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Campanian–Early Eocene Stratigraphy of the Southern Galala Plateau, Eastern Desert, Egypt

Ahmed Aly **ISMAIL**, Yasmine **HUSSEIN-KAMEL**, Mohamed **BOUKHARY** and Ahmed Abdel Aziz **GHANDOUR**

Key words: Larger foraminifera, Campanian–Early Eocene, Southern Galala Plateau, Eastern Desert, Egypt.

Abstract

Several species of larger foraminifera have been recorded in the Campanian–Early Eocene succession of the Southern Galala Plateau. These species include *Orbitoides media* (ARCHIAC), *Omphalocyclus macropora* (LAMARK) in the Campanian–Maastrichtian rocks (Gebel Thelmet Formation and Sudr Chalk) and *Fallotella* (*Fallotella*) *kochanskae persica* HOTTINGER & DROBNE, *Fabularia zitteli* HOTTINGER, *Alveolina pasticillata* (SCHWAGER), *Glomalveolina dachelensis* (SCHWAGER), *Miscellanea rhomboidea* KUSS & LEPPIG and *Nummulites* cf. *subramondi* DE LA HARPE in the Palaeocene–Early Eocene sediments (Southern Galala Formation). There are few intervals yielding planktonic species that contributed significantly to the determination of the age assignment for the larger foraminifera. These species include *Globigerina triloculinoides* PLUMMER, *Morozovella uncinata* (BOLLI), *Morozovella trinidadensis* (BOLLI), *Morozovella* cf. *conicotruncata* (SUBBOTINA), *Morozovella angulata* (WHITE), *Planorotalites pseudomenardii* (BOLLI) and *Acarinina primitiva* (FINLAY). These planktonic species placed the *Glomalveolina dachelensis* (SCHWAGER) zone as being older than the *Morozovella angulata* (WHITE) zone (Early–Middle Palaeocene). The occurrence of the algae *Ethelia alba* (PFENDER) and *Neomeris plagnensis* DELOFFRE further supports the referred age.

1. INTRODUCTION

The Upper Cretaceous–Lower Tertiary rocks are widely distributed all over the Eastern Desert, extending from Gebel Shabrawet in the north, through the Gebel Ataqa and Galala massifs, to Wadi Qena in the south. In the north Eastern Desert (Gebel Shabraweet), these rocks are greatly affected by movement of the Syrian arc which gradually diminishes southward in the Galala massifs until its effect is very reduced in Wadi Qena. Several Palaeozoic–Jurassic outcrops are exposed on the foot slopes of the Galala massifs through Wadi Araba and underlie the Cretaceous–Eocene rocks.

The Campanian–Early Eocene deposits are of carbonate platform facies type that predominate in both Galalas. The distribution of planktonic and larger foraminifera within the investigated succession allowed an integrated biostratigraphic study to be achieved. Generally, several authors have been involved with the stratigraphy and palaeontology of the Southern Galala Plateau, e.g. FARAG (1954), AWAD & ABDALLAH (1966), ABDALLAH & EISSA (1971), ABDALLAH et al. (1971), MAZHAR et al. (1979), KUSS (1986), KUSS & LEPPIG (1989), SELIMA & ASKALANY (1996), KEHEILA (2000), SCHEIBNER et al. (2000, 2001), and ISMAIL & BOUKHARY (2001). There are no publications from the study area, 20 km west of Saint Anthony Monastery (Fig. 1) to nearly the western part of the Southern Galala Plateau. For this reason, the following aims were selected for the study area:

(1) to carry out a detailed stratigraphic analysis including lithostratigraphic units and biostratigraphic zones in order to increase the understanding of the nature of the basin of deposition in the Southern Galala plateau during the Late Cretaceous–Early Eocene time.

(2) to determine the relationship between horizons yielding smaller foraminifera (planktonic and benthonic) and those yielding larger ones in order to understand why the Southern Galala has different facies from those recorded in the Western Desert and in Sinai during the same interval.

2. MATERIAL AND METHODS

A total of 91 rock samples were collected from two surface sections covering the Campanian–Early Eocene succession in the western part of Southern Galala Plateau. The first section, Umm Khayshar (UK) lies 20 km west of Saint Anthony Monastery, and is 139 m in thickness. The second, Umm Damaranah section (UD) is located 30 km west of Saint Anthony Monastery (197 m thickness). Forty nine samples were collected from the Umm Khayshar section covering the Campanian–Maastrichtian, while forty two samples were collected from the Umm Damaranah section covering the Campanian–Early Eocene succession.

The collected samples were described and washed for separating microfossils. These microfossils (plank-

Geology Department, Faculty of Science, Ain Shams University, Abbassia 11566, Cairo, Egypt;
e-mail: aaaismail2002@yahoo.com

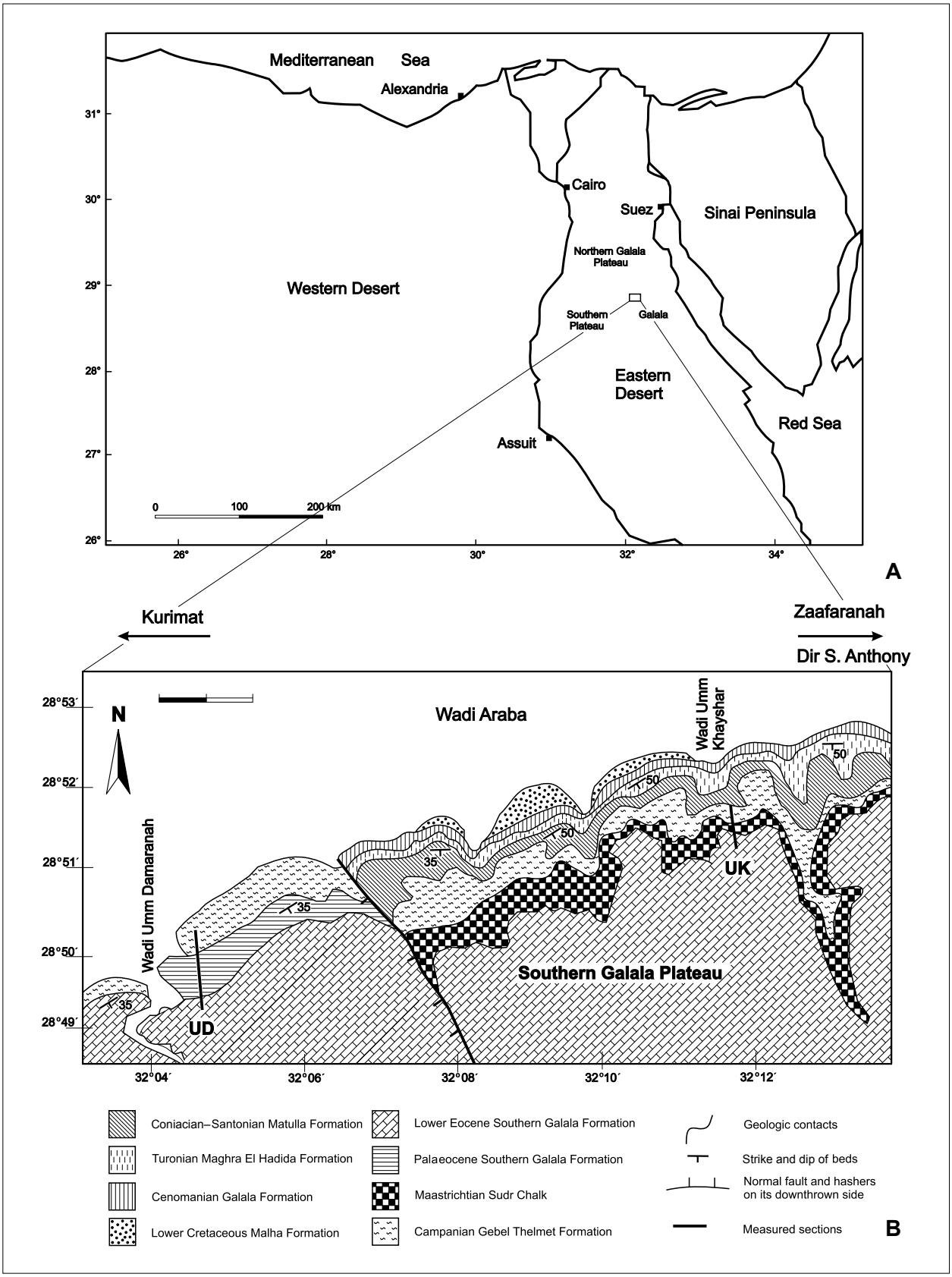

Fig. 1 Location map (A) and geological map (after GHANDOUR, 2000) of the study area (B).

tonic and benthic foraminifera) were identified, photographed by Scanning Electron Microscope (SEM) and are illustrated in four plates. For larger foraminifera, normal photography was used. Some samples were prepared for thin-sections to study the larger foraminifera, in addition some thin-sections were made through the free tests of these foraminifera. It is worth mentioning that the Umm Khayshar (UK) section starts with the

Fig. 2 A general view of Umm Khayshar section.

Fig. 3 A panoramic view of Umm Damaranah section.

Galala Formation (Cenomanian), Maghra El Hadida Formation (Turonian) and Matulla Formation (Coniacian–Santonian), which have been treated elsewhere (ISMAIL et al., in press).

3. STRATIGRAPHY

The stratigraphic analysis of the studied rocks depends mainly on the distribution of foraminifera through the Campanian–Early Eocene succession. In intervals that lack foraminifera, macrofossils were used whenever possible. The identified foraminiferal assemblages include planktonic, small benthonic and larger foraminifera that were extracted from the Umm Khayshar and Umm Damaranah measured sections (Figs. 2, 3 & 10). The identified foraminiferal assemblages were correlated with the standard Cretaceous biozones of CARON (1985) and the standard Palaeocene–Eocene biozones of TOUMARKINE & LUTERBACHER (1985). Furthermore, the rock units in the study area are the Gebel Thelmet Formation, Sudr Chalk and Southern Galala Formation (Figs. 4 & 5). The lithostratigraphic description, in addition to the faunal content (Figs. 6 & 7) is discussed below.

