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Lower Miocene foraminifera from some exposures in the Cairo-Suez district, Eastern Desert, Egypt

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ABSTRACT—The carbonate/siliciclastic Miocene rocks in the Cairo–Suez district indicate that lithostratigraphical correlation is very difficult. These beds comprise a complex alternation of autochthonous and detrital sediments. The Lower Miocene age (zone N5 to zone N7) of this succession has been determined by the planktonic foraminifera. In addition, there are benthic assemblages and the larger foraminifera also contributed, to a great extent, to the correlation of the measured sections. Thirty-four of the smallest foraminiferal species, among the 59 recognised, were selected for taxonomic treatment. © 1999 Elsevier Science Limited. All rights reserved.

RÉSUMÉ—Les roches carbonatées et siliciclastiques du Miocène de la région du Caire–Canal de Suez indiquent que la corrélation lithostratigraphique est très difficile. Ces formations comprennent une alternance complexe de sédiments autochtones et détritiques. L'âge du Miocène Inférieur (zone N5 répartir en zones N7) de cette succession a été déterminé par les foraminifères planctoniques. De plus, il y a des assemblages benthiques et les plus grands foraminifères ont également contribué, dans une grande mesure, à la corrélation des sections mesurées. Trente-quatre des plus petites espèces de foraminifères parmi les 59 reconnues ont été sélectionnées pour traitement taxonomique. © 1999 Elsevier Science Limited. All rights reserved.

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INTRODUCTION

The Miocene rocks are well-exposed north and south of the Cairo-Suez road, at the southern end of the Maadi-Sukhna road, in the Sadat area and in the Isthmus of the Suez district (Fig. 1). These rocks occupy the low areas surrounding the Eocene topographic highs: Gabal Ataqa; Gabal Abu Treifyia; Gabal Um Zeita; Gabal Okheider; and Gabal El Galala El Bahariya. Furthermore, the studied rocks represent one of three different Miocene facies distributed in northern Egypt; the north Western Desert (Moghra clastics and Marmarica Limestone), the Gulf of Suez region (Gharandal and Ras Malaab groups) and the Cairo-Suez district (the present study). The study area lies between longitudes 32°6′E and 32°25′E and between latitudes 29°42′N and 30°10′N.

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Numerous papers deal with the Miocene rocks in the Cairo-Suez district (Sadek, 1926, 1959, 1968; Macfadyen, 1930; Metwalli, 1963; Souaya, 1961, 1963; Cherif, 1966, 1980; Hamam, 1966; Abdallah and Abdelhady, 1968; Farag and Sadek, 1968; El Gamal, 1971; Alahwani, 1977; Cherif and Yehia, 1977; Hamza, 1992). Most of these publications focus on the stratigraphy of the Miocene rocks with little emphasis on the microfossils that could delineate, to a great extent, the age of the different rock units as shown in Fig. 2. In the encountered successions, there are some intervals which contain small foraminifera (planktonic and benthic) and others yield larger foraminifera (*Miogypsina, Planostegina* and *Heterostegina*). The larger foraminifera are currently being studied with results abstracted from Piller *et al.* (1995), Toleikis *et al.* (1995) and Abdelghany *et al.* (1996).

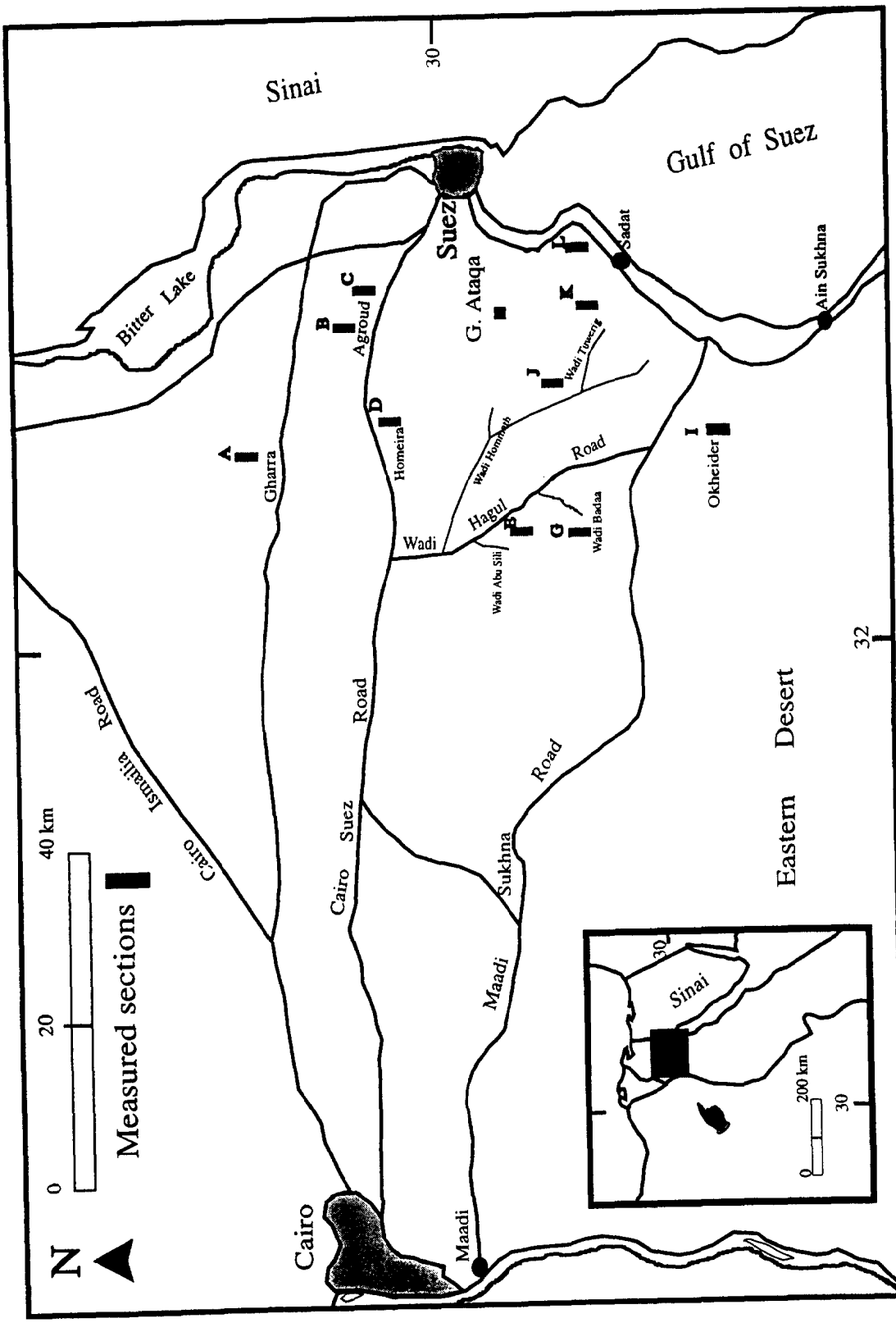


Figure 1. Location map of the study area showing the measured sections.

Age	Sadek, 1926	Abdallah and Abdelhady, 1968	National Committee, 1976	Said, 1990 G. Gharra		Present study Rock units		Fossils	
Upper Miocene	Upper Series M3	Hagul Fm.	Hagul Fm.						
Middle Miocene	Middle Series M2	Hommath Fm.	Genefe Fm. Hommath Fm.	Early Langhian	Genefe Fm.	(?) Hommath Fm.			
Lower Miocene	Lower Series M1	Sadat Fm.	Sadat Fm.	Burdigalian	Gharra Fm.	Burdigalian	Gharra Fm. Sadat Fm.	*Miogypsina (M.)* spp.	*Globigerinoides altiaperturus*-*Gs. bisphericus*

Figure 2. Correlation table showing the different rock units and their ages.

STRATIGRAPHY

Ten sections have been measured (Fig. 3) ranging from 23 m to 140 m in thickness, although the greatest thickness of the Miocene is nearly 154 m (in sections K and J, which are superimposed). The measured sections show high facies variability, making lithostratigraphical correlation very difficult. Generally, all sections reflect an alternation of carbonate and siliciclastic rocks.

The smaller foraminifera (benthic and planktonic) from the measured sections are used to recognise the age of the different rock units and justify their correlation. A detailed study of the identified larger foraminifera (*Miogypsina* spp., *Planostegina* spp. and *Heterostegina* sp.) is currently prepared as separate publications by O. Abdelghany and W. Piller. According to the previous literature, the following formations and members can be distinguished: Sadat Formation; Gharra Formation; and Hommath Formation. The main lithological characteristics, fossil content and thicknesses of these rock units will be discussed.

Sadat Formation

The Sadat Formation was first described by Abdallah and Abdelhady (1968) at Wadi El Ramiya, Sadat Quarry, Suez-Sukhna district. It measures 98 m in thickness and overlies unconformably the Eocene strata and underlies the Hommath Formation. According to Cherif and Yehia (1977), it can be subdivided into the Taratir and Quarry Members as follows.

Taratir Member

This member has been formerly described as the Lower Sandy 'Member' by Cherif and Yehia (1977) and dated as Upper Burdigalian. It consists mainly of coralline algal limestone rich in larger foraminifera (*Planostegina* spp.), echinoderms and molluscs, and is intercalated with a non-fossiliferous laminated gypsiferous, claystone layer, and measures 23.5 m in thickness. It is represented by section (L). In the present study, the Taratir Member can be equated with the lower part of section (E), and is substituted northward by the Agroud Member in sections (A), (B) and (D) due to the facies and faunal similarity.

