower marly-shaly member (165 m thick), and the upper carbonate member (140 m thick) at Gebel Um Horeiba. The basal part of the Galala Formation is not exposed while the upper part (near C-T boundary) is represented by red dolostone and sandy dolostone beds. The latter beds are directly followed by the ammonite bed of the Abu Qada Formation [e.g., *Choffaticeras* (*Choffaticeras*) *segne*].

Twenty-one larger foraminiferal species have been identified from this formation. They are *Cisalveolina fraasi* (GUEMBEL, 1872), *C.* cf. *lehneri* REICHEL (1941), *Biconcava bentori* HAMAOUI & SAINT-MARC (1970), *Orbitolina* (*Mesorbitolina*) *texana* (ROEMER, 1849), *Reticulinella reicheli* CUVILLIER *et al*. (1969), *Praealveolina iberica* REICHEL (1936), *P. cretacea* (D'ARCHIAC, 1837), *P. tenuis* REICHEL (1933), *Sellialveolina viallii* COLALONGO (1963), *Cuneolina cylindrical* HENSON, (1948), *C. parva* HENSON (1948), *C. pavonia* D'ORBIGNY (1846), *Nezzazata concava* (SMOUT, 1956), *Palaeosigmoilopsis apenninica* CHIOCCHINI (2008), *Spiroloculina cenomana* CHIOCCHINI (2008), *Spirosigmoilina* sp., *Quinqueloculina* sp., *Praechrysalidina infracretacea* LUPERTO SINNI (1979), *Pseudormarssonella* sp., *Pseudorhapydionina laurinensis* (DE CASTRO, 1965), and *Pseudorhipidionina casertana* DE CASTRO (1965) (Figs. 3-5).

3.2. Abu Qada Formation (Late Cenomanian-Early Turonian)

The Abu Qada Formation attains about 75 m thick, and consists mainly of dolostones, limestones, and marls with minor sand intercalations. The limestone beds are grey, thinly laminated, marly, and fossiliferous with ammonites. Based on ammonites, the Abu Qada Formation is assigned herein to Late Cenomanian-Early Turonian. In addition, the Cenomanian-Turonian boundary is placed in the lower part of the Abu Qada Formation between the extinction of the Late Cenomanian oysters (e.g.,