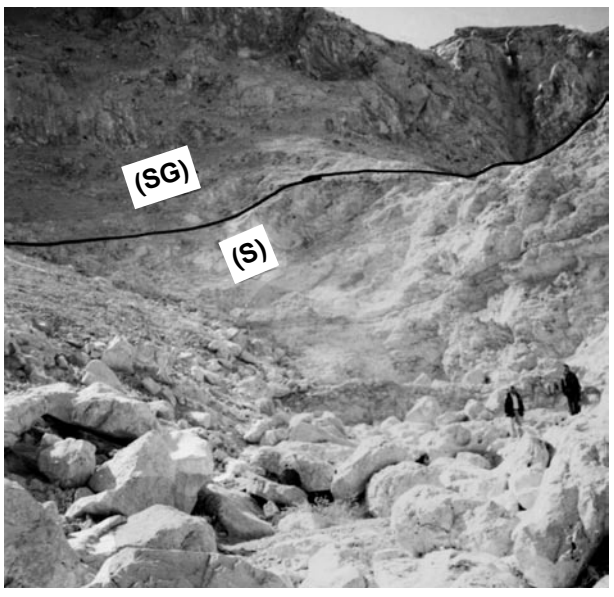

Fig. 4 A field photograph showing the Sudr Chalk (SC) Formation and the unconformably overlying Southern Galala Formation (SG).

3.1 Late Campanian–Early Maastrichtian deposits

Sediments of Late Campanian and Early Maastrichtian age are widely distributed in the upper parts of the Southern Galala Plateau and the foot slopes of the Northern Galala Plateau facing Wadi Araba. In the lower part they are composed of well-bedded flaky limestone intercalated with chalk and sandstones. In the upper part they consist of fossiliferous, chalky, sandy and argillaceous limestones intercalated with green shales. The thickness of this interval reaches 69 m in the Umm Khayshar section and >40 m in the Umm Damaranah Section. The interval is named the Gebel Thelmet Formation by ABDALLAH & EISSA (1971) at Gebel Thelmet, Southern Galala. It contains some larger foraminifera of stratigraphic significance.

In the Umm Khayshar section, the sequence is characterized by the abundance of *Orbitoides media* (ARCHIAC) and *Omphalocyclus macroporus* (LAMARCK) and overlain by a horizon containing several planktonic and small benthic foraminiferal species of Late Campanian–Early Maastrichtian affinity: *Haplophragmoides calculus* CUSHMAN & WATERS, *H. excavata* CUSHMAN & WATERS, *H. globulosa LOZO*, *H. hausa* PETTERS, *Ammobaculites subcretaceus* CUSHMAN & ALEXANDER, *A. texanus* CUSHMAN, *Cyclammina cancellata* BRADY, *Heterohelix glabrans* (CUSHMAN), *Globigerinelloides prairiehillensis* PESSAGNO, *Hastigerinoides subdigitata* (CARMAN), *Rugoglobigerina macrocephala* BRONNIMANN, *Bulimina kickapooensis* COLE, *B. reussi* MORROW, *Discorbis beadnilli* SAID & BARAKAT, *Anomalina umbonifera* (SCHWAGER) and *Gyroidinoides goodkoffi* (TRUJILLO). The sug-

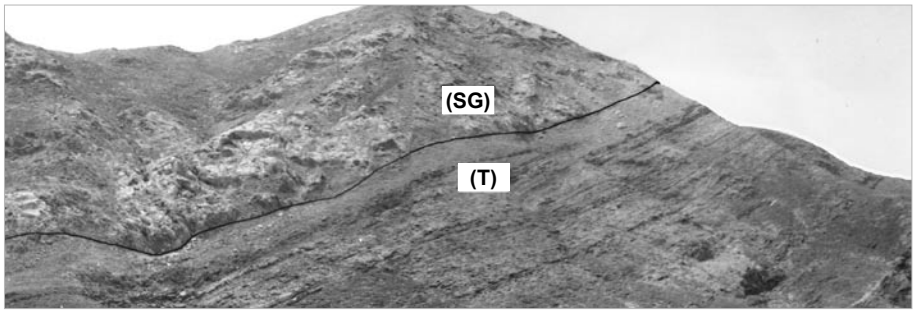

Fig. 5 A field photograph showing the Gebel Thelmet Formation (T) and the Southern Galala Formation (SG) at the Umm Damaranah Section.

gested Early Maastrichtian age may be partially equated to the Globotruncanella havanensis zone.

In Umm Damaranah, the presence of the larger foraminifera *Orbitoides media* (ARCHIAC) and *Omphalocyclus macroporus* ascribe the upper part of the Gebel Thelmet Formation to the Late Campanian (ISMAIL & BOUKHARY, 2001). It is overlain by a nonfossiliferous sequence of chalky limestone, which suggests the extension of its age to the Early?–Middle Palaeocene as evidenced by the appearance of *Glomalveolina dachelensis* (SCHWAGER) and *Fallotella* (*F.*) *kochanskae persica* HOTTINGER & DROBNE.

3.2 Early Maastrichtian deposits

The chalky deposits are widely distributed within this interval, named the Sudr Chalk by GHORAB (1961) in Wadi Sudr, west central Sinai. In the study area, it ranges from the first occurrence of *Globotruncana aegyptiaca* NAKKADY to the first occurrence of the oysters *Exogyra overwegi* BOCH and *E. cornuarietis* COQUAND (Middle Maastrichtian). The thickness of this interval is 45 m, and it overlies the horizon yielding *Orbitoides media* (ARCHIAC) and *Omphalocyclus macroporus* (LAMARCK) of the Late Campanian, and underlies a shallow carbonate horizon yielding the oysters *Exogyra overwegi* and *E. cornuarietis* of the Middle Maastrichtian. The associated foraminiferal assemblage is composed of *Pseudoclavulina maqfiensis* LE ROY, *Dentalina colei* CUSHMAN & DUSENBURY, *D. communis* (D'ORBIGNY), *Lenticulina muensteri* (ROEMER), *Heterohelix globulosa* (EHRENBERG), *H. moremani* (CUSHMAN), *H. striata* (CUSHMAN), *Globigerinelloides prairiehillensis* PESSAGNO, *G. subcarinata* (BRONNIMANN), *Hedbergella holmedlensis* OLSSON, *Globotruncana aegyptiaca* NAKKADY, *G. bulloides* VOLGER, *G. linneana* (D'ORBIGNY), *Contusotruncana fornicata* (PLUMMER), *Globotruncanita stuarti* (DE LAPPARENT), *Archaeoglobigerina blowi* PESSAGNO, *Rugoglobigerina macrocephala* BRONNIMANN, *R. rugosa* (PLUMMER), *Bulimina kickapooensis* COLE, *B. reussi* MORROW, *Bulimina* sp., *Cibicides praecursorius* (SCHWAGER), *Anomalina umbonifera* (SCHWAGER), *Anomalinoides nakkadyi* SAID & KENAWY, *A. sinaensis* SAID & KENAWY, *Heterolepa hispaiolae* (BERMUDEZ) and *Gyridina* cf. *Subangulata* (PLUMMER).

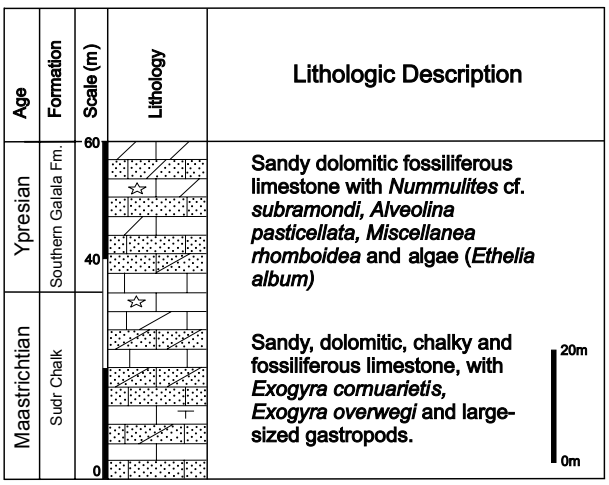

Fig. 6 Stratigraphic column of the Umm Khayshar section (UK).

3.3 Middle Maastrichtian deposits

These deposits are only recorded at the Umm Khayshar section where they occupy the upper part of the Sudr Chalk. The thickness of this interval attains 30 m. It overlies the *Globotruncana aegyptiaca* interval zone of the Early Maastrichtian and unconformably underlies the *Nummulites* cf. *subramondi–Alveolina pasticellata* horizon of the Early Eocene. This horizon yields the oysters *Exogyra overwegi* and *E. cornuarietis* of Middle Maastrichtian age (LUGER, 1985), in addition to large gastropods. This horizon is equivalent to the *Gansserina gansseri* zone of CARON (1985), SIGAL (1977) and POSTUMA (1971). There are a few beds yielding some long-ranging planktonic foraminiferal species – *Heterohelix globulosa*, *Hedbergella holmedelensis* and *Contusotruncana fornicate*.

3.4 Early?–Middle Palaeocene deposits

Early?–Middle Paleocene deposits are only recorded in the Umm Damaranah section and occupy the lower part of the Southern Galala Formation. The thickness of this horizon is 127.5 m. It overlies the *Orbitoides media* and *Omphalocyclus macropora* assemblage zone of the Late Campanian and underlies the *Morozovella angulata* zone of the Middle Palaeocene. This horizon is characterized by a large number of white globular larger fora-