Quarry Member

This member has been formerly described as the Upper Calcareous 'Member' by Cherif and Yehia (1977) and dated as Langhian. The Quarry Member is represented by section (K), the upper part of section (E), section (G) and section (I). The Quarry Member is substituted northward by the Sadat Member in sections (A), (B) and (D). This member measures 50 m in thickness. It unconformably overlies the Taratir Member and underlies the Hommath Formation. It consists mainly of reefal, coralline algal limestones, rich in corals and molluscs. There are some intercalations of siliciclastic layers composed of coarse-grained, cross-bedded sandstone and bioturbated calcareous sandstone. The Quarry Member is capped by a larger foraminiferal packstone layer rich in *Planostegina* spp. The planktonic foraminiferal assemblage in this member is *Globigerina ciperoensis ottnangiensis*, *Globigerinella* sp., *Globigerinella obesa*, *Globigerinoides altiaperturus*, *Gs. primordius* and *Gs. trilobus.* Cherif and Yehia (1977) dated this formation as Burdigalian to Langhian. In the present study this formation is restricted to the Early Miocene (Burdigalian) on the basis of *Globigerinoides altiaperturus* and *Gs. primordius*.

Gharra Formation

This formation was first described by Ghorab and Marzouk (1967) in Gabal Gharra to designate the marine Miocene of the Cairo-Suez-Sukhna (Sadat) region. It measures 104 m in thickness. In the present study, the following members recorded by El Gamal (1971) have been followed.

Agroud Member

This member was first described by El Gamal (1971) to designate the lowest subdivision of the Gharra Formation in the Cairo-Suez-Sadat region. The type section is represented by the lower part of the composite section measured by Hamam (1966) in the Agroud area. There, the Agroud Member measures 56.8 m in thickness, overlies the pre-Miocene deposits (mainly Oligocene) and underlies the Sadat Member. It includes the lower half of the G. Gharra section (A) and two thirds of both the Agroud area section (B) and the G. Homeira section (D). It consists mainly of coarse-grained sandstone, siltstone, and calcareous sandstone with intercalated fossiliferous sandy limestone layers. The top is made up of a characteristic thick layer of claystone alternating with thin layers of ironstone, fine sandstone and coal seams. There is a reworked fauna from the Eocene deposits at the base of this member, such as *Acarinina* sp., *Morozovella formosa gracilis* and *M.* sp. cf. *M. lensiformis*. The Miocene planktonic foraminiferal assemblage in this member is *Globigerinella* sp., *Ge. obesa; Catapsydrax* sp., *Globoquadrina dehiscens, Globigerinoides altiaperturus, Gs. sp. cf. Gs. parawoodi, Gs. primordius, Gs. sp.* cf. *Gs. quadrilobatus* and *Gs. trilobus.* The fauna

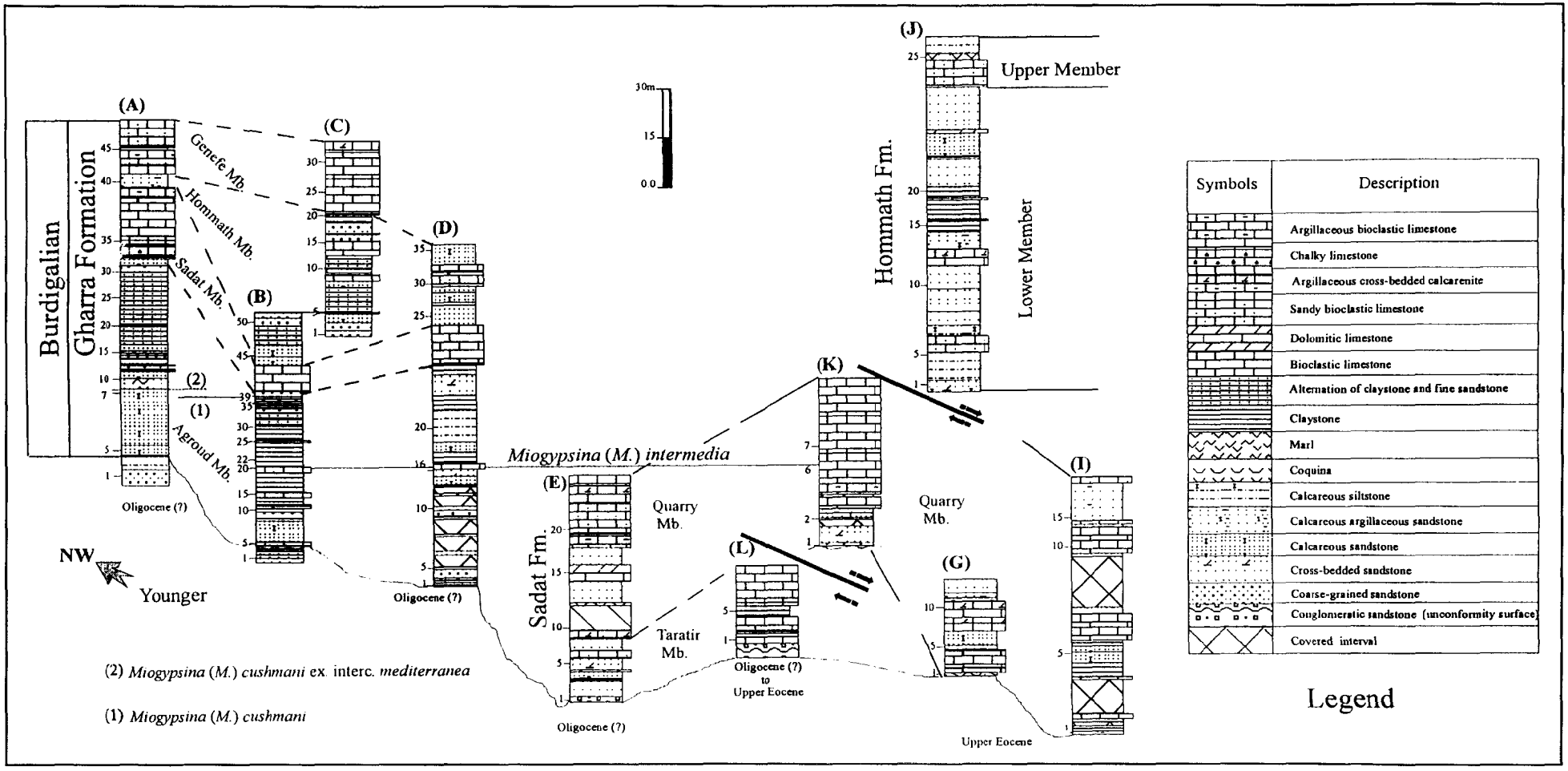


Figure 3. *Lithostratigraphical correlation of the measured sections (correlation based on the* Miogypsina *bed).*

of this member was previously ascribed to the Early Miocene (Burdigalian). Furthermore, the calcareous nannoplanktonic zone, *Helicosphaera ampliaperta*, was detected representing the NN4 zone of Martini (1971) and has been recorded in the Gebel Gharra section (A), Agroud Member, sample 14.

Sadat Member

This member overlies the Agroud Member in sections (A), (B) and (D). It measures 26.4 m in thickness and consists mainly of coralline algal limestone with rhodoliths (5-6 cm in size), green algae (*Halimeda* sp.), isolated coral heads (up to 10 cm in size) and molluscs (oysters). This member has a lesser thickness in the Agroud area section ([B], 8.4 m) and the G. Homeira section ([D], 13.5 m) than in the G. Gharra section ([A], 26.4 m). Based on the recognised larger foraminifera, *Miogypsina* spp. and calcareous nannoplanktonic (*Helicosphaera ampliaperta*), this member is dated as Burdigalian.

Hommath Member

This member overlies the Sadat Member in the G. Gharra section (A) and the G. Homeira section (D). It also includes the top part of the Agroud area section (B) and the lower half of section (C). It measures 4.1 m in thickness and represents a siliciclastic unit composed mainly of sandstone, siltstone, and claystone with intercalated fossiliferous sandy limestone layers. This unit is thinner in the G. Gharra section ([A], 4.1 m), than in the Agroud area sections ([B] and [C], 49 m), and the G. Homeira section ([D], 27.8 m). The foraminiferal assemblage comprises *Catapsydrax* sp., *Globoquadrina dehiscens*, *Globigerinella* sp., *Globigerinoides altiaperturus* and *Gs. trilobus*. It is dated as Burdigalian.

Genefe Member

This member was first defined by Ghorab and Marzouk (1967) in Gabal Genefe. It represents the topmost part of the Gharra Formation in the Cairo-Suez-Sadat region. In the study area, it is represented only by the upper part of the G. Gharra section (A). It measures 16.7 m in thickness and is composed mainly of coral and coralline algal limestone and sandy bioturbated limestone intercalated with dark claystones rich in smaller foraminifera, ostracoda and small molluscs. This unit is thinner in the G. Gharra section ([A], 16.7 m), than in the Agroud area section ([C], 24 m), with low angle cross-bedding at the top of this unit in the Agroud area section (C). The foraminiferal assemblage is *Catapsydrax* sp., *Globigerina ciperoensis ottnangiensis*, *Globigerinella* sp., *Ge. obesa*, *Globigerinoides altiaperturus*, *Gs. bisphericus*, *Gs. obliquus*, *Gs. primordius*, *Gs.* sp. cf. *Gs. quadrilobatus* and *Gs. trilobus*. This unit is ascribed to Late Burdigalian time based on the above fauna.

Hommath Formation

This formation has been well-defined and mapped by Abdallah and Abdelhady (1968) at the southern side of Wadi Hommath, Ataqa area, West Gulf of Suez. It overlies unconformably the Sadat Formation and underlies the non-marine Miocene of the Hagul Formation. According to Cherif and Yehia (1977) this formation is subdivided into two members (Lower Member and Upper Member) at its type locality, where it measures 104 m in thickness.