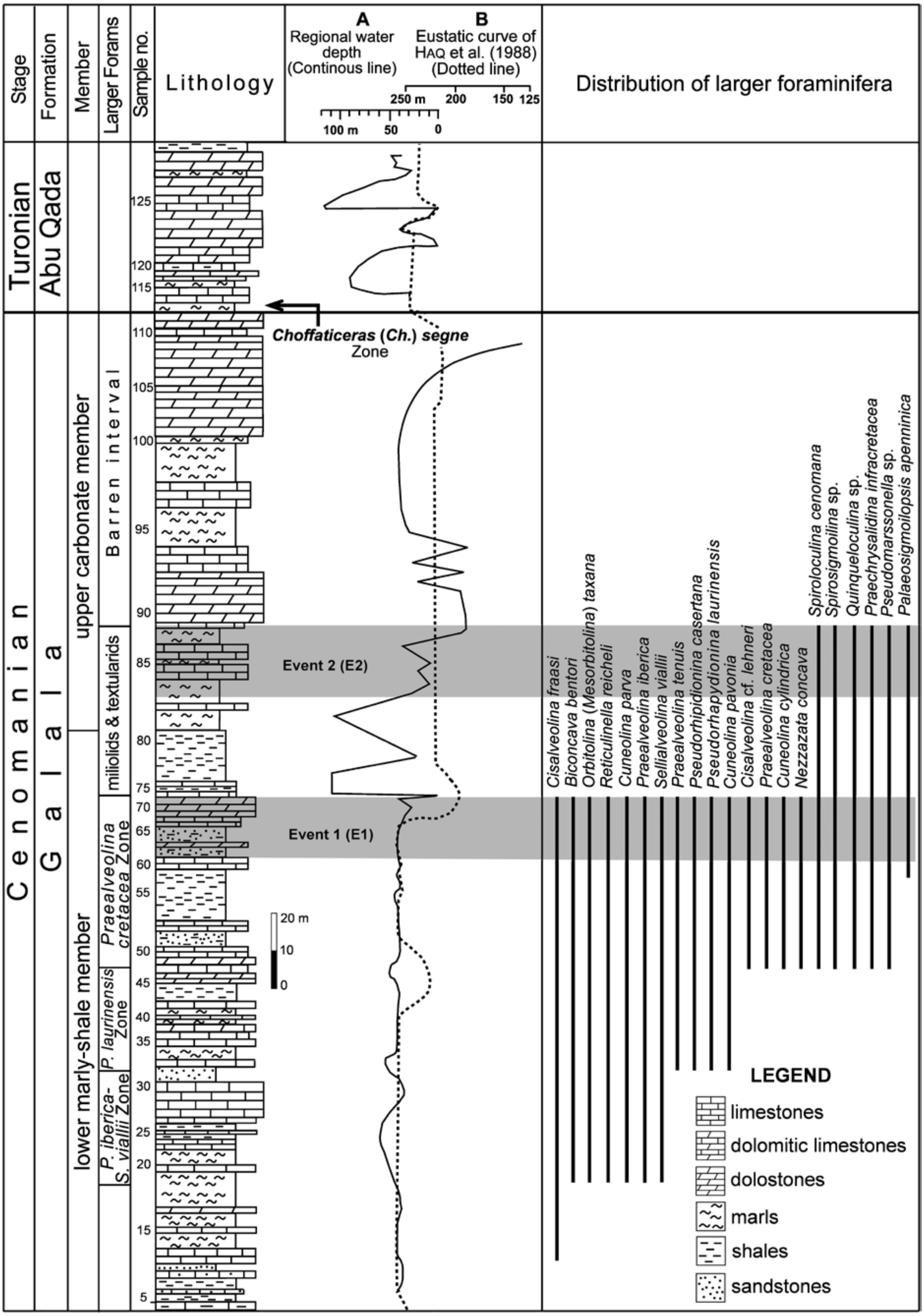


Fig. 2: Lithology and distribution of larger foraminifera along the Cenomanian-Turonian succession of Gebel Um Horiba (Mittla Pass). Note the two step patterns of extinction (E1, E2) of larger foraminifers along the Cenomanian Galala Formation of the studied section.

Costagyra olisiponensis Sharpe) and the appearance of early Middle Turonian ammonite *Choffaticeras* (*Ch.*) *segne* (Fig. 2).

4. MATERIAL AND METHODS

One section was described and measured bed-by-bed from the Cenomanian sediments of west-central Sinai in order to obtain a complete vertical succession with lithology, nature of contact, and faunal content (Fig. 2). These data was obtained from several field trips, which performed during 2009-2010. Most foraminiferal samples derive from shale, marl and foraminiferal-molluscan wackestones at interval of 165 m of the lower marly shale member of the Cenomanian Galala Formation. In order to identify the larger benthic foraminifera, fifty rock samples were collected to cover all possible rock varieties in the stratigraphic section, and about thirty thin-sections were prepared. These studies were carried to be a complement with the biostratigraphic studies. The material has been deposited in the Museum of the Geology Department, Banha University, under the collection prefix MU.B.UNI.S.

5. BIOSTRATIGRAPHY

The stratigraphic distribution of the identified larger foraminiferal species enabled the subdivision of the Cenomanian succession of the studied section into three biozones from the base to top: *Praealveolina iberica-Sellialveolina viallii* Zone (Early Cenomanian), *Pseudorhapydionina laurinensis* Zone (Middle Cenomanian), and *Praealveolina cretacea* Zone (Late Cenomanian). The proposed biozones are correlated and compared with similar taxa recorded from the Cenomanian sediments in the Mediterranean realm (e.g. Hamaoui & Saint-Marc, 1970; Schroeder & Neumann, 1985; Hallock, 2000; Hottinger, 2006; Ghabeishavi *et al.*, 2010).

5.1 *Praealveolina iberica-Sellialveolina viallii* Zone (Early Cenomanian)

The *Praealveolina iberica-Sellialveolina viallii* Zone is defined by the first appearance (FA) of *Praealveolina iberica* and *Sellialveolina viallii* at the base and the FA of *Pseudorhapydionina laurinensis* at the top. This zone comprises about 32.5 m from the lower part of the lower marly-shale member of the Galala Formation at the Um Horeiba section. The *P. iberica-S. viallii* Zone is fossiliferous with other larger foraminiferal species such as *Cisalveolina frassi* (Gűmbel, 1872), *Orbitolina* (*Mesorbitolina*) *texana* (Roemer, 1849), *Biconcava bentori* Hamaoui & Saint-Marc, 1970, *Reticulinella reicheli* (Cuvillier *et al.*, 1969) and *Cuneolina parva* Henson, 1948. Based on the latter assemblage, this zone is assigned to Early Cenomanian. The present zone is equivalent to *Praealveolina iberica-Daxia cenomana-Merlingina* Zone from the early Cenomanian of Spain and France by Bilotte (1985) and to the lower part of Early Cenomanian *Sellialveolina viallii* Zone of Greece by Fleury (1980) (Fig. 6).

5.2 *Pseudorhapydionina laurinensis* Zone (Middle Cenomanian)

The zone is defined by the FA of *Pseudorhapydionina laurinensis* at the base and the FA of *Praealveolina cretacea* at the top. It is represented by 30 m thick at the middle part of lower marly-shale member of the Galala Formation. The *P. laurinensis* Zone is highly fossiliferous with other larger foraminifera species such as *Praealveolina tenuis* Reichel, 1933, *Pseudorhipidionina casertana* (De Castro, 1965), *Cuneolina pavonia* d'Orbigny, 1839, *Cisalveolina frassi* (Gűmbel, 1872), *Sellialveolina viallii* Colalongo, 1963, *Biconcava bentori* Hamaoui & Saint-Marc, 1970, *Orbitolina* (*Mesorbitolina*) *texana* (Roemer, 1849), *Reticulinella reicheli* (Cuvillier *et al.*, 1969), *Praealveolina iberica* Reichel, 1936, and *Cuneolina parva* Henson, 1948. This zone is equivalent to the lower two-third of the Middle Cenomanian *Pseudorhapydionina dubia-Pseudorhapydionina laurinensis* Zone of Italy by Chiocchini & Mancinelli (2001) and Chiocchini (2008) and the Middle Cenomanian *Orbitolina* (*Conicorbitolina*) *conica* Zone of Spain and France by (Bilotte, 1985) (Fig. 6).