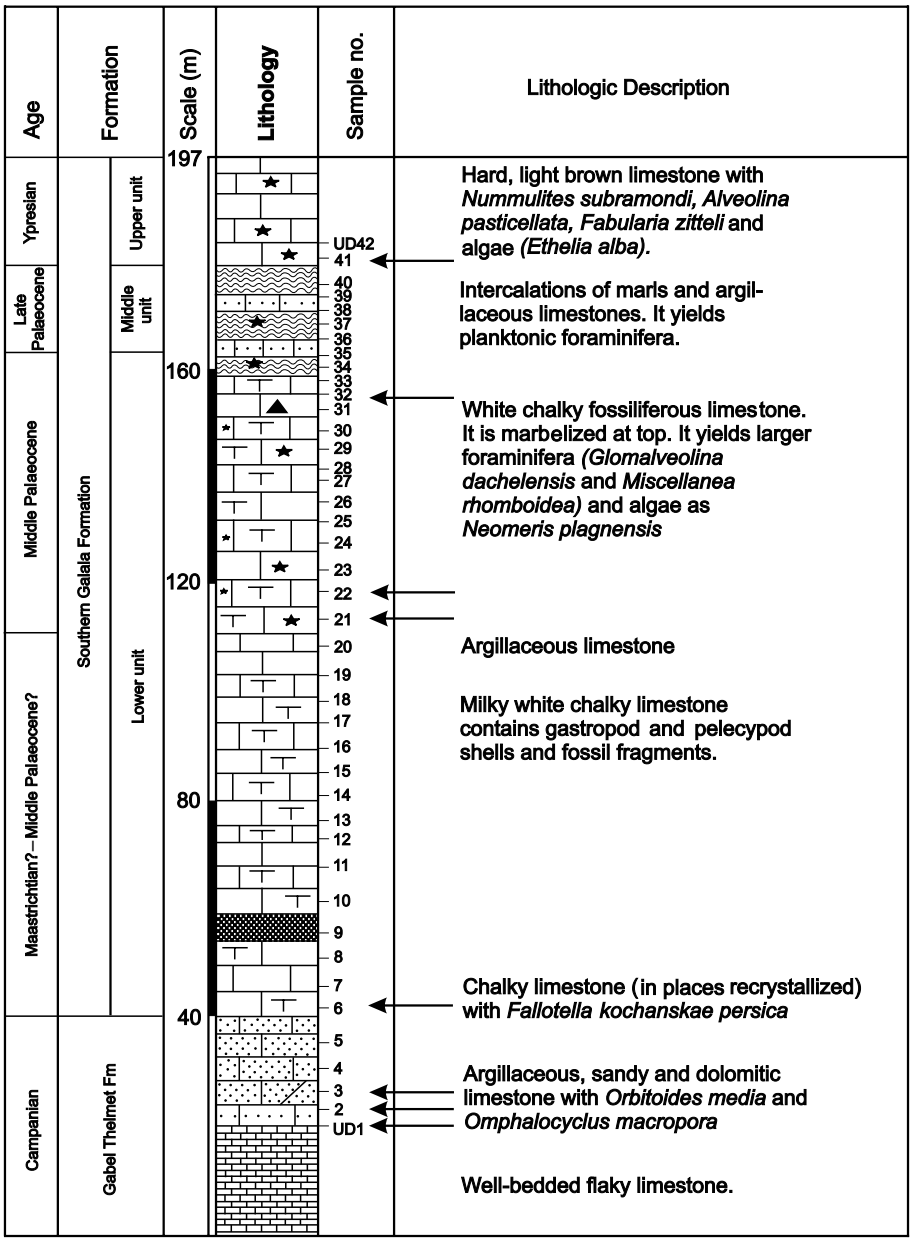

Fig. 7 Stratigraphic column of the Umm Dammaranah section (UD).

minifera *Glomalveolina dachelensis* (SCHWAGER), in addition to *Miscellanea rhomboidea* KUSS & LEPPIG and *Fallotella* (*F.*) *kochanskae persica* HOTTINGER & DROBNE. KUSS & LEPPIG (1989), equated the *Glomalveolina dachelensis* zone to the *Alveolina* (*Glomalveolina*) *levis* zone of CUVILLIER & POMEROL (1986), which is equivalent to the upper part of the *Planorotalites psudomenardii* zone (Early Late Palaeocene). In the Umm Damaranah section, this zone underlies the *Morozovella angulata* zone of Middle Palaeocene age. This may suggest extension of the *Glomalveolina dachlensis* zone downward to an Early?–Middle Palaeocene age (Figs. 8 & 9).

3.5 Middle Palaeocene deposits

These are recorded in the Umm Damaranah section, which occupy the middle part of the Southern Galala Formation. The thickness of this zone is 6 m. It overlies the *Glomalveolina dachlensis* horizon of the Early?–Middle Palaeocene and underlies the *Planorotalites peudomenardii* zone of Early Late Palaeocene time. This zone is of low diversity, where few species are recorded – *Morozovella angulata* (WHITE) and *Morozovella conicotruncata* (SUBBOTINA), in addition to some badly preserved specimens of the same affinity.

3.6 Late Palaeocene deposits

Late Palaeocene deposits are only recorded in the Umm Damaranah section, where they comprise the upper part of the Southern Galala Formation and are 14 m thick. They overlie the *Morozovella angulata* zone of Middle Palaeocene age and unconformably underlie the *Nummulites* cf. *subramondi* and *Alveolina pasticellata* (SCHWAGER) horizon of Ypresian age. The associated

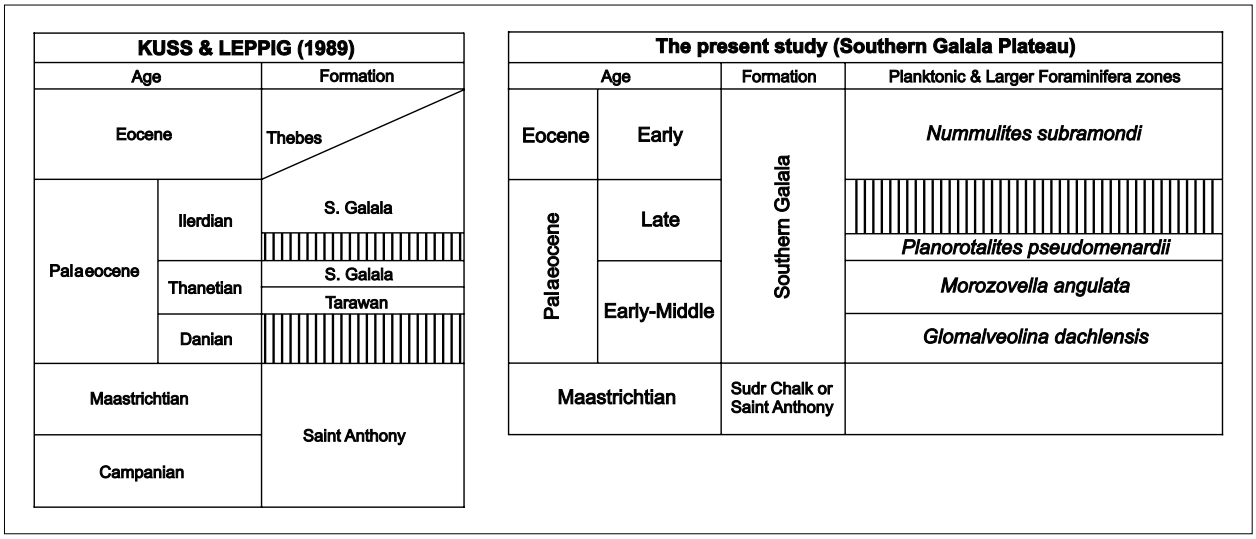

Fig. 8 A correlation table of the rock units with the faunal content.

assemblage includes *Planorotalites pseudomenardii* (BOLLI), *Morozovella angulata* (WHITE), *M. trinidadensis* (BOLLI), *M. uncinata* (BOLLI), *Acarinina primitiva* (FINLAY), *Nodosarella mappa* (CUSHMAN & JARVIS), *Reussoolina apiculata* (REUSS), *Globigerina triloculinoides* PLUMMER, *Cibicidoides padella* (JENNINGS) and *Cibicidoides* cf. *succedens* (BROTZEN).

3.7 Early Eocene (Ypresian) deposits

These are recorded in the accessible, uppermost part of the Southern Galala Formation in the two measured sections. In the Umm Khayshar section, these deposits unconformably overlie the *Exogyra overwegi–E. cornuarietis* horizon of Middle Maastrichtian age. However, in the Umm Damaranah section, they overlie the *Plano-*

Age			BERGGREN et al. (1995)		BERGGREN & PEARSON (2005)	
Eocene			P5	*Morozovella velascoensis*	P5	*Morozovella velascoensis*
Palaeocene	Late	Thanetian	P4c	*Acarinina soldadoensis – Globanomalina pseudomenardii*	P4c	*Acarinina soldadoensis – Globanomalina pseudomenardii*
			P4b	*Acarinina subsphaerica – Acarinina soldadoensis*	P4b	*Acarinina subsphaerica*
			P4a	*Globanomalina pseudomenardi – Acarinina subsphaerica*		
		Selandian	P3b	*Igorina albeari – Globanomalina pseudomenardi*	P4a	*Globanomalina pseudomenardi – Praemurica variolaria*
					P3b	*Igorina albeari*
			P3a	*Morozovella angulata – Igorina albeari*	P3a	*Igorina pusilla*
	Early	Danian	P2	*Praemurica uncinata – Morozovella angulata*	P2	*Praemurica uncinata*
			P1c	*Globanomalina compresa – Praemurica inconstans*	P1c	*Globanomalina compresa – Praemurica inconstans*
			P1b	*Subbotina triloculinoides – Globanomalina compressa*	P1b	*Subbotina triloculinoides*
			P1a	*Praemurica eugubina – Subbotina triloculinoides*	P1a	*Praemurica pseudobulloides*
			P & P0	*Praemurica eugubina Guembelitria cretacea*	P & P0	*Praemurica eugubina Guembelitria cretacea*

Fig. 9 Palaeogene zonations after BERGGREN et al. (1995) and BERGGREN & PEARSON (2005).

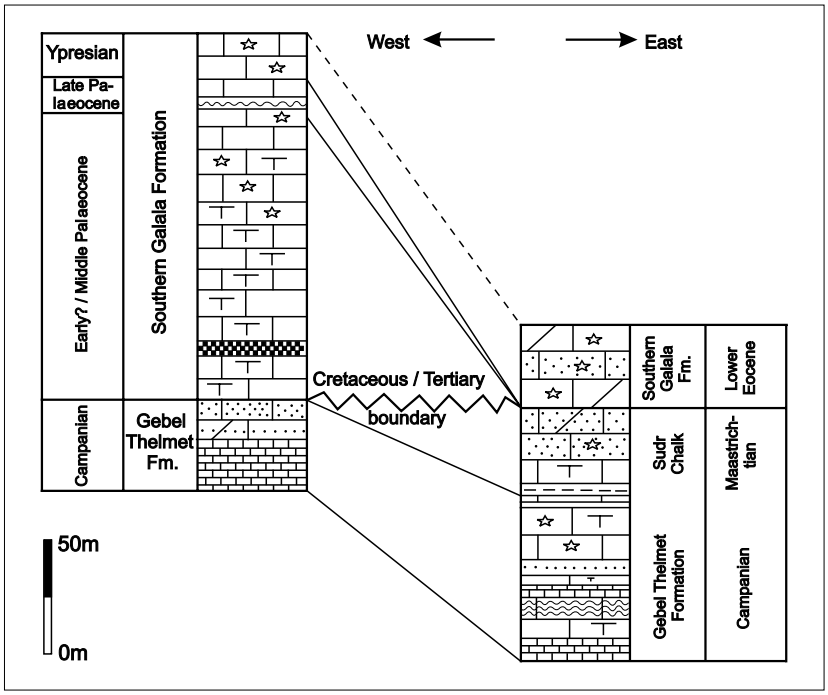

Fig. 10 Correlation between two studied sections.

rotalites pseudomenardii zone of Late Palaeocene age. This interval contains the following species of Ypresian age: *Nummulites* cf. *subramondi*, *Alveolina pasticellata*, *Fabularia zitteli* HOTTINGER and algae such as *Ethelia alba* (PFENDER).