Lower Member

This member was described as the 'Lower Member' by Cherif and Yehia (1977) and dated as Serravallian. It is described in this paper as a siliciclastic unit composed mainly of sandstones, siltstones and claystone, with fossiliferous sandy limestone beds in between. It measures 89 m at Wadi Tuweirig (section [J]).

Upper Member

This member was described as the 'Upper Member' by Cherif and Yehia (1977) and dated as Serravallian-Tortonian. It is composed mainly of highly fossiliferous sandy limestones, followed by a bryozoan bed (1 m thick) of a yellow, soft marl (bed 19), topped by a non-fossiliferous siltstone layer. It is represented by the upper part of the Wadi Tuweirig section (J) and measures 15 m in thickness. It is dated either as Burdigalian on the basis of its stratigraphical position, or younger in the absence of diagnostic fossils.

DEPOSITIONAL ENVIRONMENT

The Lower Miocene (Burdigalian) rocks in the northern part of the Eastern Desert between the Gulf of Suez and the Nile Delta (Cairo-Suez-Sukhna region), exhibit extensive outcrops of sediments deposited in a neritic environment, documented by the high abundance of larger foraminifera (*Amphistegina*, *Miogypsina*, *Heterostegina*, *Operculina*, and *Planostegina*), including the coralgal facies.

The majority of the identified planktonic foraminifera are of *Globigerinoides* species which live predominantly in the upper 50 m depth (Murray, 1991). Generally, from the above data and the low percentage of planktonic foraminifera throughout

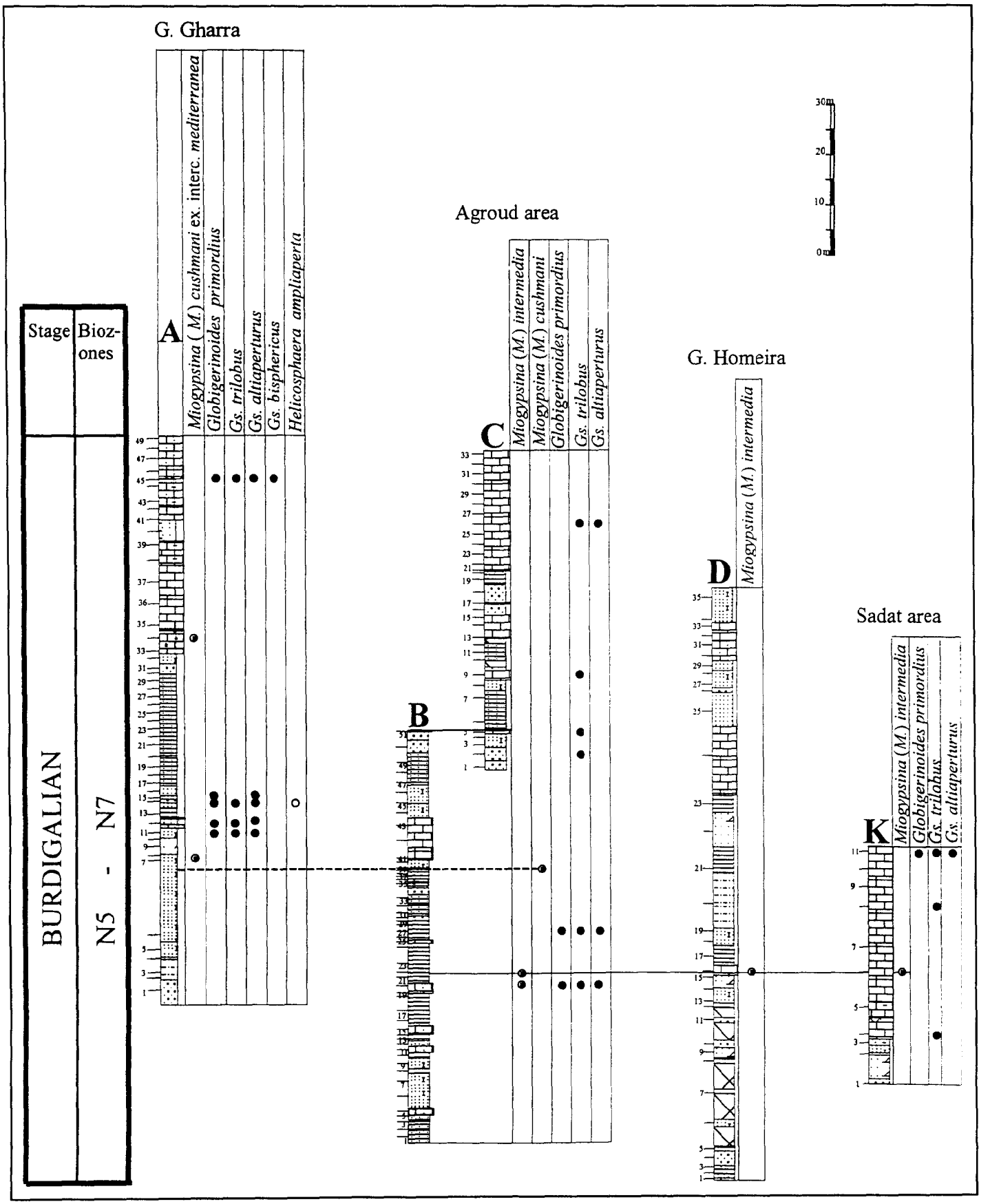


Figure 4. *Correlation between some sections based on stratigraphically important microfossils.*

the studied sections, an inner neritic environment can be inferred.

Larger foraminifera (except *Amphistegina*) are abundant in certain strata. They are restricted in their depth range to the photic zone (Drooger, 1983) and cover a wide range of neritic environments (Hottinger, 1983). Further, the occurrence of *Miogypsina intermedia* plays a significant role in refining the stratigraphical position for the measured sections (Fig. 4).

The macrofauna of the different biotopes of the Burdigalian transgression is represented by assemblages of pelecypods (genera *Ostrea* and *Pecten*) and echinoids (genera *Scutella* and *Clypeaster*), in the lithotopes of fine- to coarse-grained sandstone and calcareous sandstone. This macrofauna is represented sometimes by thick walled oysters and *Pecten coquina* layers throughout the studied sections, although some of the outcrops also contain accumulations of corals (sections [E], [I] and [K]), calcareous green-algae (*Halimeda* sp.) (section [A]), calcareous red-algae (rhodoliths) (sections [A], [B], [D] and [K]), and bryozoa (top of section [J]). This reflects a moderately agitated, marine, shallow water environment.

The Burdigalian deposits in sections (A), (B), (D) and (E) start with siliciclastic sediments, intercalated with calcareous beds, and unconformably overlie sands and gravels of probable Oligocene age. Then comes a thick carbonate sequence, varying in thickness from section (A) (43.1 m) to section (D) (13.5 m), with intercalated detrital sediments. In the south and southeastern part of the study area, sections (G), (I) and (L), the Burdigalian deposits start with shallow water carbonate sediments, rich in miliolids, corals, larger foraminifera (*Miogypsina* and *Planostegina* spp.), unconformably overlying Upper Eocene deposits. Section (L), and section (K), as well as section (J), are tectonically separated (Cherif, 1966; Youssef *et al.*, 1971). This tectonic movement may be related to a local, syn-sedimentary(?) uplift. Siliciclastics were then deposited in section (J).

CONCLUSIONS

The Miocene facies in the Cairo-Suez district represents a complex alternation of carbonate/siliciclastic sediments. The present study has been achieved by measuring the following sections: Gebel Gharra, section (A); Agroud area, sections (B) and (C); Homeira area, section (D); Wadi Abu Sili, section (E); Wadi Badaa, section (G); Wadi Okheider, section (I); Sadat area, sections (L) and (K); and Wadi Hommath, section (J) (Fig. 1). The lithostratigraphical study subdivided the encountered succession into three main rock units, as previously mentioned by different authors: the Gharra Formation, the Sadat Formation and the Hommath Formation (locally recognised in section [J]). In the northern part of the study area, the Gharra Formation is subdivided into four members named from base to top, the Agroud, Sadat, Hommath and Genefe Members. On the other hand, in the southern part of the study area, The Sadat Formation is divisible into the Taratir and Quarry Members. The Hommath Formation is, in section (J), also subdivided into a lower member and an upper member. The micropalæontological investigations revealed some intervals yielding small benthic and planktonic foraminifera, and others containing larger foraminifera, in addition to macrofaunal assemblages (*Ostrea* sp., *Pecten* sp., *Scutella* sp. and *Clypeaster sp.*). Among the eleven recognised planktonic species, four of them (*Globigerinoides altiaperturus, Gs. primordius, Gs. bisphericus* and *Globoquadrina dehiscens*) ascribed the sections (A), (B), (C), (D) and (K) to the Burdigalian—Zones N5 to N7. About 48 small benthic foraminifera species have been identified representing an Early Miocene assemblage and reflecting a shallow marine environment in this interval. Several species of larger foraminifera have also been recorded in this work: *Miogypsina* (*M.*) *intermedia*; *Miogypsina* (*M.*) *cushmani; Miogypsina* (*M.*) *cushmani* ex. interc. *mediterranea*; *Heterostegina* cf. *H. borneensis*; *Operculina complanata*; *Planostegina heterostegina*; *P.* cf. *praecostata*; and *P. costata*. The detailed description of these species and their application in systematic palæontology are currently being carried out by Abdelghany and Piller. The *Miogypsina* (*M.*) *intermedia* species plays a great role in correlating the measured sections within the Early Miocene interval. Furthermore, one calcareous nannoplakton zone, that of *Helicosphaera ampliaperta*, was detected. It indicates the NN4 Zone of Martini (1971) and has been recorded in the Gebel Gharra section (A), Agroud Member, sample 14.