5.3 *Praealveolina cretacea* Zone (Late Cenomanian)

This zone is defined by the FA of *Praealveolina cretacea* at the base and the LA of all larger benthic foraminifera and Miliolidae at the top. The *P. cretacea* Zone attains a thickness of 97.5 m thick at the upper part of the lower marly-shale member and the basal part of the upper carbonate member of the Cenomanian Galala Formation. The zone is associated with other larger foraminiferal species such as *Cuneolina cylindrica* Henson, 1948, *Spiroloculina cenomana* Chiocchini, 2008, *Quinqueloculina* sp., *Spirosigmoilina* sp., *Nezzazata concava* (Smout, 1956), *Praechrysalidina infracretacea* Luperto Sinni, 1979, *Palaeosigmoilopsis apenninica* Chiocchini, 2008, *Cisalveolina* cf. *lehneri* (Reichel, 1941) and *Pseudomarssonella* sp. In addition, the *cretacea* Zone topped by six miliolids and textularids species, which are: *Palaeosigmoilopsis apenninica, Spiroloculina cenomana, Spirosigmoilina* sp., *Quinqueloculina* sp., *Praechrysalidina infracretacea*, and *Pseudormarssonella* sp. survived during this event, to become extinct ~52 m higher, at a level that can be

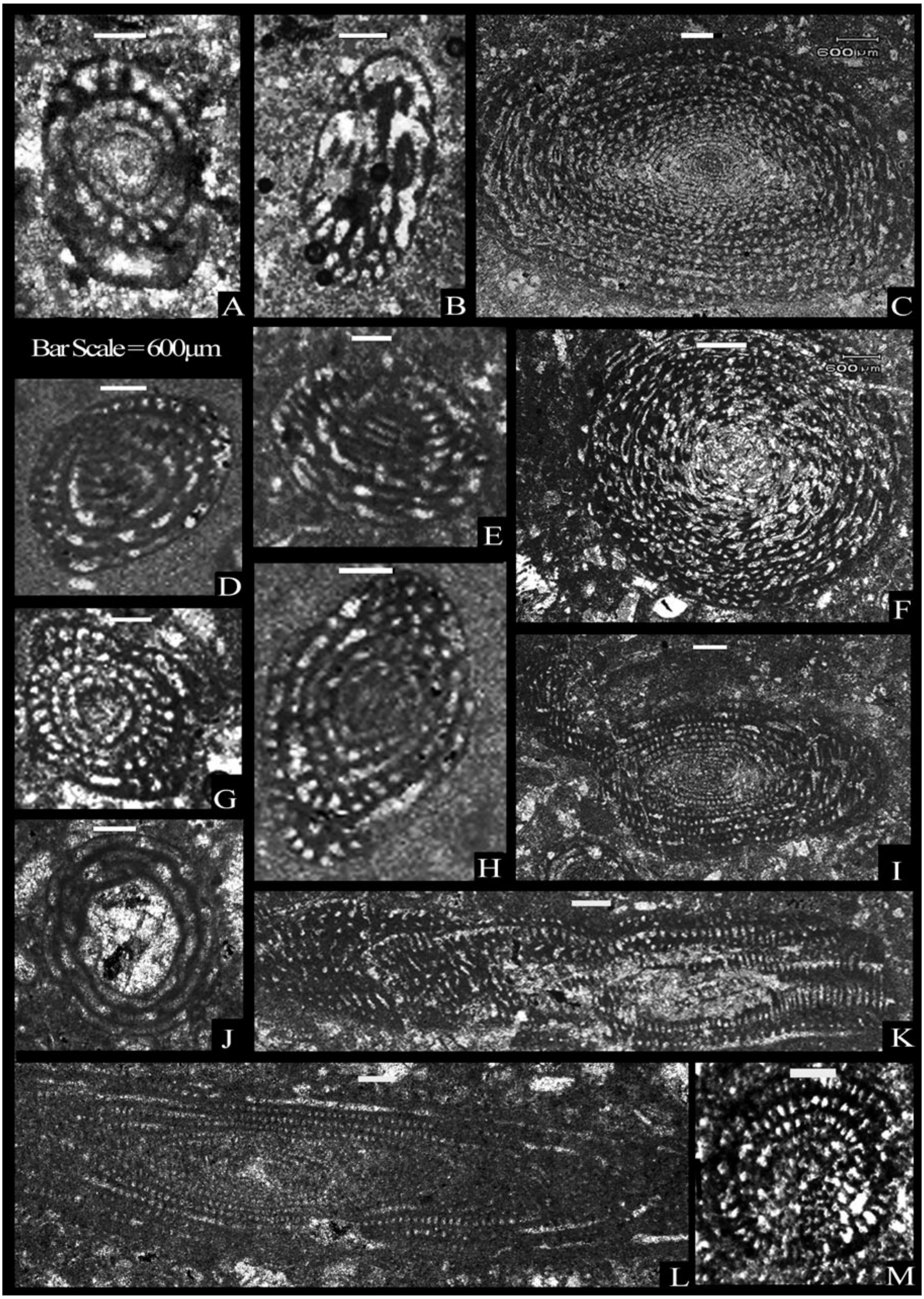


Fig. 3: A, M: *Cisalveolina frassi* (GŰMBEL, 1872), Axial section; MU.B.UNI.S.11, 47. B, H: *Sellialveolina viallii* COLALONGO, 1963, Tangential section; MU.B.UNI.S. 19, 59. C, I, K, L) *Praealveolina cretacea* (D' ARCHIAC, 1837), Transverse section; MU.B.UNI.S. 74, 58. D, E) *Praealveolina iberica* REICHEL, 1936, Oblique subaxial tangential section; MU.B.UNI.S. 59, 19. F: *Praealveolina tenuis* REICHEL, 1933, Transverse section; MU.B.UNI.S. 32. G: *Reticulinella reicheli* (CUVILLIER *et al*., 1969), Axial section; MU.B.UNI.S.19. J: *Cisalveolina* cf. *lehneri* (REICHEL, 1941), Equatorial section; MU.B.UNI.S. 75.