4. TAXONOMIC NOTES

This discussion includes the synonymy, special remarks and stratigraphic distribution for each species. For planktonic foraminifera the Cretaceous scheme of CARON (1985) and the Palaeocene–Eocene scheme of TOUMARKINE & LUTERBACHER (1985) have been followed, while several publications (e.g. HENSON, 1948; OMARA, 1956; SAID & KENAWY, 1956; SAID & BARAKAT, 1957; NEUMANN, 1967; SLITER, 1968; ISMAIL, 1992; BOLLI et al., 1994, etc.) have been used for identification of benthic foraminifera. Furthermore, the Treatise of LOEBLICH & TAPPAN (1988) facilitated the classification of the different genera. The identified small foraminiferal species (Fig. 11) were photographed by Scanning Electron Microscope (SEM) and the larger foraminiferal species, in addition to thin sections were photographed by a high power petrographic microscope, while normal photography was used for separated specimens. The larger foraminiferal species are illustrated in 2 plates. Type specimens of the identified species are deposited in the Geological Museum of the Department of Geology, Faculty of Science, Ain Shams University, Cairo, Egypt (Ismail Collection).

Family Heterohelicidae CUSHMAN, 1927
Genus *Heterohelix* EHRENBERG, 1843
Heterohelix glabrans (CUSHMAN)

Pl. I, Fig. 1

1938 *Guembelitria glabrans* CUSHMAN, p. 15, pl. 3, figs. 1 & 2.

1968 *Heterohelix glabrans* (CUSHMAN) – SLITER, p. 94, pl. 13, fig. 17.

Remarks: It has a subacute periphery, subrectangular chambers and smooth surface.

Distribution: In the study area, it is recorded from the Umm Khayshar section, sample UK 75, Gebel Thelmet Formation (Campanian).

Heterohelix striata (EHRENBERG)

Pl. I, Fig. 2

1840 *Textularia striata* EHRENBERG, p. 135, pl. 4, figs. 1a, 2a & 3a.

1985 *Heterohelix striata* (EHRENBERG) – CARON, p. 60, pl. 24 (figs. 12 & 13).

Remarks: This species is easily distinguished by the fine striations on the surface of the test.

Distribution: In the study area, it is recorded from the Umm Khayshar section, sample UK 80, Sudr Chalk (Maastrichtian).

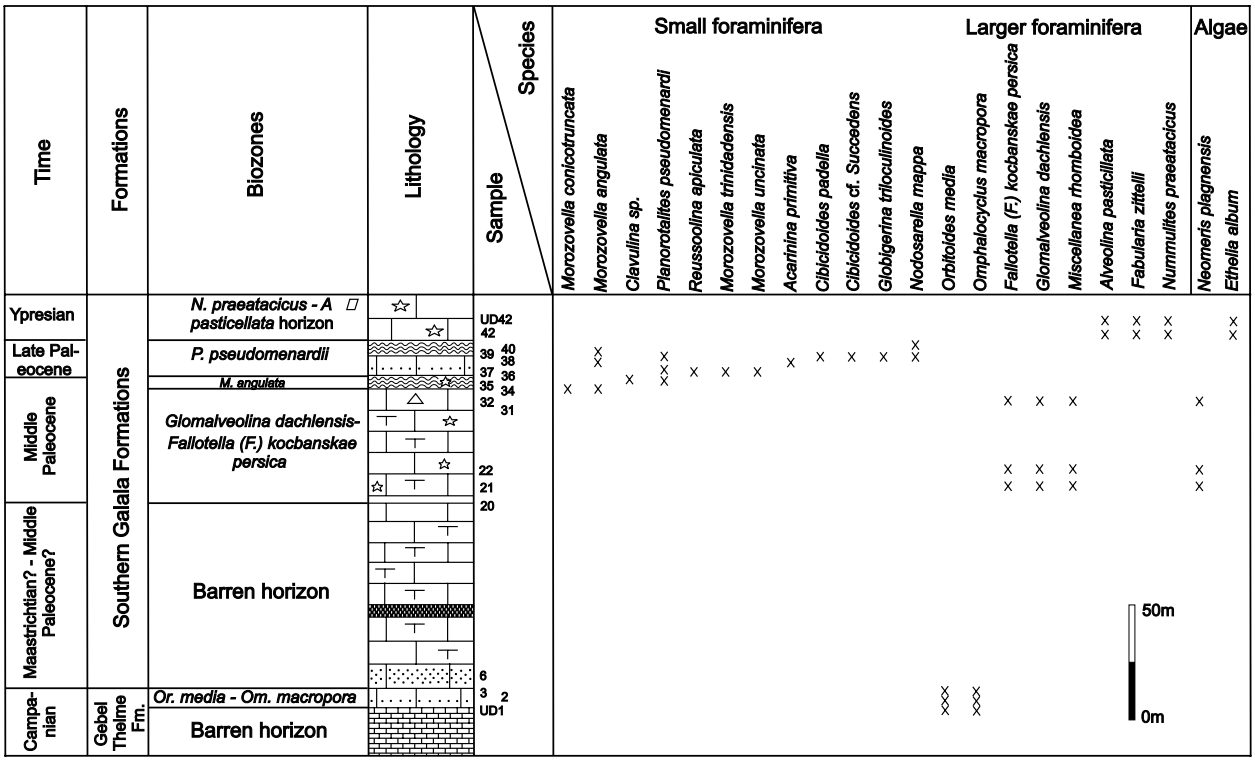

Fig. 11 Distribution chart of species determined at the Um Damaranah Section.

Family Globigerinelloididae LONGORIA, 1974
Genus *Globigerinelloides* CUSHMAN & TEN DAM, 1984
***Globigerinelloides prairiehillensis* PESSAGNO**

Pl. I, Fig. 3

1967 *Globigerinelloides prairiehillensis* PESSAGNO, pl. 90, figs. 1 & 2.

1985 *Globigerinelloides prairiehillensis* PESSAGNO – CARON, p. 47, fig. 29 (14–15).

Remarks: This species is characterized by globular chambers, which increase rapidly in size.

Distribution: In the study area, it is recorded from the Umm Khayshar section, samples UK 75 and UK 78, Gebel Thelmet Formation (Campanian), and samples UK 80 and UK 82, Sudr Chalk (Maastrichtian).

***Globigerinelloides subcarinata* (BRONNIMANN)**

Pl. I, Fig. 4

1952 *Globigerinelloides messinae subcarinata* BRONNIMANN, p. 44–45, pl. 1, figs. 10–11.

1985 *Globigerinelloides subcarin*ata (BRONNIMANN) – CARON, p. 47, fig. 29 (16–17).

Remarks: This species possesses an imperforate peripheral band in all chambers of the last whorl.

Distribution: In the study area, it is recorded from the Umm Khayshar section, sample UK 84, Sudr Chalk (Maastrichtian).

***Hedbergella holmdelensis* OLSSON**

Pl. I, Fig. 5

1964 *Hedbergella holmdelensis* OLSSON, p. 160, pl. 1, fig. 2.

1985 *Hedbergella holmdelensis* OLSSON – CARON, p. 59, fig. 25 (10–11).

Remarks: This species is characterized by its compact arrangement of the subglobular chambers.

Distribution: In the study area, it is recorded from the Umm Khayshar section, samples UK 80 and UK 100, Sudr Chalk (Maastrichtian).

Family Globotruncanidae BROTZEN, 1942
Genus *Globotruncana* CUSHMAN, 1927
***Globotruncana aegyptiaca* NAKKADY**

Pl. I, Fig. 6

1950 *Globotruncana aegyptiaca* NAKKADY, p. 690, pl. 90, fig. 20.

1985 *Globotruncana aegyptiaca* NAKKADY – CARON, p. 50, fig. 19 (1–3).

Remarks: It has 4 chambers in the last whorl and two closely spaced keels.

Distribution: In the study area, it is recorded from the Umm Khayshar section, sample UK 80, Sudr Chalk (Maastrichtian).

***Globotruncana bulloides* VOLGER**

Pl. I, Fig. 7

1941 *Globotruncana linnei* (D'ORBIGNY) subsp. *bulloides* VOLGER, p. 287, pl. 23, figs. 32–39.

1985 *Globotruncana bulloides* VOLGER – CARON, p. 50, fig. 20 (1–2).

Remarks: This species is characterized by inflated chambers on both sides and two widely spaced keels.

Distribution: In the study area it is recorded from the Umm Khayshar section, sample UK 80, Sudr Chalk (Maastrichtian).

Family Rugoglobigerinidae SUBBOTINA, 1959
Genus *Archaeoglobigerina* PESSAGNO, 1967
***Archaeoglobigerina blowi* PESSAGNO**

Pl. I, Fig. 8

1967 *Archaeoglobigerina blowi* PESSAGNO, p. 316, pl. 59, figs. 5–7.

1985 *Archaeoglobigerina blowi*, PESSAGNO – CARON, p. 43, fig. 16 (3–4).

Remarks: It has 4 chambers in the last whorl and a rounded periphery.

Distribution: In the study area, it is recorded from the Umm Khayshar section, samples UK 80, Sudr Chalk (Maastrichtian).

Genus *Rugoglobigerina* BRONNIMANN, 1952
***Rugoglobigerina macrocephala* BRONNIMANN**

Pl. I, Fig. 9

1952 *Rugoglobigerina (Rugoglobigerina) macrocephala* BRONNIMANN, p. 25, pl. 2, figs. 1–3.

1985 *Rugoglobigerina mac*rocephala BRONNIMANN – CARON, p. 92, fig. 14 (5–7).

Remarks: *Rugoglobigerina macrocephala* BRONNIMANN differs from *Rugoglobigerina rugosa* (PLUMMER) in having 4 instead of 5 inflated chambers in the last whorl.

Distribution: In the study area, it is recorded from the Umm Khayshar section, samples UK 75, Gebel Thelmet Formation (Campanian) and samples UK 80 and UK 82, Sudr Chalk (Maastrichtian).

***Rugoglobigerina rugosa* (PLUMMER)**

Pl. I, Fig. 10

1926 *Globigerina rugosa* PLUMMER, p. 38, pl. 2, fig. 10.

1985 *Rugoglobigerina rugosa* (PLUMMER) – CARON, p. 72, fig. 34 (9–10).

Distribution: In the study area, it is recorded from the Umm Khayshar section, samples UK 80, Sudr Chalk (Maastrichtian).

Family Globorotaiidae CUSHMAN, 1927
Genus *Planorotalites* MOROZOVA, 1957
***Planorotalites pseudomenardii* (BOLLI)**

Pl. II, Figs. 1–3

1957 *Globorotalia pseudomenardii* BOLLI, p. 77, pl. 20, figs. 14–17.