TAXONOMIC NOTES

In the following paragraphs, the taxonomy of some species of smaller foraminifera (benthic and planktonic) will be dealt with. The classification of Loeblich and Tappan (1988) has been followed. The microfossils were photographed by a Scanning Electron Microscope (SEM).

Order: Foraminiferida Eichwald, 1830
Suborder: Textulariina Delage and Hoerouard, 1896
Family: Textulariidae Ehrenberg, 1838
Genus: *Textularia* Defrance, 1824
Textularia gramen d'Orbigny, 1846 (Fig. 5: 1)
Textularia gramen d'Orbigny (1846, p. 248, pl. 15, figs. 4-6).
Textularia gramen d'Orbigny: Papp and Schmid (1985, p. 87, pl. 81, figs. 1-8).
Remarks: Test slightly compressed, expanded-broad at the apertural end.
Occurrence: Sample 12, 14, 45 section (A); sample 3, 6, 20, section (B); sample 1, 2, section (C); sample 13, section (D); sample 11, section (I); sample 2, 3, 6, 8, section (J); sample 7, section (L).

Textularia mariae d'Orbigny, 1846 (Fig. 5: 2)
Textularia mariae d'Orbigny (1846, p. 246, pl. 14, figs. 29-31).
Textularia articulata Cicha and Zapletalova(1965, p. 121, fig. 15).
Textularia mariae d'Orbigny: Papp and Schmid (1985, p. 86, pl. 79, figs. 5-8).
Remarks: Test slender and long, the chambers are short and high.
Occurrence: Sample 12, section (A); sample 20, section (B); sample 1, section (C); sample 3, 8, section (J); sample 4, section (K).

Textularia nussdorfensis d'Orbigny, 1846 (Fig. 5 :3)
Textularia nussdorfensis d'Orbigny (1846, p. 243, pl. 14, figs. 17-19).
Textularia nussdorfensis d'Orbigny: Papp and Schmid (1985, p. 84, pl. 78, figs. 1-3).
Remarks: Test textulariid, biserial, flat, with low, almost horizontally arranged chambers; distinctly keeled.
Occurrence: Sample 12, section (A); sample 20, section (B); sample 1, 2, section (C); sample 4, 8, 11, section (I); sample 3, 8, section (J).

Family: Pseudogaudryinidae Loeblich and Tappan, 1985
Genus: *Clavulinoides* Cushman, 1936
Clavulinoides tricarinatus Leroy, 1941 (Fig. 5: 4)
Clavulinoides tricarinatus Leroy (1941, p. 20, pl. 3, figs. 92, 93).
Clavulinoides tricarinatus Leroy: Boomgaart (1949, p. 58, pl. 4, figs. 8, 9).
Clavulinoides tricarinatus Leroy: Marks (1951, p. 35, pl. 6, fig. 1).
Remarks: Test elongate, triserial in early stage, then biserial, only a few chambers comprising the uniserial stage. It has parallel sides with pyramidal-shaped chambers. Sutures distinct, limbate, depressed. Periphery acute. Aperture terminal, rounded.
Occurrence: Sample 14, section (B); sample 7, section (D).

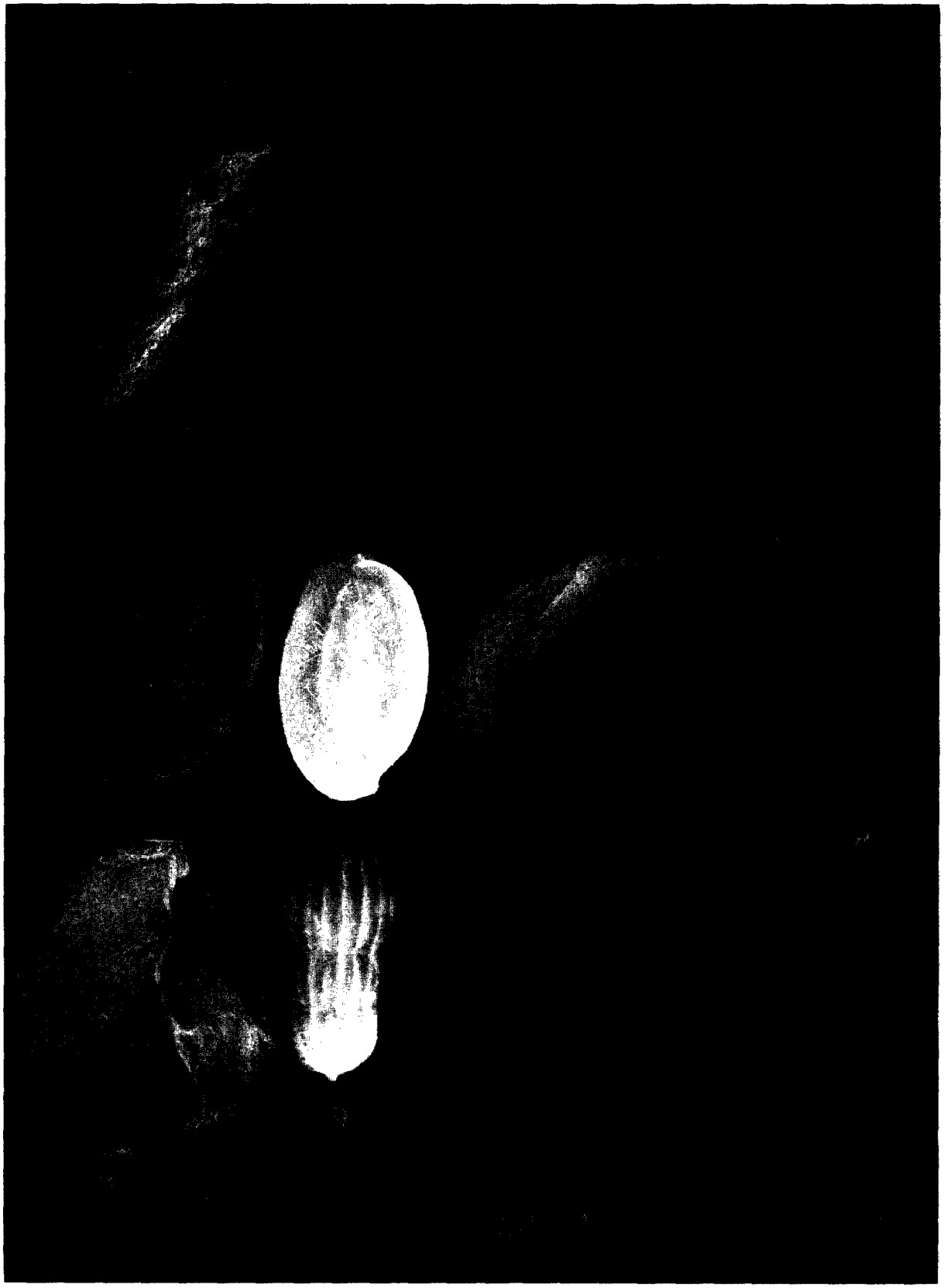
Family: Hauerinidae Schwager, 1876
Genus: *Massilina* Schlumberger, 1893
Massilina tenuis (Czjzek, 1848) (Fig. 5: 5)
Quinqueloculina tenuis Czjzek (1848, p. 149, pl. 13, figs. 31-34).
Quinqueloculina tenuis Czjzek: von Reuss (1850, p. 385, figs. 1-8).
Massilina tenuis (Czjzek): Hamam (1966, p. 74, pl. 2, fig. 16).
Remarks: Test ovate, slightly flattened. Early chambers quinqueloculine and separated by depressed sutures. Later added in a single plane on alternate sides as in *Spiroloculina*. It shows a tendency to become planispiral in later stage. *Massilina* is quinqueloculine in the early stage, whereas *Spiroloculina* is planispiral throughout.
Occurrence: Sample11, section (A).

Genus: *Quinqueloculina* d'Orbigny, 1826
Quinqueloculina akneriana d'Orbigny, 1846 (Fig. 5: 6)
Quinqueloculina pauperata d'Orbigny (1846, p. 286, pl. 17, figs. 22-24).
Quinqueloculina akneriana Luczkowska (1974, p. 35).
Quinqueloculina akneriana Luczkowska: Papp and Schmid (1985, p. 97, pl. 91, figs. 1-4).
Remarks: Test is relatively small in size with smooth surface. The last chamber is less elevated.
Occurrence: Sample 11, 13, 14, 15, section (A); sample 3, 11, 39, section (B); sample 1, section (C); sample 14, section (E); sample 3, section (G); sample 11, 13, section (I); sample 3, section (J).

Genus: *Triloculina* d'Orbigny, 1826
Triloculina gibba d'Orbigny, 1826 (Fig. 5: 7)
Triloculina gibba d'Orbigny (1825, p. 133, Nr. 3, [fide Ellis and Messina]).
Triloculina gibba d'Orbigny (1946, p. 274, pl. 16, figs. 22-24).
Triloculina gibba d'Orbigny: Luczkowska (1974, p. 134, pl. 23, figs. 2 a-c).
Triloculina gibba d'Orbigny: Papp and Schmid (1985, p. 93, pl. 86, figs. 1-4; text-plate 14, fig. 1).
Remarks: Test triangular in shape, very broad with rounded coils, without prominent ridge, sutures depressed.
Occurrence: Sample 14, 42, section (A); sample 26, section (C); sample 18, 24, section (D); sample 22, section (E); sample 10, 11, section (I); sample 6, 22, section (J).