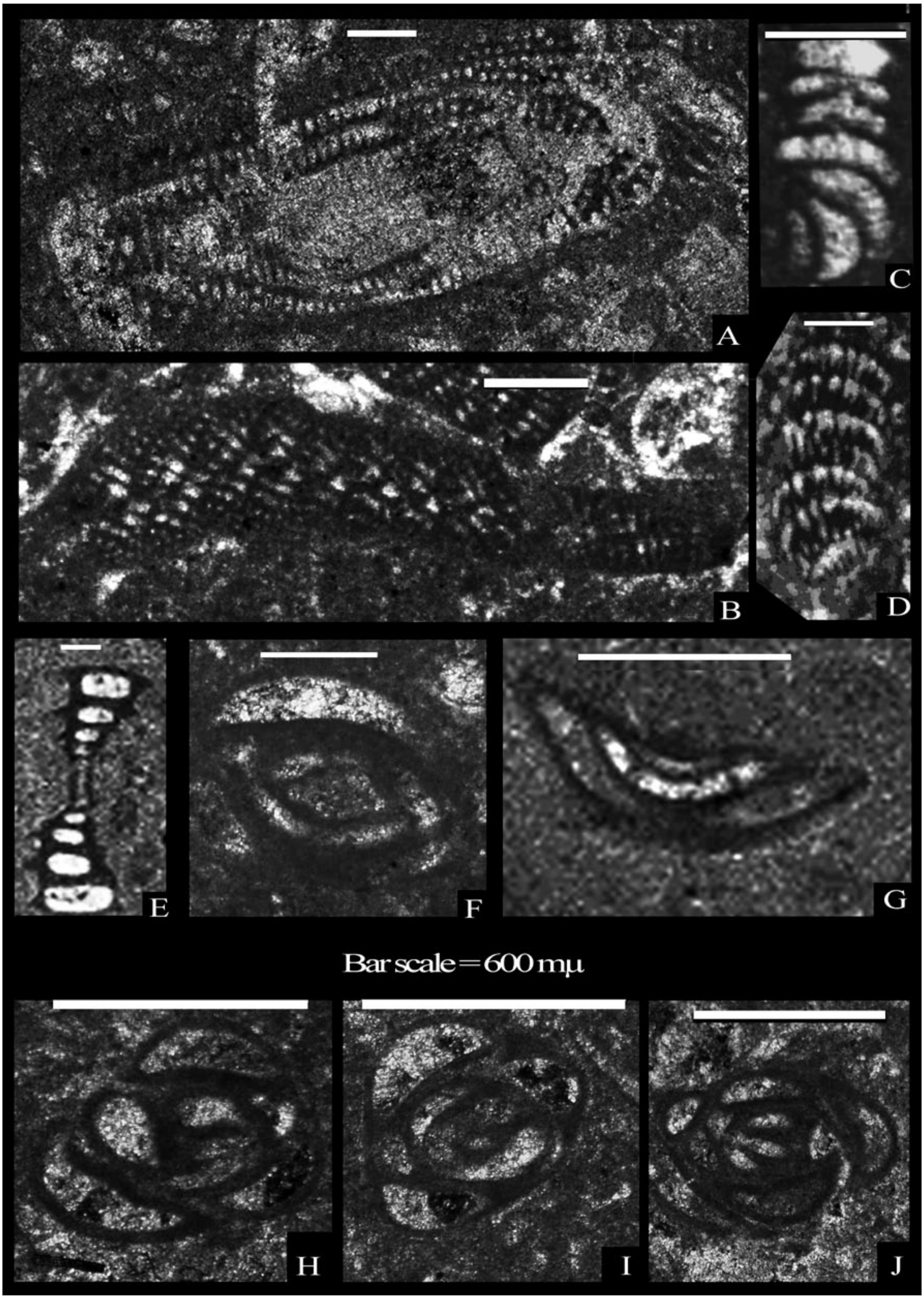


Fig. 4: A: *Praealveolina cretacea* (D' ARCHIAC, 1837), Subaxial tangential section; MU.B.UNI.S. 58. B: *Orbitolina* (*Mesorbitolina*) *texana* (ROEMER, 1849), Vertical section; MU.B.UNI.S.19. C: *Pseudorhapydionina laurinensis* (DE CASTRO, 1965), Subequatorial section; MU.B.UNI.S.32. D: *Pseudorhipidionina casertana* (DE CASTRO, 1965), Subequatorial section; MU.B.UNI.S.32. E: *Spiroloculina cenomana* CHIOCCHINI, 2008, Axial section; MU.B.UNI.S.59. F: *Spirosigmoilina* sp. Subequatorial section; MU.B.UNI.S.75. G: *Nezzazata concava* (SMOUT, 1956), Subaxial section; MU.B.UNI.S.59. H-J) Larger Miliolids, Aquatorial section; MU.B.UNI.S.58.