1985 *Planorotalites pseudomenardii* (BOLLI) – TOUMARKINE & LUTERBACHER, p. 108, fig. 12 (3–4).

Remarks: This species has a biconvex lenticular smooth test and imperforate keel.

Distribution: In the study area, it is recorded from the Umm Damaranah section, samples UD 36 and UD 37, Southern Galala Formation (Middle Palaeocene) and sample UD 39, Southern Galala Formation (Late Palaeocene).

Family Truncrotalididae LOEBLICH & TAPPAN, 1961
Genus *Acarinina* SUBBOTINA, 1953
***Acarinina primitiva* (FINLAY)**

Pl. II, Fig. 4

1947 *Globoquadrina primitiva* FINLAY, p. 291, pl. 8, figs. 129–134.

1985 *Acarinina primitiva* (FINLAY) – TOUMARKINE & LUTERBACHER, p. 116, fig. 17 (6 & 7).

Remarks: It has 4 chambers in the last whorl, and a small but deep umbilicus. The last chamber represents one half of the test and the surface is pustulose.

Distribution: In the study area, it is recorded from the Umm Damaranah section, sample UD 38, Southern Galala Formation (Late Palaeocene).

Genus *Morozovella* McGOWRAN, 1968
***Morozovella angulata* (WHITE)**

Pl. II, Figs. 5 & 6

1928 *Globigerina angulata* WHITE, p. 191, pl. 27, fig. 13.

1985 *Morozovella angulata* (WHITE) – TOUMARKINE & LUTERBACHER, p. 111, fig. 14 (5–6).

Remarks: All chambers of the last whorl are angular conical. Instead of a peripheral keel, delicate spines are concentrated around the periphery and the umbilical shoulders.

Distribution: In the study area, it is recorded from the Umm Damaranah section, samples UD 34, Southern Galala Formation (Middle Palaeocene) and samples UD 38 and UD 39, Southern Galala Formation (Late Palaeocene).

***Morozovella* cf. *conicotruncata* (SUBBOTINA)**

Pl. II, Fig. 7

1947 *Globorotalia conicotruncata* SUBBOTINA, p.

115, pl. 4, figs. 11–13; pl. 9, figs. 9–11.

1999 *Globorotalia conicotruncata* SUBBOTINA – OLSSON et al., p. 60, pl. 11, figs. 10–15.

Remarks: This species is characterized by its conicotruncate shape in lateral view, with 6 chambers in the last whorl and the chambers are angular conical.

Distribution: In the study area, it is recorded from the Umm Damaranah section, samples UD 34, Southern Galala Formation (Middle Palaeocene).

***Morozovella trinidadensis* (BOLLI)**

Pl. II, Fig. 8

1957 *Globorotalia trinidadensis* BOLLI, p. 73, pl. 16, figs. 19–23.

1985 *Morozovella trinidadensis* (BOLLI) – TOUMARKINE & LUTERBACHER, p. 110, fig. 13 (3–4).

Remarks: This species has 5 angular conical chambers in the last whorl and it also has a wide umbilicus.

Distribution: In the study area, it is recorded from the Umm Damaranah section, samples UD 37, Southern Galala Formation (Middle Palaeocene).

***Morozovella uncinata* (BOLLI)**

Pl. II, Fig. 9

1957 *Globorotalia uncinata* BOLLI, p. 74, pl. 17, figs. 13–15.

1985 *Morozovella uncinata* (BOLLI) – TOUMARKINE & LUTERBACHER, p. 110, fig. 14 (3–4).

Remarks: The early chambers of the last whorl are angular conical and the suture lines on the spiral side are strongly curved backwardly.

Distribution: In the study area, it is recorded from the Umm Damaranah section, sample UD 37, Southern Galala Formation (Middle Palaeocene).

Family Globigerinidae CARPENTER, PARKER & JONES, 1862
Genus *Globigerina* D'ORBIGNY
***Globigerina triloculinoides* PLUMMER**

Pl. II, Figs. 10 & 11

1926 *Globigerina triloculinoides* PLUMMER, p. 134, pl. 8, fig. 10.

1985 *Globigerina triloculinoides* PLUMMER – TOUMARKINE & LUTERBACHER, p. 117, fig. 19 (1–2).

Remarks: It has a trochospiral test with 3 globular chambers and the last one occupies one half of the entire whorl.

Distribution: In the study area, it is recorded from the Umm Damaranah section, sample UK 39, Southern Galala Formation (Late Palaeocene).

Family Orbitoididae SCHWAGER, 1876
Genus *Orbitoides* D'ORBIGNY, 1848
***Orbitoides media* (ARCHIAC)**

Pl. III, Figs. 1–4, 6–7 & 11

1837 *Orbitoides media* ARCHIAC, p. 178

2001 *Orbitoides media* (ARCHIAC) – ISMAIL & BOUKHARY, p. 81, pl. 1, figs. 1–9; pl. 2, figs.1–4.

Remarks: It has a lenticular test, symmetrically biconvex, the megalospheric test has four-chambered embryo surrounded by thick wall, and its surface is smooth.

	Diameter	Thickness
Maximum	4.6	1.4
Minimum	2.2	0.7

Distribution: It was recorded by FAUJAS DE SAINT-FOND (1802) from the Maastrichtian of Holland, and from the Upper Cretaceous of France by SCHLUMBERGER (1901). Although some authors considered *Orbitoides media* to belong to the Early Maastrichtian (SERONIE-VIVIEN, 1972, and ANDREIEFF & MARIONNAUD, 1973), both historical and micropaeontological evidence ascribes these sediments to the Late Campanian (VAN HINTE, 1965; GOHARIAN, 1971; VAN GORSEL, 1973; PLATEL, 1977, and LAMBERT, 1980). In Egypt, it was recorded from the Campanian of Gebel Thelmet, Southern Galala by ISMAIL & BOUKHARY (2001).

In the study area, *Orbitoides media* is recorded from samples UK 66, UK 67 and UK 71 in the Umm Khayshar section, Gebel Thelmet Formation, Campanian, and samples UD 1, UD 2 and UD 3 in the Umm Damaranah section, also Gebel Thelmet Formation, Campanian. At the Umm Khayshar section, the beds which yield both *Orbitoides media* (ARCHIAC) and *Omphalocyclus macropora* (LAMARK) are overlain by beds containing planktonic foraminifera of Early Maastrichtian affinity (such as *Globotruncana aegyptiaca* NAKKADY, *Globotruncana bulloides* VOLGER, *Globotruncana linneana* D'ORBIGNY, *Rosita fornicata* PLUMMER, *Archaeoglobigerina blowi* PESSAGNO, *Rugoglobigerina macrocephala* BRONNIMANN, *Rugoglobigerina rugosa* BRONNIMANN). Therefore, *Orbitoides media* (ARCHIAC) and *Omphalocyclus macropora* (LAMARK) in the study area are of Campanian affinity according to ISMAIL & BOUKHARY (2001).

Genus *Omphalocyclus* BRONN, 1853
***Omphalocyclus macropora* (LAMARCK)**

Pl. III, Figs. 5 & 8–10

1920 *Omphalocyclus macropora* (LAMARCK) – DOUVILLE, p. 209, pl. 8, figs. 5–14.

2001 *Omphalocyclus macropora* (LAMARCK) – ISMAIL & BOUKHARY, p. 82, pl. 3, figs. 5–7.

Remarks: It has a biconcave test, the megalospheric embryo is quadrilocular followed by cycles of arched equatorial chambers.

Distribution: *Omphalocyclus macropora* **w**as recorded from the Upper Cretaceous of Libya by KRUMBECK (1906), from the Maastrichtian of Switzerland by RENZ (1937), from the Maastrichtian of Holland by NEUMANN (1958), and from the Maastrichtian of Cuba by HANZAWA (1962). In Egypt, it was recorded from the Campanian of Gebel Thelmet, Southern Galala by ISMAIL & BOUKHARY (2001).

In the study area, it is recorded from samples UK 66, UK 67 and UK 71 in the Umm Khayshar section, Gebel Thelmet Formation, Campanian, and samples UD 1, UD 2 and UD 3 from the Umm Damaranah section, also Gebel Thelmet Formation, Campanian.

Family Orbitolinidae MARTIN, 1890
Genus *Fallotella* MANGIN, 1954
Fallotella (*Fallotella*) *kochanskae persica* HOTTINGER & DROBNE

Pl. IV, Fig. 11

1980 *Fallotella* (*Fallotella*) *kochanskae persica* HOTTINGER & DROBNE, p. 239, pl. 15, fig. 15–29.

Remarks: It is characterized by its high conical form with horizontal partitions. The diameter of this specimen is 1.4 mm and its height is 1.5 mm.

Distribution: *Fallotella* (*Fallotella*) *kochanskae persica* was recorded from the Palaeocene of Iran by HOTTINGER & DROBNE (1980), in association with *Alveolina* (*Glomalveolina*) *dachelensis*, *Miscellanea* sp. and *Kathina* sp. In the study area, it is recorded from samples UD 21, UD 22 and UD 32 in the Umm Damaranah section, (together with *Glomalveolina dachelensis* and *Miscellanea rhomboidea*), Southern Galala Formation, Middle Palaeocene.

Family Fabulariidae EHRENBERG, 1839
Genus *Fabularia* DEFRANCE, 1820
Fabularia zitteli HOTTINGER

Pl. IV, Fig. 7

1969 *Fabularia zitteli* HOTTINGER, pl. 8, fig. 97.

Remarks: This specimen has a milioline type of coiling in the early stage, becoming two-chamber growth in the adult stage. The adult stage is adapted to be of discoidal shape with only two chambers per whorl.

Distribution: In the study area, *Fabularia zitteli* is recorded from the Umm Khayshar section (samples UK 102, UK 104, UK 106, UK 108 and UK 109), Southern Galala Formation, Ypresian, and from the Umm Damaranah section (samples UD 41 and UK 42), Southern Galala Formation, Ypresian.

Family Alveolinidae EHRENBERG, 1839
Genus *Alveolina* D'ORBIGNY, 1826
Alveolina pasticillata (SCHWAGER)

Pl. IV, Figs. 8–9 & 12

1883 *Alveolina* (*Flosculina*) *pasticillata* SCHWAGER, p. 104, pl. 26 (III), fig. 2.

1960 *Alveolina pasticillata* (SCHWAGER) – HOTTINGER, p. 88, pl. 4, figs. 26–33.