Family: Nodosariidae Ehrenberg, 1838
Genus: *Nodosaria* Lamarck, 1812
Nodosaria badenensis d'Orbigny, 1846 (Fig. 5: 8)
Nodosaria badenensis d'Orbigny (1846, p. 38, pl. 1, figs. 34, 35).
Nodosaria badenensis d'Orbigny: Papp and Schmid (1985, p. 27, pl. 7, figs. 4-8).
Remarks: Test has four chambers, a long neck and clear longitudinal costae.
Occurrence: Sample 12, 14, section (A); sample 2, 5, section (C).

Nodosaria scalaris (Batsch, 1791) (Fig. 5: 9)
Nautilus (Orthoceras) scalaris Batsch (1791, pl. II, figs. 4a, b).
Nodosaria scalaris (Batsch): Brady (1884, p. 510, pl. LXIII, figs. 28-31; pl. LXIV, figs. 16-19).



Nodosaria scalaris (Batsch): Macfadyen (1930, p. 73, pl. 2, fig. 34).
Nodosaria scalaris (Batsch): Cushman (1931, p. 65, pl. 8, figs. 12, 13).
Nodosaria scalaris (Batsch): Hamam (1966, p. 82, pl. 4, fig. 17).
Remarks: Test small elongate; (3-6) chambers, globular, increasing gradually in size. Surface ornamented with longitudinal costae; sutures distinct, thickened at right angle to the ornamentation.
Occurrence: Sample 12, 14, section (A); sample 2, 5, section (C); sample 13, 16, section (D).

Genus: *Lenticulina* Lamarck, 1804
Lenticulina cf. *ariminensis* (d'Orbigny, 1825) (Fig. 5: 10)
Robulina ariminensis d'Orbigny (1825, p. 123, Nr. 15 [fide Ellis and Messina]).
Robulina ariminensis d'Orbigny (1846, p. 95, pl. 4, figs. 8, 9).
Lenticulina ariminensis (d'Orbigny): Papp and Schmid (1985, p. 41, pl. 28, figs. 1-3).
Remarks: Test planispiral, involute, aperture open, wide and areal, without central pillar, and non-keeled.
Occurrence: Sample 11, 14, 45, section (A); sample 20, section (B); sample 12, 16, 24, section (D); sample 10, 12, 22, section (E); sample 5, section (F); sample 10, section (J); sample 4, section (L).

Family: Lagenidae Reuss, 1862
Genus: *Lagena* Walker and Jacob, 1798
Lagena striata (d'Orbigny, 1839) (Fig. 5: 11)
Oolina striata d'Orbigny (1839, p. 21, pl. 5, fig. 12).
Lagena striata (d'Orbigny): Brady (1884, p. 460, pl. 57, figs. 22-24).
Lagena striata (d'Orbigny): Omara and Ouda (1969, pl. 1, fig. 14).
Lagena striata (d'Orbigny): Cimerman and Langer (1991, p. 53, pl. 55, figs. 6-7).
Remarks: Test flask-shaped, single chamber with fine striations. Aperture rounded, phialine on neck.
Occurrence: Sample 14, 5, section (A).

Family: Ellipsolagenidae Silvestri, 1923
Genus: *Oolina* d'Orbigny, 1839
Oolina cf. *acuticosta* (von Reuss, 1862) (Fig. 5: 12)
Lagena acuticosta von Reuss (1862, p. 305, pl. 1, fig. 4).
Lagena acuticosta Reuss: Cushman (1923, p. 5, pl. 1, figs. 1-3).
Oolina apiopleura (Reuss): Todd and Low (1967, p. 28, pl. 3, fig. 24).
Oolina acuticosta (Reuss): Knudsen (1971, p. 222, pl. 6, fig. 1; pl. 17, fig. 1).
Remarks: Test unilocular, pyriform. It has a few fine longitudinal ribs with apiculate base.
Occurrence: Sample 45, section (A).

Family: Pappinidae Haunold, 1990
Genus: *Pappina* Haunold, 1990
Pappina parkeri (Karrer, 1877) (Fig. 6: 1)
Uvigerina parkeri Karrer (1877, s. 385-386, taf. 16 b, fig. 50).
Uvigerina compressa Cushman (1925, p. 10, pl. 4, figs. 2 a-c).
Hopkinsina bononiensis (Fornasini): Marks (1951, p. 62-63, pl. 7, fig. 8).
Uvigerina compressa Cushman: Rupp (1986, s. 68, taf. 39, fig. 6).
Pappina bononiensis compressa (Cushman): Haunold (1990a, p. 61, figs. 4, 5, 12; pl. 2, figs. 3-5).
Pappina parkeri (Karrer): Haunold (1990b, s. 90, 91, taf. 1, figs. 3, 4, taf. 3, figs. 15-18).
Pappina parkeri (Karrer): Haunold (1995, s. 80, 81, taf. 2, fig. 14).
Remarks: Test elongate, fusiform, comparatively slender. Initial chambers are slightly inflated, arranged in planes approximately 144° apart; later becoming biserial, with numerous longitudinal ribs on each chamber. Aperture rounded, simple at the end with a short neck.
Occurrence: Sample 12, 14, section (A); sample 12, section (B); sample 19, section (D).

Family: Reussellidae Cushman, 1933
Genus: *Reussella* Galloway, 1933
Reussella spinulosa (von Reuss, 1850) (Fig. 6: 2)
Verneuilina spinulosa von Reuss (1850, p. 374, pl. 47, fig. 12).
Reussella spinulosa (Reuss): Cushman (1945, p. 33, pl. 6, figs. 8, 9).
Reussella spinulosa (Reuss): Marks (1951, p. 61).
Reussella spinulosa (Reuss): Hamam (1966, p. 100, pl. 3, fig. 15).

Figure 5. ***1:*** Textularia gramen *d'Orbigny, 1846. Section (A), sample 12, 14, 45; section (D), sample 3, 6, 20; section (C), sample 1, 2; section (D), sample 13; section (I), sample 11; section (J), sample 2, 3, 6, 8; section (L), sample 7; X = 70;* ***2:*** Textularia mariae *d'Orbigny, 1846. Section (A), sample 12; section (B), sample 20; section (C), sample 1; section (J), sample 3, 8; section (K), sample 4; X = 112;* ***3:*** Textularia nussdorfensis *d'Orbigny, 1846. Section (A), sample 12; section (B), sample 20; section (C), sample 1, 2; section (I), sample 4, 8, 11; section (J), sample 3, 8; X = 5;* ***4:*** Clavulinoides tricarinatus *Leroy, 1941. Section (B), sample 14; section (D), sample 7; X = 42;* ***5:*** Massilina tenuis *(Czjzek, 1848). Section (A), sample 11; X = 133.;* ***6:*** Quinqueloculina akneriana *d'Orbigny, 1846. Section (A), sample 11, 13, 14, 15; section (B), sample 3, 11, 39; section (C), sample 1; section (E), sample 14; section (G), sample 3; section (I), sample 11, 13; section (J), sample 3; X = 11;* ***7:*** Triloculina gibba *d'Orbigny, 1825. Section (A), sample 14, 42; section (C), sample 26; section (D), sample 18, 24 section (E), sample 22; section (I), sample 10, 11; section (J), sample 6, 22; X = 126;* ***8:*** Nodosaria badenensis *d'Orbigny, 1846. Section (A), sample 12, 14; section (C), sample 2, 5; X = 70;* ***9:*** Nodosaria scalaris *(Batsch, 1791). Section (A), sample 12, 14; section (C), sample 2, 5; section (D), sample 13, 16; X = 119;* ***10:*** Lenticulina *cf.* ariminensis *(d'Orbigny, 1825). Section (A), sample 11, 14, 45; section (B), sample 20; section (D), sample 12, 16, 24; section (E), sample 10, 12, 22; section (F), sample 5; section (J), sample 10; section (L), sample 4; Side v.; X = 98;* ***11:*** Lagena striata *(d'Orbigny, 1839). Section (A) sample 14, 45; X = 210;* ***12:*** Oolina *cf.* acuticosta *(von Reuss, 1862). Section (A), sample 45; X = 189.*

Remarks: Test triserial, triangular in transverse section, with acute angles and flattened sides, slightly depressed in the centre, tapering at base, edges slightly and broadly serrated, broad at the apertural end, chambers numerous increasing in size as added, wall calcareous finely perforate with roughened surface. Sutures distinct and aperture triangular in shape.
Occurrence: Sample 14, 45, section (A); sample 4, section (K).

Family: Virgulinellidae Loeblich and Tappan, 1984
Genus: *Virgulinella* Cushman, 1932
Virgulinella pertusa (von Reuss, 1860) (Fig. 6: 3)
Virgulina pertusa von Reuss (1860, pl. 2, figs. 16 a, b).
Virgulina pertusa Cushman (1829, p. 53, pl. 9, figs. 1-4).
Bulimina andreaei Macfayden (1930, p. 54, pl. 1, fig. 18).
Virgulinella pertusa (Reuss): Hamam (1966, p. 99, pl. 3, fig. 10).
Remarks: Test elongate, fusiform, sharply pointed at the base. Chambers inflated increasing rapidly in size as added. Sutures distinct, depressed, distinctly oblique, marked by numerous depressions. Aperture elongate, loop shaped.
Occurrence: Sample 12, 13, 14, 45, section (A); sample 12, section (B); sample 2, 3, section (C).