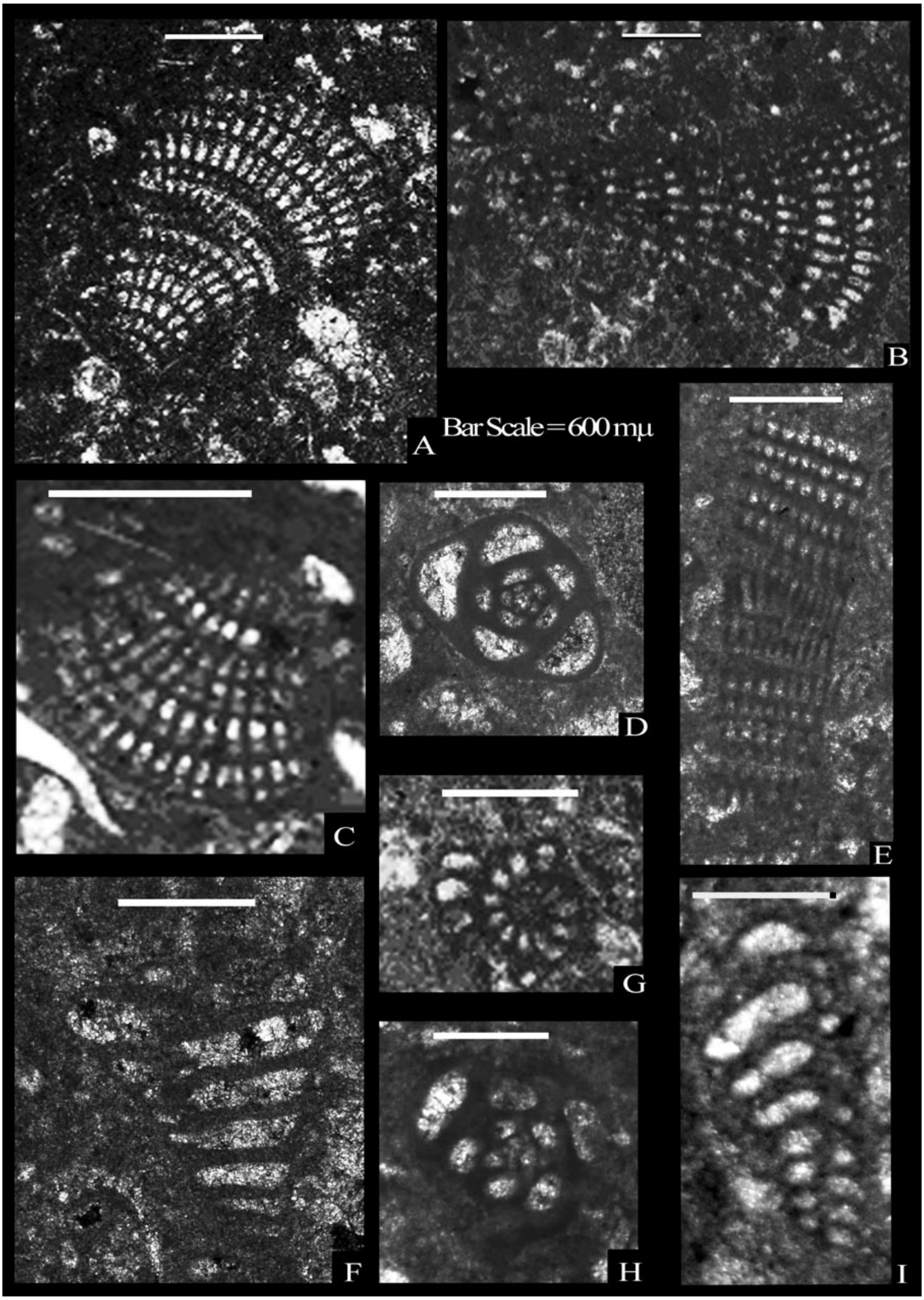


Fig: 5: A, C: *Cuneolina pavonia* D'ORBIGNY 1839, Vertical section; MU.B.UNI.S.42, 47. B: *Cuneolina parva* HENSON, Vertical section; MU.B.UNI.S. 19. D: *Quinqueloculina* sp., Axial section; MU.B.UNI.S.75. E: *Cuneolina cylindrica* HENSON, Vertical section; MU.B.UNI.S.58. F: *Pseudomarssonella* sp., Axial section; MU.B.UNI.S.58. G: *Biconcava bentori* HAMAOUI & SAINT-MARC, 1970, Equatorial section; MU.B.UNI.S.19. H: *Palaeosigmoilopsis apenninica* CHIOCCHINI, 2008, Transverse section; MU.B.UNI.S.75. I: *Praechrysalidina infracretacea* LUPERTO SINNI, 1979, Longitudinal section; MU.B.UNI.S.75.