Remarks: The test is almost spherical, only slightly nautiloid whorls in the B-form are flosculinized circular. The last whorls have a thick basal layer. The early whorls are widely spaced while the last whorls are narrowly spaced. Diameter in the B-form is nearly 2.8 mm, 7 whorls in radius 1.38 mm. A- and B-forms are close in overall size or diameter.

Chamberlets in the last whorls are quadrate and beaded in the early whorls. In the A-form, the last whorls lack a thickened basal layer which is thin, chamberlets beaded all over the test, and the last whorls are narrowly separated, early whorls at regular step size. The proloculus is globular, the diameter of the protoconch is 0.16 mm, diameter of deuteroconch is 0.11 mm., diameter of the test is 3.05 mm, number of whorls per radius are 11 whorls in a radius of 1.44 mm.

Distribution: *Alveolina pasticillata* was recorded from the Early Eocene of France by HOTTINGER (1958). In Egypt, It was recorded from the Early Eocene of Egypt by SCHWAGER (1883), HOTTINGER (1960) and KUSS & LEPPIG (1989). In the study area, *Alveolina pasticillata* is recorded from both measured sections, Umm Khayshar section (samples UK 102, UK 104, UK 106, UK 108 and UK 109), Southern Galala Formation, Ypresian, and from Umm Damaranah section (samples UD 41 & UK 42), Southern Galala Formation, Ypresian.

Genus *Glomalveolina* HOTTINGER, 1962
Glomalveolina dachelensis (SCHWAGER)

Pl. IV, Figs. 1 & 2

1883 *Alveolina* cf. *ovulum* SCHWAGER, p. 95, pl. 24, fig. B (a–c).

1980 *Alveolina* (*Glomalveolina*) *dachelensis* SCHWAGER – HOTTINGER & DROBNE, pl. 15, fig. 2g.

1989 *Alveolina* (*Glomalveolina*) *dachelensis* SCHWAGER – KUSS & LEPPIG, p. 302, figs. 5 (a–b).

Remarks: The subgenus *Glomalveolina* was raised to generic rank as it has characters which differ from *Alveolina.* These characters include equidimensional test of nearly spherical outline and a test diameter of 2.5 mm. The diameter of *Glomalveolina dachelensis* is less than that of *Alveolina* (*Glomalveolina*) *levis* whose diameter is 2.8 mm, thus this taxon exists in an older zone than that of *Alveolina* (*Glomalveolina*) *levis* and *Alveolina* (*Glomalveolina*) *primaeva* of the Late Palaeocene.

Distribution: HOTTINGER (1960) described *Alveolina* (*Glomalveolina*) from its type locality (Qasr Dachl) in the Libyan Desert (Egypt), as well as from Gebel Thelmet, Southern Galala, Egypt. In both localities Cretaceous deposits are transgressively overlain by sediments with *Alveolina* (*Glomalveolina*) *dachelensis*, *Operculina libyca* and *Assilina* sp. (KUSS & LEPPIG, 1989). In the study area these beds are overlain in the Umm Damaranah section by Middle Palaeocene rocks (with *Morozovella angulata* and *Morozovella* cf. *conicotruncata*). *Glomalveolina dachelensis* is recorded from the Umm Damaranah section (samples UD 21, UD 22 & UK 32), Southern Galala Formation, Middle Palaeocene.

Family Pellatispiridae HANZAWA, 1937
Genus *Miscellanae* PFENDER, 1935, 1952
***Miscellanea rhomboidea* KUSS & LEPPIG**

Pl. IV, Figs. 4–6

1989 *Miscellanea rhomboidea* KUSS & LEPPIG, p. 303, fig. 6(a–g).

Remarks: This genus is characterized by having alternating whorls, the first whorl with discoidal planispiral evolute coiling, the other whorls are of the spiroloculine type of coiling. The outer outline of the test is planispiral involute. There are two types of side pillars, the first type interfinger with the whorls while the other occurs over the whorls. In *Miscellanea rhomboidea* KUSS & LEPPIG, the diameter of the megalospheric form reaches 1.7 mm. The megalospheric form of the protoconch is surrounded by two chambers in trilateral shape and the diameter of the protoconch is 0.312 mm.

Distribution: It was recorded from the Middle Palaeocene of the Southern Galala by KUSS & LEPPIG (1989). In the study area *Miscellanea rhomboidea* is recorded from samples UD 21, UD 22 and UK 32 in the Umm Damaranah section, Southern Galala Formation, Middle Palaeocene.

Family Nummulitidae DE BLAINVILLE, 1827
Genus *Nummulites* LAMARCK, 1801
***Nummulites* cf. *subramondi* DE LA HARPE 1883 – SCHAUB 1951**

Pl. IV, Fig. 3

cf. 1883 *Nummulites ramondi*, DE LA HARPE, p. 173, pl. II, figs. 5, 12 (form B).

cf. 1883 *Nummulites sub-ramondi*, DE LA HARPE, p. 175, pl. II, figs. 13–17 (form A).

cf. 1951 *Nummulites subramondi* DE LA HARPE – SCHAUB, p. 128, figs. 119–127.

Remarks: *Nummulites subramondi* was probably derived from *N. globulus* (sensu SCHAUB, 1981), as both have similar septa and chambers; our material is recorded only from thin section and can be compared with *Nummulites subramondi* but due to the absence of external characters, the open nomenclature is used.

Distribution: This species was originally recorded from the Thebes Formation, Gebel Deir, near Esna, Nile Valley. Here, *Nummulites* cf. *subramondi* is found together with *Alveolina pasticellata* (SCHWAGER) and *Fabularia zitteli* HOTTINGER. In the study area it is recorded from samples UK 102, UK 104, UK 106, UK 108 and UK 109 in the Umm Khayshar section, Southern Galala Formation, Ypresian, and from the Umm Damaranah section (samples UD 41 and UK 42), Southern Galala Formation, Ypresian.

Green Algae
Family Dasycladaceae KUTZING, 1843
Genus Neomeris LAMOUROUX, 1816
***Neomeris plagnensis* DELOFFRE**

Pl. IV, Fig. 13

1977 *Neomeris plagnensis* DELOFFRE – DELOFFRE et al., p. 41, pl. 5, fig. 5 (3–7).

1989 *Neomeris plagnensis* DELOFFRE – KUSS & LEPPIG, pl. 4, figs. 7–8; pl. 8, figs. 1–3.

Red Algae
Family Corallinaceae (coralline Algae)
Genus Ethelia (PFENDER)
***Ethelia album* (PFENDER)**

Pl. IV, Figs. 10, 14

1938 *Ethelia album* (PFENDER), p. 303, pl. 19, figs. 1–5.

5. SUMMARY AND CONCLUSIONS

The present study is an attempt to throw more light on the stratigraphy of the Southern Galala Plateau. This is a very detailed stratigraphic analysis both lithostratigraphically and biostratigraphically, and has some additional chronostratigraphic implications. The exposed rocks in the area west of the Saint Anthony Monastery have not been previously studied, except for inclusion in some general publications on the Southern Galala Plateau.

The stratigraphic analysis is based on a detailed micropalaeontologic investigation of some Upper Cretaceous rocks exposed in the area west of the Saint Anthony Monastery, Southern Galala, Eastern Desert, Egypt. Two stratigraphic sections were described, measured and sampled – the Umm Khayshar section (139 m thick, 49 samples) and the Umm Damaranah section (197 m thick, 42 samples). The stratigraphic studies subdivided the Campanian–Early Eocene rocks exposed into three rock units. These units are (from base to top): the Gebel Thelmet Formation (Campanian), Sudr Chalk (Maastrichtian) and Southern Galala Formation (Palaeocene–Early Eocene). The distribution of the identified foraminifera either small or large with some macrofos-

sil horizons were the main basis for the biostratigraphic studies.

The occurrence of *Orbitoides media* (ARCHIAC)–*Omphalocyclus macropora* (LAMARCK) in the Gebel Thelmet Formation, in addition to a reasonable number of small foraminifera in the Umm Khayshar section, defines the Late Campanian–Early Maastrichtian period here. This larger foraminiferal horizon is overlain by chalky deposits (Sudr Chalk of GHORAB, 1961) yielding numerous planktonic foraminiferal species. Among these species, the *Globotruncana aegyptiaca* delineates the Early–Middle Maastrichtian, in addition to *Exogyra overwegi* BOCH and *Exogyra cornuarietis* COQUAND (Middle Maastrichtian). The associated foraminiferal assemblage is: *Pseudoclavulina maqfiensis* LE ROY, *Dentalina colei* CUSHMAN & DUSENBURY, *Dentalina communis* (D'ORBIGNY), *Lenticulina muensteri* (ROEMER), *Heterohelix globulosa* (EHRENBERG), *Heterohelix moremani* (CUSHMAN), *Heterohelix striata* (CUSHMAN), *Globigerinelloides prairiehillensis* PESSAGNO, *Globigerinelloides subcarinata* (BRONNIMANN), *Hedbergella holmedlensis* OLSSON, *Globotruncana aegyptiaca* NAKKADY, *Globotruncana bulloides* VOLGER, *Globotruncana linneana* (D'ORBIGNY), *Contusotruncana fornicata* (PLUMMER), *Globotruncanita stuarti* (DE LAPPARENT), *Archaeoglobigerina blowi* PESSAGNO, *Rugoglobigerina macrocephala* BRONNIMANN, *Rugoglobigerina rugosa* (PLUMMER), *Bulimina kickapooensis* COLE, *Bulimina reussi* MORROW, *Bulimina* sp., *Cibicides praecursorius* (SCHWAGER), *Anomalina umbonifera* (SCHWAGER), *Anomalinoides nakkady* SAID & KENAWY, *Anomalinoides sinaensis* SAID & KENAWY, *Heterolepa hispaiolae* (BERMUDEZ) and *Gyroidina* cf. *subangulata* (PLUMMER).

The Gebel Thelmet Formation represents a continuation of the transgression and deposition in an open marine environment in its lower part, and coastal marine to near shore shelf seas in its upper part. The Sudr Chalk begins with deposition under an open marine environment and ended with sedimentation in a shallow marine environment. The Southern Galala Formation represents deposition in a shallow marine environment (coastal marine). The shallow water carbonates within the Palaeogene stratigraphy of the Southern Galala Plateau yield several larger foraminiferal species of stratigraphic significance. A few beds also contain some planktonic foraminifera, which aids determination of the stratigraphic position of the larger foraminifera. *Glomalveolina dachlensis* was recorded in the *Morozovella angulata* zone. This indicates that the stratigraphic level of *Glomalveolina dachlensis* is possibly Early–Middle Palaeocene. Furthermore, the occurrence of the algae *Ethelia album* (PFENDER) and *Neomeris plagnensis* DELOFFRE supports the suggested age for *Glomalveolina dachlensis* (pers. comm. with Professor J. KUSS). Most of the planktonic foraminifera were poorly preserved which makes it difficult to delineate the Palaeocene/Eocene boundary. The Early Eocene rocks contain *Nummulites* cf. *subramondi*. In the Southern Galala, the Early Eocene rocks represent a remarkable sequence that unconformably overlie the Palaeocene rocks and form a steep and vertical inaccessible scarp.