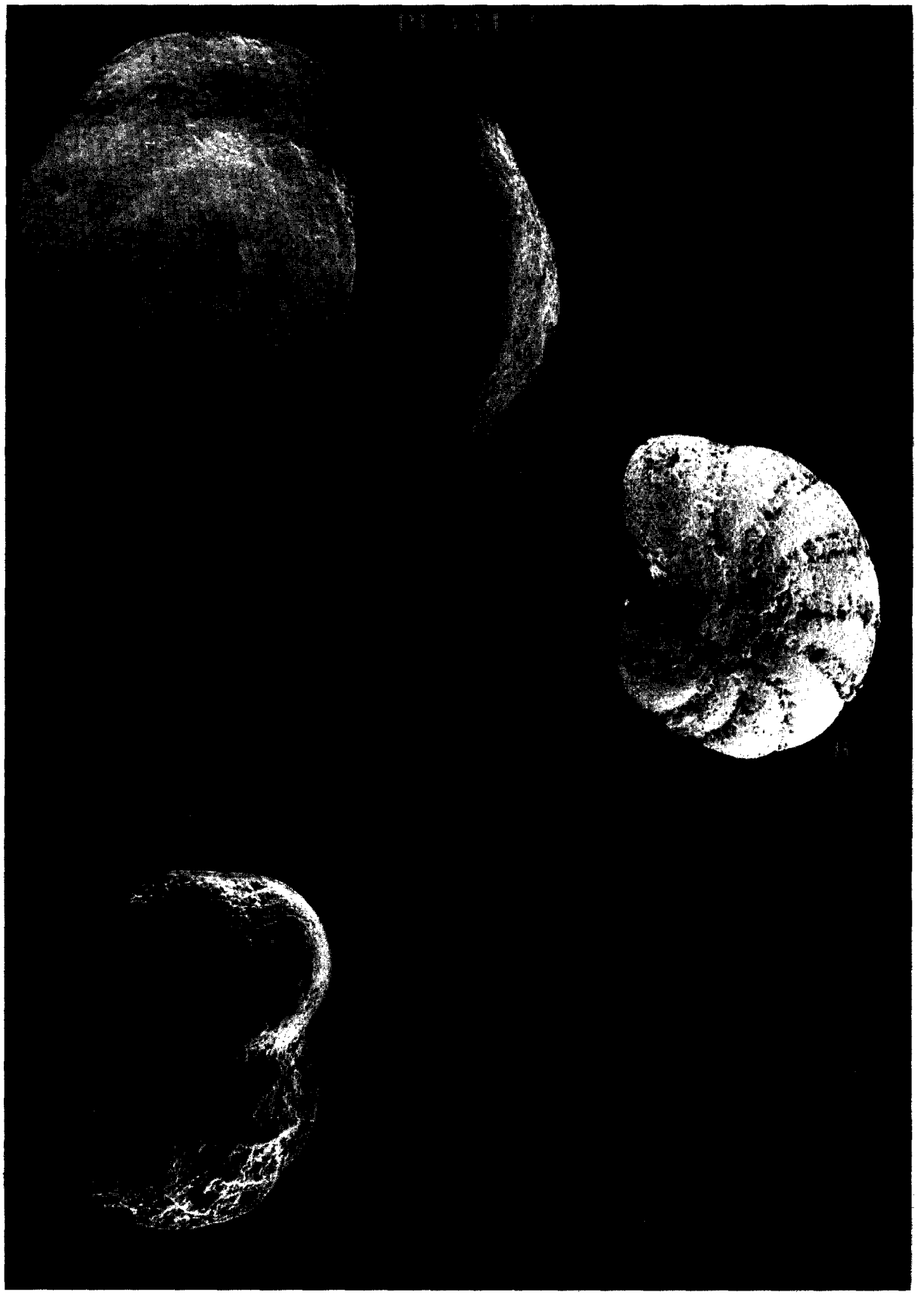
Family: Bagginidae Cushman, 1927
Genus: *Cancris* Montfort, 1808
Cancris auriculus (Fichtel and Moll, 1798) (Fig. 6: 4, 5)
Nautilus auricula Fichtel and Moll (1798, p. 108, pl. 20, figs. a-c).
Rotalia brongniarti (Fichtel and Moll): d'Orbigny (1846, p. 158, pl. 8, figs. 22-24).
Cancris auriculus (Fichtel and Moll): Marks (1951, p. 66).
Cancris auriculus (Fichtel and Moll): Papp and Schmid (1985, p. 61, pl. 52, figs. 7-13).
Remarks: Test asymmetrically coiled, flat, keeled; the chambers increase more or less distinctly in height. The last chamber on the ventral side overlaps several earlier chambers and occupies nearly half of the whole length of the test.
Occurrence: Sample 8, 14, 45, section (A); sample 20, section (B).

Family: Cibicididae Cushman, 1927
Genus: *Cibicides* Montfort, 1808
Cibicides ungerianus (d'Orbigny, 1846) (Fig. 6: 6, 7)
Rotalia ungeriana d'Orbigny (1846, p. 157, pl. 8, figs. 16-18).
Cibicides ungerianus (d'Orbigny): Marks (1951, p. 73, pl. 8, figs. 2 a, b).
Cibicides ungerianus (d'Orbigny): Cicha and Zapletalova (1965, p. 13, pl. 6, figs. 4-6).
Cibicides ungerianus (d'Orbigny): Papp and Schmid (1985, p. 60, pl. 51, figs. 7-11).
Remarks: Test sharply keeled, relatively thin with distinct pores. The dorsal side of the test is flat and exhibits a distinct crenulation. The ventral side is arched and the chambers converge in the centre.
Occurrence: Sample 8, 11, 12, 14, 15, 45, section (A); sample 12, 20, section (B); sample 16, section (D); sample 11, 21, section (E); sample 4, section (F); sample 11, section (I); sample 6, 10, section (J); sample 4, section (K); sample 8, section (L).

Family: Asterigerinidae d'Orbigny, 1839
Genus: *Asterigerina* d'Orbigny, 1826
Asterigerina planorbis d'Orbigny, 1846 (Fig. 6: 8, 9)
Asterigerina planorbis d'Orbigny (1846, p. 205, pl. 11, figs. 1-3).
Asterigerina planorbis d'Orbigny: Marks (1951, p. 66, pl. 8, figs. 1a-c).
Asterigerinata planorbis d'Orbigny: Hofker (1959, p. 258, text-plate 25).
Asterigerina planorbis d'Orbigny: Papp and Schmid (1985, p. 75, pl. 66, figs. 9-14).
Remarks: Test trochoid, strongly planoconvex, much depressed, flat concave ventral side, circular in outline, periphery acute. Four to six chambers visible ventrally, not including the secondary chambers which form a stellate arrangement.
Occurrence: Sample 11, 14, 15, 45, section (A); sample 14, 20, section (B); sample 5, section (C); sample 9, 19, section (D); sample 22, section (E); sample 6, section (L).

Family: Nonionidae Schultze, 1854
Genus: *Nonion* Montfort, 1808
Nonoin fabum (Fichtel and Moll, 1798) (Fig. 6: 10, 11)
Nautilus faba Fichtel and Moll (1798, p. 103, pl. 19, figs. a-c).
Nonion fabum (Fichtel and Moll): Rupp (1986, p. 65, pl. 28, figs. 1, 2).
Remarks: Test planispiral involute, compressed, numerous chambers, increasing gradually in size as added. Umbilical region depressed and filled with finely granulose matter. Surface smooth. Aperture a low opening in the base of the broadly triangular apertural face.

Figure 6. 1: Pappina parkeri *(Karrer, 1877). Section (A), sample 12, 14; section (B), sample 12; section (D), sample 19; X = 105;* ***2:*** Reussella spinulosa *(von Reuss, 1850). Section (A), sample 14, 45; section (K), sample 4; X =98.;* ***3:*** Virgulinella pertusa *Reuss, 1860, Section (A), sample 12, 13, 14, 45; section (B),sample 12; section (C), sample 2, 3; X = 133;* ***4, 5:*** Cancris auriculus *(Fichtel and Moll, 1798). Section (A), sample 8, 14, 45; section (B), sample 20; 4-Ventral v.; X = 154, 5-Side v.; X = 126;* ***6, 7:*** Cibicides ungerianus *(d'Orbigny, 1846). Section (A), sample 8, 11, 12, 14, 15, 45; section (B), sample 12, 20; section (D), sample 16; section (E), sample 11, 21; section (F), sample 4; section (I), sample 11; section (J), sample 6, 10; section (K), sample 4; section (L), sample 8; 6- side v.; X = 77, 7-Ventral v.; X = 91;* ***8, 9:*** Asterigerina planorbis *d'Orbigny, 1846. Section (A), sample 11, 14, 15, 45; section (B), sample 14, 20; section (C), sample 5; section (D), sample 9, 19; section (E), sample 22; section (L), sample 6; 8-Dorsal v.; X = 161, 9-Ventral v.; X = 161;* ***10, 11:*** Nonion fabum *(Fichtel and Moll, 1798). Section (A), sample 12, 14, 15, 45; section (B), sample 6, 11, 12, 20, 28; section (D), sample 12, 16; section (E), sample 14; section (F), sample 4, 5; section (J), sample 8, 11; section (L), sample 6; 10-Ventral v.; X = 133, 11-Side v.; X = 189.*



Occurrence: Sample 12, 14, 15, 45, section (A); sample 6, 11, 12, 20, 28, section (B); sample 12, 16, section (D); sample 14, section (E); sample 4, 5, section (F); sample 8, 11, section (J); sample 6, section (L).