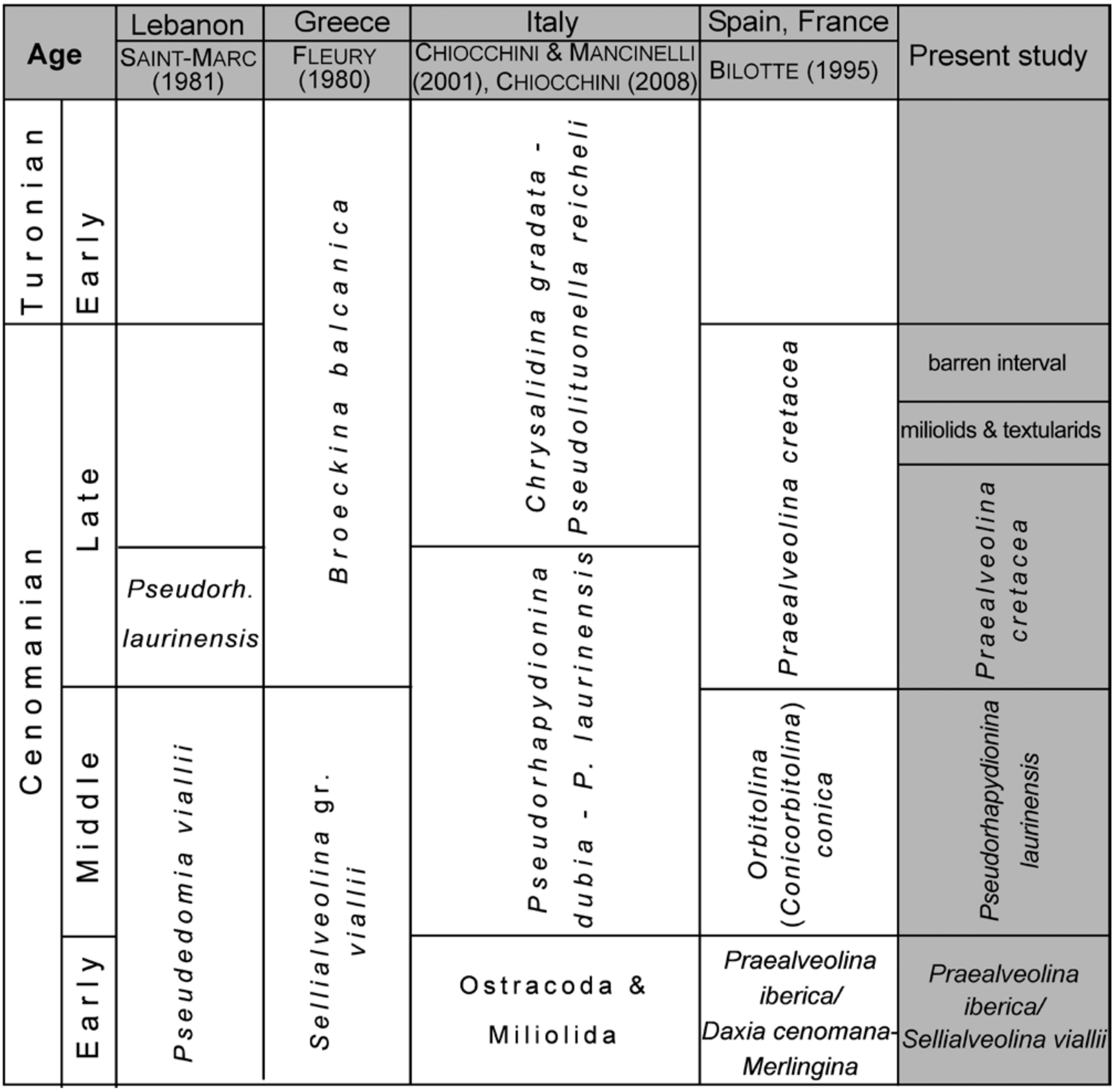


Fig. 6: Proposed larger foraminiferal zones in the study area and their correlation with those proposed by previous authors from Lebanon, Greece, Italy, France and Spain.

correlated with the *Whiteinella archaeocretacea* Zone (Parente *et al.*, 2008). The upper most part of the Cenomanian Galala Formation is completely barren from larger benthic foraminifera. The mostly upper part of the Late Cenomanian *P. cretacea* Zone of Bilotte (1995) from Spain and France equivalents to these miliolids and textularids species (Fig. 6). The *P. cretacea* Zone is equal with the Late Cenomanian *Praealveolina cretacea* Zone of Spain and France by (Bilotte, 1985).