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PLATE I

1 *Heterohelix glabrans* (CUSHMAN), sample UK 75, Gebel Thelmet Formation, Campanian (Deposit no. uk 75 1).

2 *Heterohelix striata* (EHRENBERG), sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 6).

3 *Globigerinelloides prairiehillensis* PESSAGNO, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 7).

4 *Globigerinelloides subcarinata* (BRONNIMANN), ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 8).

5 *Hedbergella holmdelensis* OLSSON, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 9).

6 *Globotruncana aegyptiaca* NAKKADY, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 10).

7 *Globotruncana bulloides* VOLGER, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 13).

8 *Archaeoglobigerina blowi* PESSAGNO, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 16).

9 *Rugoglobigerina macrocephala* BRONNIMANN, ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 17).

10 *Rugoglobigerina rugosa* (PLUMMER), ventral view, sample UK 80, Sudr Chalk, Maastrichtian (Deposit no. uk 80 18).

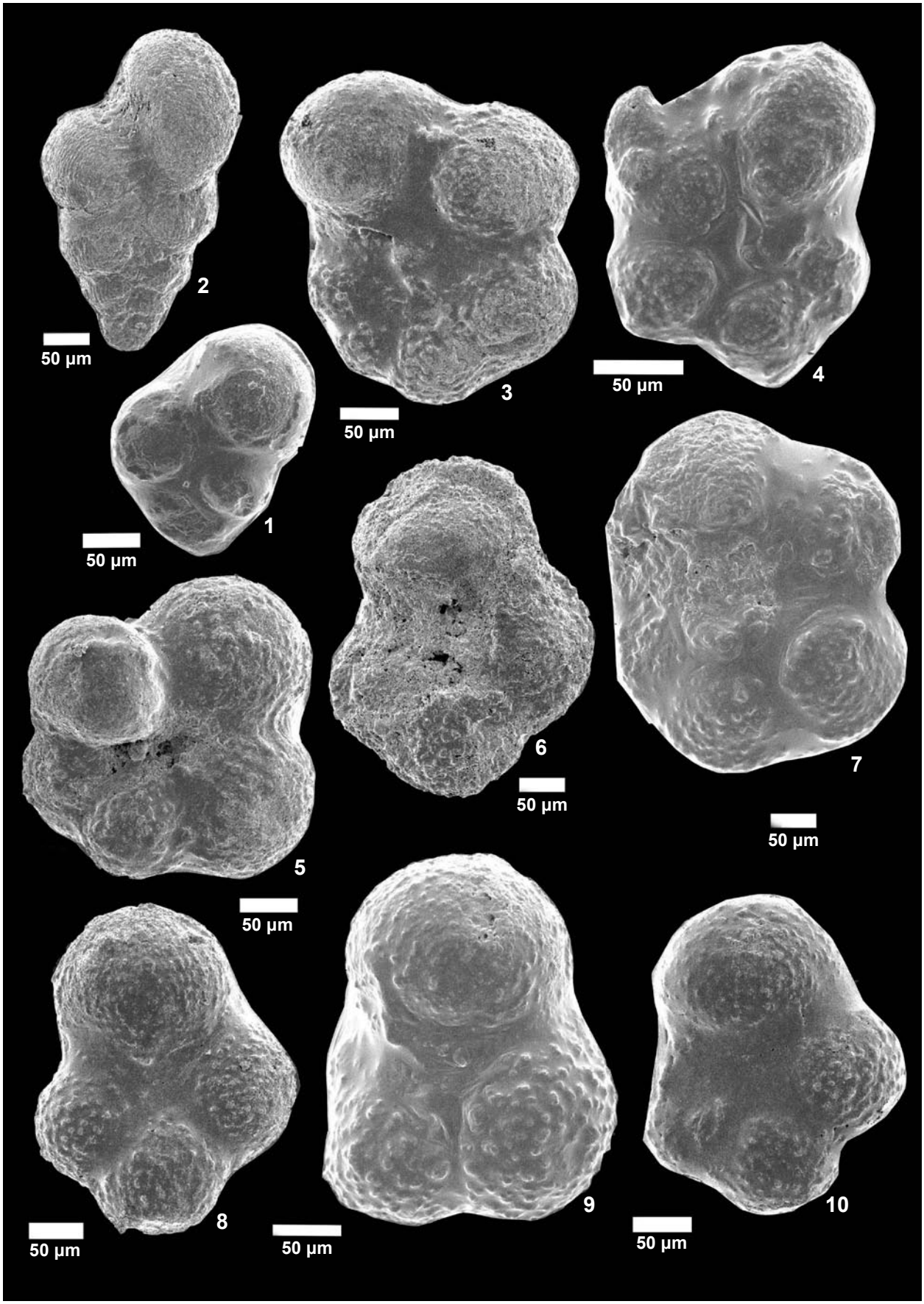
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PLATE II

1–3 *Planorotalites pseudomenardii* (BOLLI), 1 – ventral view, sample UD 36, Southern Galala Formation, Middle Palaeocene (Deposit no. ud 36 1), 2 – dorsal view, sample UD 39, Southern Galala Formation, Late Palaeocene (Deposit no. ud 39 1), 3 – side view, sample UD 40, Southern Galala Formation, Late Palaeocene (Deposit no. ud 40 1).

4 *Acarinina primitiva* (FINLAY), ventral view, sample UD 38, Southern Galala Formation, Late Palaeocene (Deposit no. ud 38 1).

5, 6 *Morozovella angulata* (WHITE), 5 – dorsal view, sample UD 34, Southern Galala Formation, Middle Palaeocene (Deposit no. ud 34 1), 6 – ventral view, sample UD 39, Southern Galala Formation, Late Palaeocene (Deposit no. ud 39 2).

7 *Morozovella* cf. *conicotruncata* (SUBBOTINA), ventral view, sample UD 34, Southern Galala Formation, Middle Palaeocene (Deposit no. ud 34 2).

8 *Morozovella trinidadensis* (BOLLI), ventral view, sample UD 37, Southern Galala Formation, Late Palaeocene (Deposit no. ud 37 2).

9 *Morozovella uncinata* (BOLLI), ventral view, sample UD 37, Southern Galala Formation, Late Palaeocene (Deposit no. ud 37 3).

10, 11 *Globigerina triloculinoides* PLUMMER, 10 – ventral view, sample UD 39, Southern Galala Formation, Late Palaeocene (Deposit no. ud 39 3), 11 – dorsal view, sample UD 39, Southern Galala Formation, Late Palaeocene (Deposit no. ud 39 4).

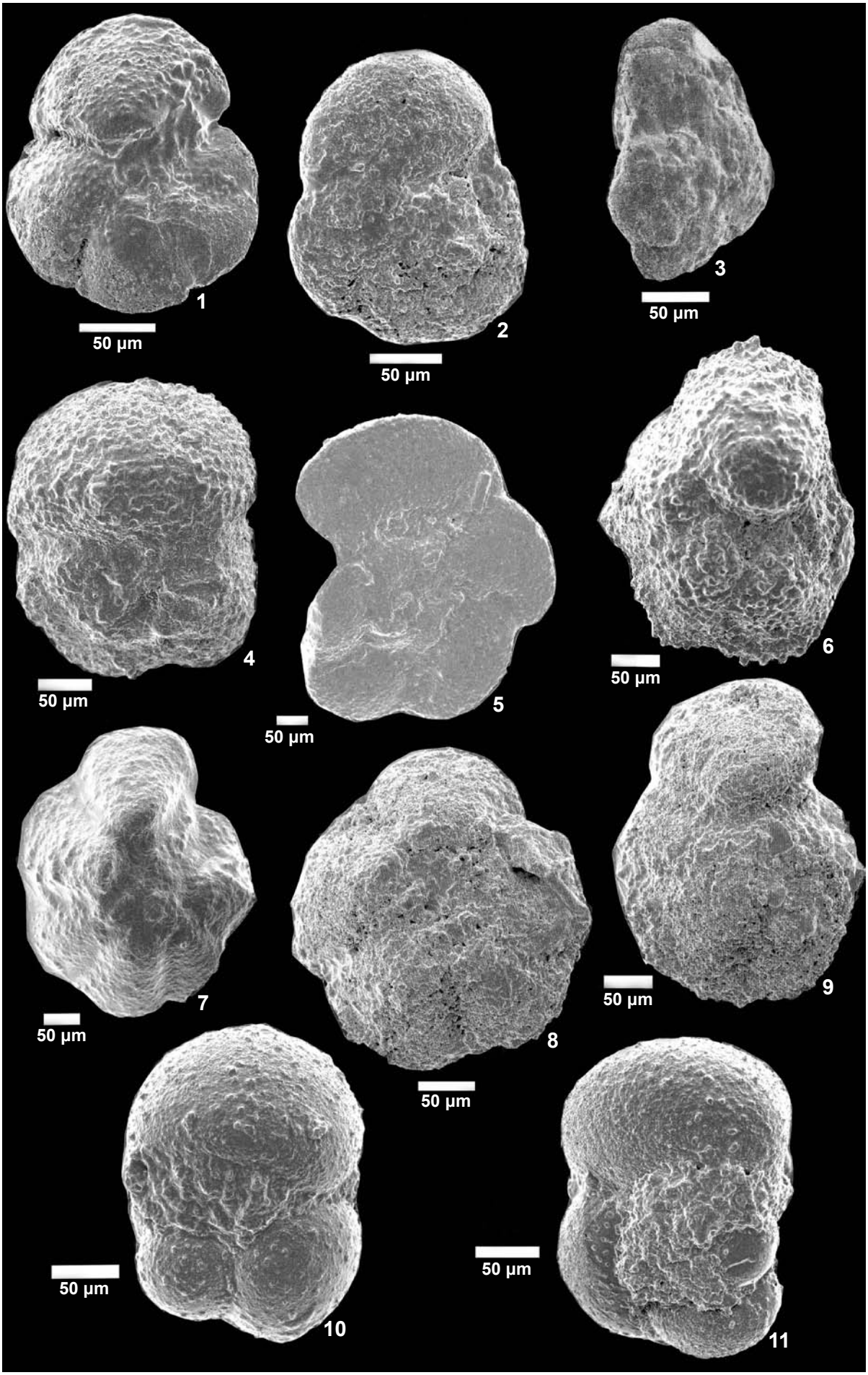
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PLATE III

1–4, 6, 7, 11 *Orbitoides media* (ARCHIAC), 1–3 – external view, specimens from sample UD2, Gebel Thelmet Formation, Campanian (Deposit no. ud 2 1, 2, 3), 4 – axial section, specimen from sample UD 3, Gebel Thelmet Formation, Campanian (Deposit no. ud 3 1), 6–7 – axial section, specimens from sample UK66, Gebel Thelmet Formation, Campanian (Deposit no. uk 66 1, 2), 11 – protochonch of *Orbitoides media* (ARCHIAC), sample UK66, Gebel Thelmet Formation, Campanian (Deposit no. uk 66 3).