Family: Heterolepidae Gonzalez-Donoso, 1969
Genus: *Heterolepa* Franzenau, 1884
Heterolepa dutemplei (d'Orbigny, 1846) (Fig. 7: 1-3)
Rotalia dutemplei d'Orbigny (1846, p. 157, pl. 8, figs. 19-21).
Cibicides dutemplei (d'Orbigny): Marks (1951, p. 72).
Cibicides dutemplei (d'Orbigny): Cicha and Zapletalova (1965, p. 18, pl. 5, figs. 1-3).
Heterolepa dutemplei (d'Orbigny): Papp and Schmid (1985, p. 61, pl. 52, figs. 1-6).
Remarks: Test thick-shelled, relatively large, dorsal side more or less elevated, ventral side highly arched; the chambers converge without forming an umbilicus. Aperture slit-like and extending from spiral side to the umbilical side on the posterior margin of the last chamber.
Occurrence: Sample 45, section (A); sample 20, section (B); sample 2, section (C); sample 3, 4, 7, section (L).

Family: Gavellinellidae Hofker, 1956
Genus: *Gyroidina* d'Orbigny, 1826
Gyroidina soldanii d'Orbigny, 1825 (Fig. 7: 4, 5)
Gyroidina soldanii d'Orbigny (1825, p. 112, Nr. 5 [fide Ellis and Messina]).
Gyroidina soldanii d'Orbigny: Marks (1951, p. 64).
Gyroidina soldanii d'Orbigny: Hamam (1966, pl. 5, fig. 10).
Gyroidina soldanii d'Orbigny: Papp and Schmid (1985, p. 60, pl. 50, figs. 4-6).
Remarks: Test thick-shelled, trochoid dorsal side almost flat with a definite channel between the whorls, ventral side distinctly convex. Umbilicus slightly recessed. Aperture slit-like, not extending into the ventral side.
Occurrence: Sample 8, 12, 14, 15, 45, section (A); sample 20, section (B); sample 12, 16, 19, section (D); sample 15, section (E); sample 4, section (F); sample 12, section (J); sample 4, 7, section (K); sample 4, section (L).

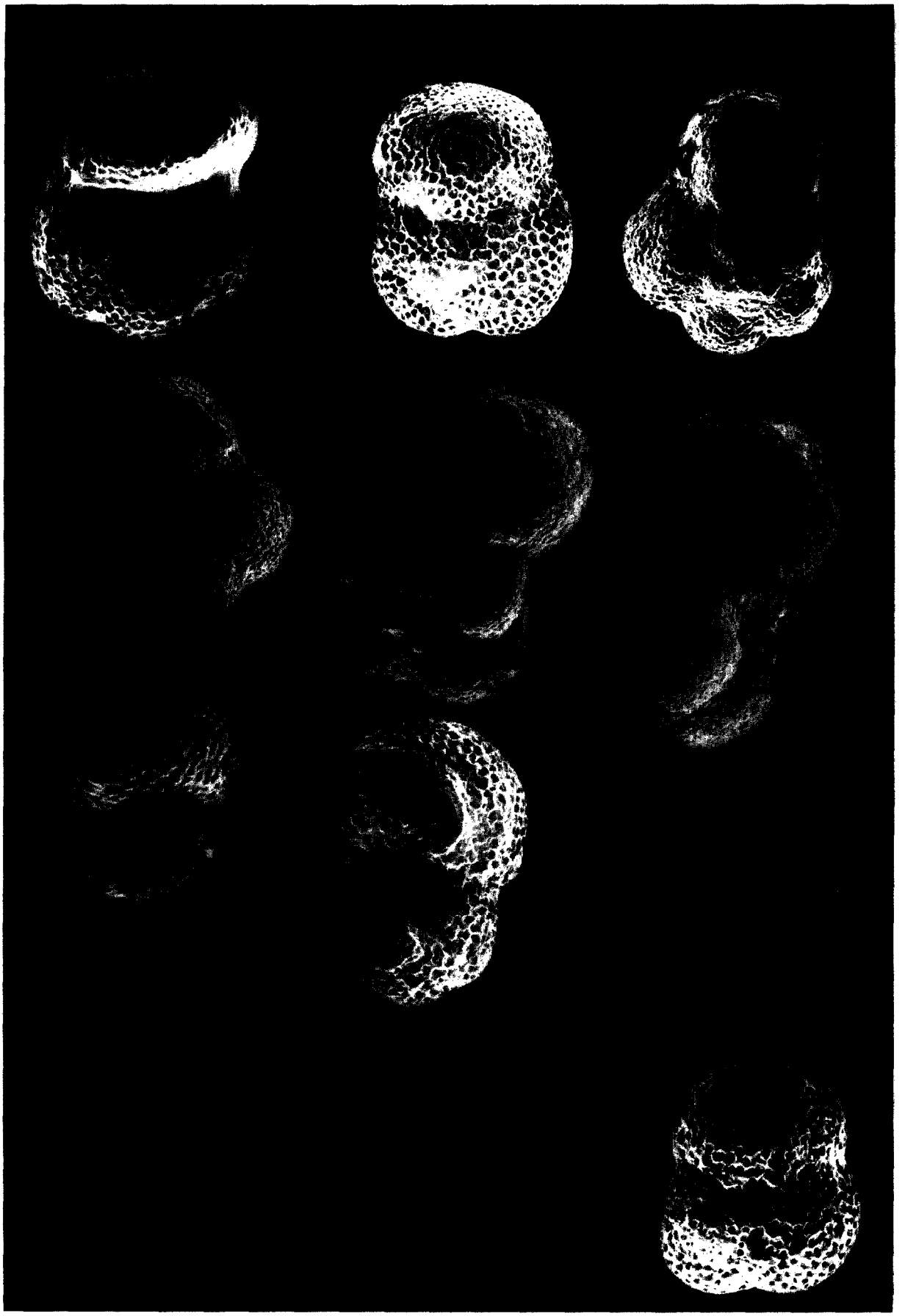
Family: Elphidiidae Galloway, 1933
Genus: *Elphidium* Montfort, 1808
Elphidium hauerinum (d'Orbigny, 1846) (Fig. 7: 6)
Polystomella hauernum d'Orbigny (1846, p. 122, pl. 6, figs. 1, 2).
Elphidium hauerinum (d'Orbigny): Papp and Schmid (1985, p. 51, pl. 41, fig. 6).
Remarks: Test planispiral involute, medium to large in size, non keeled. The pore pits are deep, medium to large in size. The septa are broad and bulging. There is no central pillar.
Occurrence: Sample 14, 15, 20, section (B); sample 11, 12, 13, 16, section (D); sample 4, section (F); sample 7, section (K); sample 8, section (L).

Elphidium jenseni Cushman, 1924 (Fig. 7: 7)
Elphidium jenseni Cushman: Cushman (1939, p. 62, pl. 17, figs. 14, 15).
Elphidium jenseni Cushman: Cimerman and Langer (1991, p. 78, pl. 92, figs. 1-3).
Remarks: Test planispiral involute, flat with acute periphery. Chambers and sutures are strongly backwards curved. It has 8-12 chambers in the last whorl. Surface ornamented by relatively large knotes.
Occurrence: Sample 12, 14, 15, 20, section (B); sample 12, section (D); sample 2, 6, section (J); sample 4, 7, section (K).

Family: Catapsydracidae Bolli, Loeblich and Tappan, 1957
Genus: *Catapsydrax* Bolli, Loeblich and Tappan, 1957
Catapsydrax sp. (Fig. 7: 8, 9)
Remarks: Test globular to ovoid, low trochospiral coil of rapidly enlarging globular chambers. Four chambers in final whorl. Peripheral outline lobulate. Aperture covered by a single umbilical bulla with one or more accessory infralaminal apertures.
Stratigraphical distribution: *Catapsydrax* is largely a Palaeogene genus reaching its maximum in diversity during the Middle Oligocene. It persists into the Early Neogene, being unimportant after Zone N7. It occurs from Middle Eocene, Zone P12 to Middle Miocene, Zone N15.
Occurrence: Sample 14, 45, section (A); sample 28, section (B); sample 2, section (C).

Genus: *Globoquadrina* Finlay, 1947
Globoquadrina dehiscens (Chapman, Parr and Collins, 1934) (Fig. 8: 1, 2)
Globorotalia dehiscens Chapman *et al.* (1934, p. 569, pl. 11, figs. 36 a-c).
Globoquadrina dehiscens (Chapman, Parr and Collins): Kennett and Srinivasan (1983, p.184, pl.44, fig. 2, pl. 45, figs. 7-9).
Globoquadrina dehiscens (Chapman, Parr and Collins): Bolli and Saunders (1985, p. 183, figs. 15.4-7; 6, 9, 12).
Remarks: Test distinctive, quadrate, low trochospiral chambers rather angular, spiral side almost flat, umbilical side strongly convex. Final chamber with steep umbilical face. Umbilicus large and deep.
Stratigraphical distribution: Zone N4B (Early Miocene) to the top of Zone N18 (Late Miocene).

Figure 7. 1-3: Heterolepa dutemplei *(d'Orbigny, 1846). Section (A), sample 45; section (B), sample 20; section (C), sample 2; section (L), sample 3, 4, 7; 1- Dorsal v., X = 161; 2-Side v., X = 84; 3-Ventral v., X = 91;* ***4, 5:*** Gyroidina soldanii *(d'Orbigny, 1825). Section (A), sample 8, 12, 14, 15, 45; section (B), sample 20; section (D), sample 12, 16, 19; section (E), sample 15; section (F), sample 4; section (J), sample 12; section (K), sample 4, 7; section (L), sample 4; 4-Side v., X = 161; 5-Dorsal v., X = 175;* ***6:*** Elphidium hauerinum *(d'Orbigny, 1846). Section (B), sample 14, 15, 20; section (D), sample 11, 12, 13, 16; section (F), sample 4; section (K), sample 4; section (L), sample 8; X = 98;* ***7:*** Elphidium jenseni *(Cushman, 1924b). Section (B), sample 12, 14, 15, 20; section (D), sample 12; section (J), sample 2, 6; section (K), sample 4, 7; X = 105;* ***8, 9:*** Catapsydrax *sp. Section (A), sample 14, 45; section (B), sample 28; section (C), sample 2; 8-Dorsal v.; X = 161, 9-Ventral v.; X = 175.*



Occurrence: Sample 12, 14, section (A); sample 2, section (C).