6. PALAEOECOLOGICAL REMARKS

The Cenomanian-Turonian boundary interval (CTBI) represents a time of major perturbation of the global carbon cycle, resulting in an episode of widespread deposition of organic-carbon rich sediments, known as Oceanic Anoxic Event 2 (OAE 2, or the Bonarelli Event; Jenkyns, 1980). Changes of nutrient fluxes and spread of anoxic waters on shallow shelves have been generally invoked as the cause of extinction (Brasier, 1988). The larger foraminifera are organisms which are the most affected by anoxic waters, among the most conspicuous producers of shallow-water carbonate grains in the late Cenomanian.

The maximum diversity of benthic foraminiferal assemblages coincides with the range of *Cisalveolina fraasi* in the middle part of the planktic foraminiferal *Rotalipora cushmani* Zone (PARENTE *et al.*, 2008). Only six species *Palaeosigmoilopsis apenninica, Spiroloculina cenomana, Spirosigmoilina* sp., *Quinqueloculina* sp., *Praechrysalidina infracretacea*, and *Pseudormarssonella* sp. survived during this event, to become extinct ~52 m higher, at a level that can be correlated with the *Whiteinella archaeocretacea* Zone (PARENTE *et al.*, 2008). In agreement with the latter authors, there are two step patterns of extinction of larger foraminifers during OAE 2 that are recognized (as in the present study). The first step (E1) was strictly coeval with the extinction of rotaliporids and reduced the diversity of larger foraminifers. This event can be documented from the Vergons Platform in southern France (GROSHENY & TRONCHETTI, 1993), the Pyrenees and Iberian Range in Spain (CALONGE *et al.*, 2002), and the southern Apennines (PARENTE *et al*., 2007). The second step (E2) can be placed at the lower part of upper carbonate member of the Galala Formation at a level that can be correlated with the base of the *Whiteinella archaeocretacea* Zone. During the latter level few small miliolids and textularids (e.g. *Praechrysalidina infracretacea* and *Spiroloculina cenomana*) survived. This event can be recorded in other platforms in the late Cenomanian (e.g., central Apennines platforms; CHIOCCHINI *et al.*, 1994; Gavrovo Platform, Greece; FLEURY, 1971).

7. CONCLUSIONS

1. Ten benthic larger foraminifera *Cisalveolina* cf. *lehneri*, *C. frassi*, *Sellialveolina viallii*, *Reticulinella reicheli*, *Orbitolina* (*Mesorbitolina*) *texana*, *Spiroloculina cenomana*, *Spirosigmoilina* sp., *Cuneolina cylindrica*, *Palaeosigmoilopsis apenninica*, *Praechrysalidina infracretacea* were recognized from Egypt for first time. They strongly resemble that of other Tethyan regions (strong Tethyan affinity).

2. Based on the larger foraminifera assemblages, three local biostratigraphic zones were recognized from the Cenomanian Galala Formation of Gebel Um Horiba; a) *Praealveolina iberica-Sellialveolina viallii* Zone (Early Cenomanian), b) *Pseudorhapydionina laurinensis* Zone (Middle Cenomanian) and c) *Praealveolina cretacea* Zone (Late Cenomanian).

3. Two step patterns of extinction of larger foraminifers were observed during OAE 2 in the studied section. The first step (E1) was represented by the extinction of rotaliporids and reduced the diversity of larger foraminifers. The second step (E2) is placed within the basal part of the *Whiteinella archaeocretacea* Zone, where only small miliolids and textularids survived. In agreement with PARENTE *et al.* (2008), the latter two extinctions were probably due to changes in nutrient availability during OAE 2.

ACKNOWLEDGMENTS

We are grateful for the reviews of anonymous which greatly improved our manuscript. We would like to thank Dr. GAMAL EL QOT, Associate professor, Geology Department, Banha University for assistance during the fieldwork.

REFERENCES

BAUER, J., J. KUSS & T. STEUBER (2003) - Sequence architecture and carbonate platform configuration (Late Cenomanian-Santonian), Sinai, Egypt. *Sedimentology*, 50: 387-414.

BILOTTE, M. (1985) - Le Crétacé supérieur des plates-formes est-pyrénéennes. *Strata*, 2: 438 pp.

BRASIER, M.D. (1988) - Foraminiferid extinction and ecological collapse during global biological events. *In*: LARWOOD, G.P. (ed.), Extinction and survival in the fossil record. *Systematics Association Special*, *Oxford, UK, Clarendon Press*, 34: 37-64.

CALONGE, A., E. CAUS, J.M. BERNAUS, & M. AGUILAR (2002) - *Praealveolina* (Foraminifera) species: A tool to date Cenomanian platform sediments. *Micropaleontology*, 48: 53-66.

CHIOCCHINI, M. (2008) - New benthic foraminifers (Miliolacea and Soritacea) from the Cenomanian and Upper Turonian of the Monte Cairo (Southern Latium, Central Italy). *Memorie Descrittive della Carta Geologica d'Italia*, L34:171-202.

CHIOCCHINI, M. & A. MANCINELLI (2001) - *Sivasella monolateralis* SIREL and GÜNDÜZ, 1978 (Foraminiferidae) in the Maastrichtian of Latium (Italy). *Revue de Micropaléontologie*, 44: 267-277.