5, 8–10 *Omphalocyclus macropora* (LAMARCK), 5 – axial section, specimen from sample UK 67, Gebel Thelmet Formation, Campanian (Deposit no. uk 67 1), 8 – axial section, specimen from sample UK 71, Gebel Thelmet Formation, Campanian (Deposit no. uk 71 1), 9 – axial section, specimen from sample UD 2, Gebel Thelmet Formation, Campanian (Deposit no. ud 2 5), 10 – equatorial section, specimen from sample UK 67, Gebel Thelmet Formation, Campanian (Deposit no. ud 67 2).

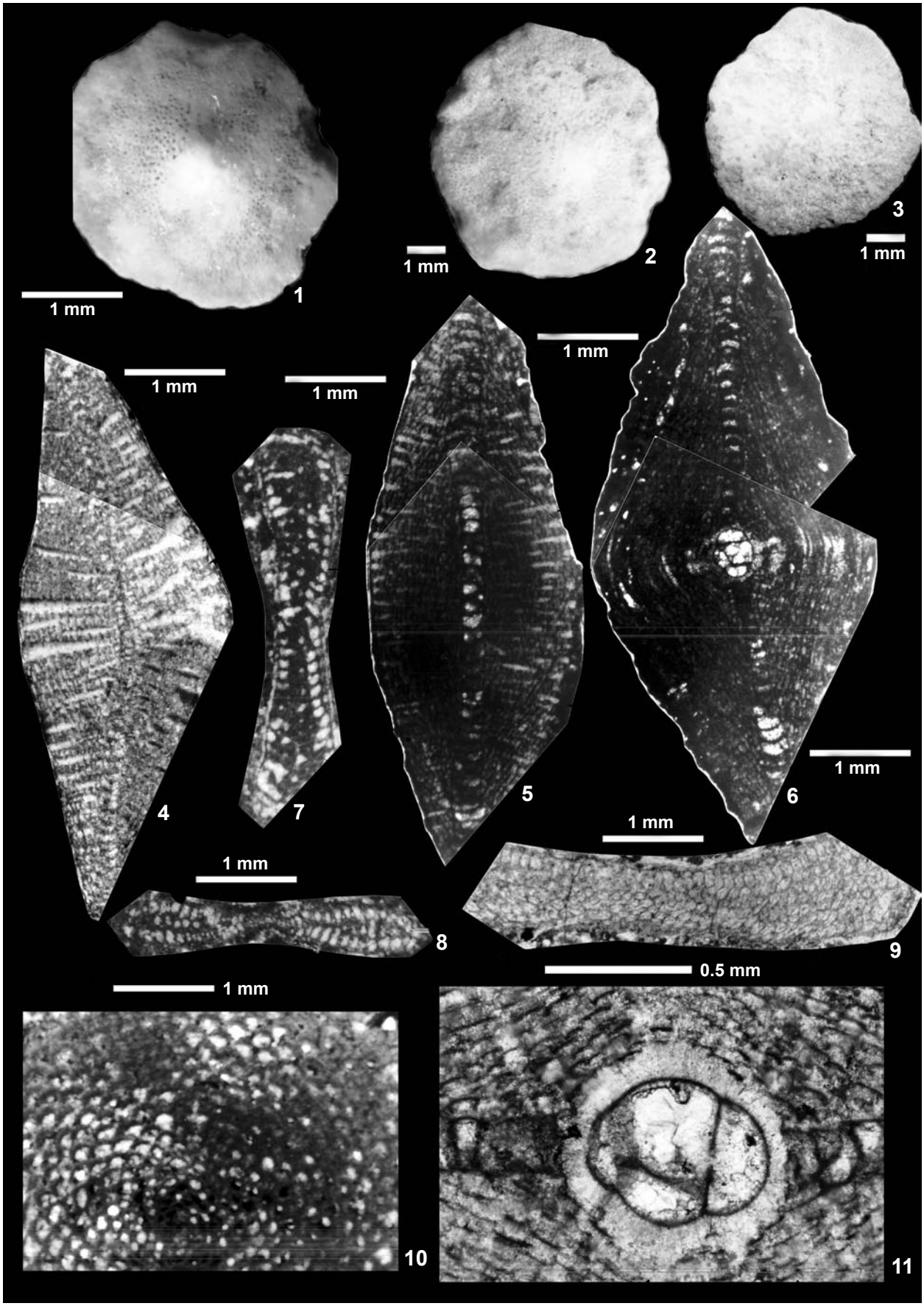
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PLATE IV

1, 2 *Glomalveolina dachelensis* (SCHWAGER), sample UD 22, Southern Galala Formation, Early?/Middle Palaeocene (Deposit no. ud 22 1, 2).

3 *Nummulites* cf. *subramondi* DE LA HARPE, axial section, specimen from sample UK 104, Southern Galala Formation, Ypresian (Deposit no. uk 104 1).

4–6 *Miscellanea rhomboidea* KUSS & LEPPIG, sample UD 22, Southern Galala Formation, Early?/Middle Palaeocene (Deposit no. ud 22 3,4,5).

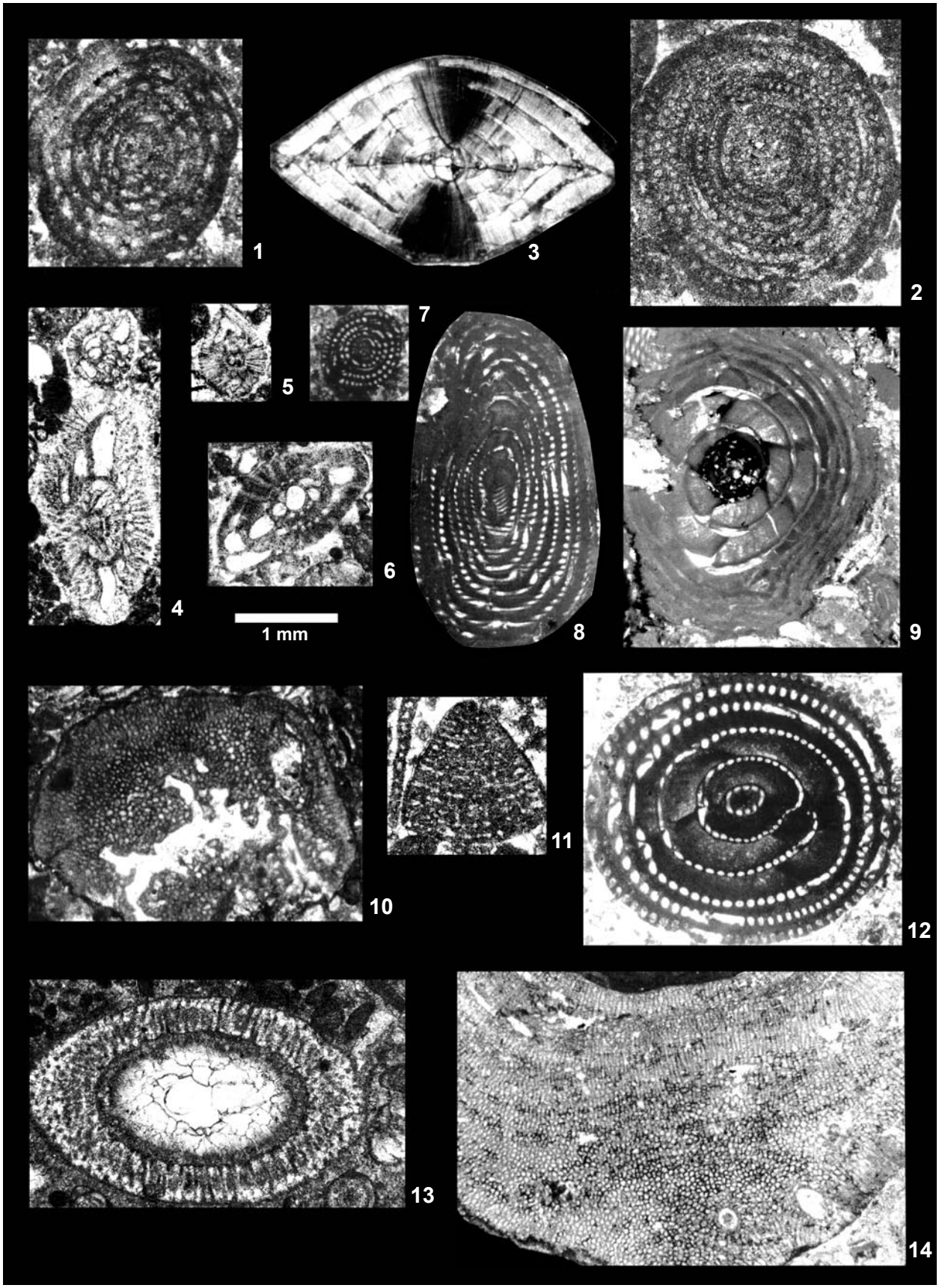
7 *Fabularia zitteli* HOTTINGER, sample UD 42, Southern Galala Formation, Ypresian (Deposit no. ud 42 1).

8–9, 12 *Alveolina pasticillata* (SCHWAGER), 8 – near axial section, sample UK 104, Southern Galala Formation, Ypresian (Deposit no. uk 104 2), 9, 12 – near equatorial section, sample UK 104, Southern Galala Formation, Ypresian (Deposit no. uk 104 3, 4).

11 *Fallotella* (*Fallotella*) *kochanskae persica* HOTTINGER & DROBNE, sample SGY 22, Southern Galala Formation, Early?/Middle Palaeocene (Deposit no. ud 22 6).

10, 14 *Ethelia album* (PFENDER), sample UK 104, Southern Galala Formation, Ypresian (Deposit no. uk 104 5,6).

13 *Neomeris plagnensis* DELOFFRE, sample UD 22, Southern Galala Formation, Early?/Middle Palaeocene (Deposit no. ud 22 7).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