CHIOCCHINI, M., A. FARINACCI, A. MANCINELLI, V. MOLINARI & M. POTETTI (1994) - Biostratigrafia a foraminiferi, Dasicladali e Calpionelle delle successioni carbonatiche mesozoiche dell'Appennino centrale (Italia). *In*: MANCINELLI, A. (ed.), Biostratigrafia dell'Italia centrale. *Studi Geologici Camerti, Speciale*: 9-129.

EL SHEIKH, H. A. & A.A. HEWAIDY (1998) - On some Early-Middle Cretaceous larger foraminifera from northern Egypt. *Egyptian Journal of Geology*, 42: 497-515.

FLEURY, J.J. (1971) - Le Cénomanien à foraminifères benthoniques du Massif du Varassova (zone du Gavrovo, Akarnanie, Grèce continentale). *Revue de Micropaléontologie*, 14: 181-194.

FLEURY, J. J. (1980) - Les zones du Gavrovo-Tripolitza et du Pinde-Olonos (Gérce continentale et Péloponnèse du Nord). Evolution d'une plate-forme et d'un bassin dans le cadre alpin. *Société Géologique du Nord*, 4: 648 pp.

GHABEISHAVI, A., H. VAZIRI-MOGHDDAM, A. TAHERI & F. TAATI (2010) - Microfacies and depositional environment of the Cenomanian of the Bangestan anticline, SW Iran. *Journal of Asian Earth Science*, 37: 275-285.

Gräfe, K.U. (2005) - Late Cretaceous benthic foraminifers from the Basque-Cantabrian Basin, Northern Spain. *Journal of Iberian Geology*, 31: 277-298.

Grosheny, D. & G. Tronchetti (1993) - La crise Cénomanien–Turonien: Réponse comparée des assemblages de foraminifères benthiques de plate-forme carbonatée et de bassin dans le Sud-Est de la France. *Cretaceous Research*, 14: 397-408.

Guiraud, R. (1998) - Mesozoic rifting and basin inversion along the northern African Tethyan margin: an overview. *Petroleum Geology of North Africa, Geological Society of London, Special Publication*, 132: 217-229.

Hallock, P. (2000) - Symbiont-bearing foraminifera: Harbingers of global change. *In*: Lee, J.J. & P.H. Muller (eds), Advances in the biology of Foraminifera. *Micropaleontology*, 46: 95-104.

Hamaoui, M. & P. Saint Marc (1970) - Microfaunas et microfacies du Cénomanian du Proche-Orient. *Bulletin du Centre de Recherches Pau-SNPA*, 4: 257-352.

Haq, B.U., J. Hardenbol & P.R. Vail (1988) - Mesozoic and Cenozoic chronostratigraphy and cycles of sea level change. *In*: Wilgus, C.K. & B.S. Hastings (eds.), Sea Level Changes: An Integrated Approach. *Society of Economic Paleontologists and Mineralogists Special Publication*, 42: 71-108.

Hottinger, L. (2006) - Illustrated glossary of terms used in foraminiferal research. *Carnets de Géologie/Notebooks on Geology, Memoir 2006/02*. pdf 1-4.

Jenkyns, H.C. (1980) - Cretaceous anoxic events: From continents to oceans. *Journal of Geological Society of London*, 137: 171-188.

Kuss, J. & M. Bachmann (1996) - Cretaceous paleogeography of the Sinai Peninsula and neighboring areas. *Comptes Rendus de l'Académie des Sciences*, 11: 915-933.

Krenkel, E. (1924) - Der syrische Bogen. *Centralblatt für Mineralogie, Geologie und Paläontologie, Abhandlungen*, B9: 274-281; 10: 301-313.

Parente, M., G. Frijia, & M. Di Lucia (2007) - Carbon-isotope stratigraphy of Cenomanian-Turonian platform carbonates from southern Apennines (Italy): A chemostratigraphic approach to the problem of correlation between shallow-water and deep-water successions. *Journal of Geological Society of London*, 164: 609-620.

Parente, M., G. Frijia, M. Di Lucia, H. Jenkyns, R. Woodfine & F. Baroncini (2008) - Stepwise extinction of larger foraminifers at the Cenomanian-Turonian boundary: A shallow-water perspective on nutrient fluctuations during Oceanic Anoxic Event 2 (Bonarelli Event). *Geology*, 36: 715-718.

Orabi, H. O. (1992) - Cenomanian-Turonian boundary in Wadi Watir, Southeastern Sinai, Gulf of Aqaba, Egypt. *Journal of African Earth Science*, 15: 281-291.

Saint-Marc, P. (1981) - Lebanon. *In*: Reyment, R. A. & P. Bengtson (eds.), *Aspects of mid-Cretaceous Regional Geology*: 103-131.

Schroeder, R. & M. Neumann (1985) - Les grands foraminifères du Crétacé moyen de la région méditerranéenne. *Geobios, Mémoire Special*, 7: 1-160.

Shahin, A. & S. El Baz (2010) - Larger benthic foraminifera from the Cenomanian carbonate platform on southwestern Sinai, Egypt. *Egyptian Journal of Paleontology*, 10: 145-178.

Accepté septembre 2012