Family: Globigerinidae Carpenter, Parker and Jones, 1862
Genus: *Globigerina* d'Orbigny, 1826
Globigerina ciperoensis ottnangiensis Roegl, 1969 (Fig. 8: 3, 4)
Globigerina ciperoensis ottnangiensis Roegl (1969, p. 221, pl. 2, figs. 7a-c, pl. 3, fig. 3).
Globigerina ciperoensis ottnangiensis Roegl (1985, p. 321, figs. 5.5; 3).
Remarks: Test globular, trochospirally enrolled, chambers spherical to ovate. The last of the five chambers forming the final whorl is highly variable in size and position. The subspecies *ottnangiensis* differs from *Globigerina ciperoensis ciperoensis* mainly in the arched and asymmetrically-shaped aperture, which extends somewhat towards the periphery.
Stratigraphical distribution: Zone NN1 (Late Egerian) to Zone NN4 (Karpatian), Early Miocene of the Central Paratethys.
Occurrence: Sample 45, section (A); sample 4, section (K).

Genus: *Globigerinella* Cushman, 1927
Globigerinella obesa (Bolli, 1957b) (Fig. 8: 5, 6)
Globorotalia obesa Bolli (1957b, p. 119, pl. 29, figs. 2a-3).
Globigerinella obesa (Bolli): Kennett and Srinivasan (1983, p. 234, pl. 59, figs. 2-5).
Remarks: Test low trochospiral, equatorial periphery strongly lobate. Chambers spherical, distinctly inflated, four to four and a half chambers in the final whorl. Umbilicus, wide, deep; aperture a low to medium arch without a lip or rim, interiomarginal, umbilical to extraumbilical.
Stratigraphical distribution: Zone P22 (Late Oligocene) to Recent.
Occurrence Sample 11, 14, 45, section (A); sample 22, section (B); sample 22, 26, section (C); sample 4, section (K).

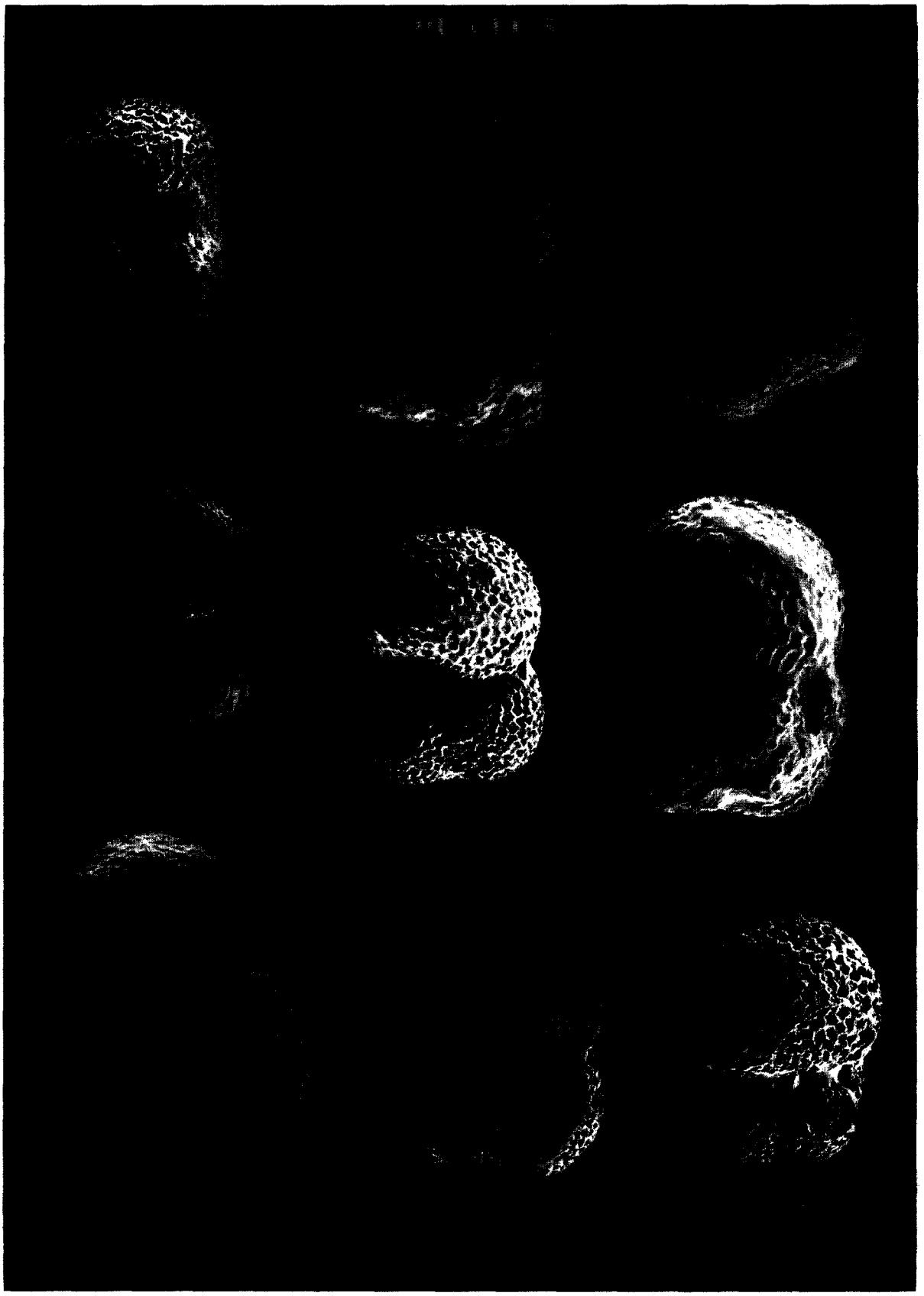
Genus: *Globigerinoides* Cushman, 1927
Globigerinoides altiaperturus Bolli, 1957b (Fig. 8: 7-9)
Globigerinoides triloba altiapertura Bolli (1957b, p. 113, pl. 25, figs. 7a-c).
Globigerinoides altiaperturus Bolli: Kennett and Srinivasan (1983, p. 54, pl. 10, fig. 1; pl. 11, figs. 4-6).
Globigerinoides altiaperturus Bolli: Bolli and Saunders (1985, p. 192, figs. 20.10; 7, 9, 12).
Remarks: Test low trochospiral, chambers spherical, increasing rapidly in size as added. Primary aperture interiomarginal, umbilical, large, a high, distinct arch bordered by a rim.
Stratigraphical distribution: Zone N5 to Zone N7 (Early Miocene).
Occurrence: Sample 11, 12, 14, 15, 45, section (A); sample 20, 28, section (B); sample 2, 5, 26, section (C); sample 11, section (K).

Globigerinoides bisphericus Todd, 1954 (Fig. 8: 10, 11)
Globigerinoides bispherica Todd (1954, p. 681, pl. 1, figs.1a-c).
Globigerinoides bisphericus Todd: Bolli and Saunders (1985, p. 199, figs. 24. 8; 7, 9, 12).
Remarks: Only two apertures are present along the suture between the last and earlier chambers, though more apertures may remain open on the spire. It is a short lived species differing from its probable ancestor, *Gs. trilobus* (Reuss), in its more enveloping last chamber which almost completely hides the umbilicus.
Stratigraphical distribution: Zone N7 (Early Miocene) to the base of Zone N9 (Middle Miocene).
Occurrence: Sample 45, section (A).

Globigerinoides obliquus Bolli, 1957a (Fig. 9: 2, 3)
Globigerinoides obliqua Bolli (1957a, p.113, pl. 25, figs. 10a-c).
Globigerinoides obliquus Bolli: Kennett and Srinivasan (1983, p. 56, pl. 11, figs. 7-9).
Remarks: Test trochospiral, chambers spherical except the final one, which is compressed in lateral oblique manner. Three to four chambers in final whorl increasing rapidly in size as added. Primary aperture a distinct, high and wide arch, interiomarginal, umbilical.
Stratigraphical distribution: Zone N5 (Early Miocene) to Zone N22 (Pleistocene). It evolved from *Gs. altiaperturus* in Zone N5 by the development of the last few chambers that are compressed in lateral and oblique manner.
Occurrence: Sample 14, 45, section (A).

Globigerinoides cf. *parawoodi* Keller, 1981 (Fig. 8: 12 and Fig. 9: 1)
Globigerinoides parawoodi Keller (1981, p. 304, pl. 4, figs. 1-11).
Globigerinoides parawoodi Keller: Kennett and Srinivasan (1981, p.70, pl. 15, figs. 1-3).
Remarks: Test small, low trochospiral; spherical to ovate chambers, three and a half in the final whorl. Umbilicus small. Primary aperture a medium-sized arch, interiomarginal, umbilical, with a distinct rim.
Stratigraphical ditribution: Zone N4B to Zone N7 (Early Miocene).
Occurrence: Sample 12, section (A).

Figure 8. 1, 2: Globoquadrina dehiscens *(Chapman, Parr and Collins, 1934). Section (A), sample 12, 14; section (C), sample 2; 1- Ventral v., X = 175, 2-Dorsal v.;X = 140;* ***3, 4:*** Globigerina ciperoensis ottnangiensis *Roegl, 1969b. Section (A); sample 45; section (K), sample 4; 3-Dorsal v. X=175, 4-Ventral v.; X = 175;* ***5, 6:*** Globigerinella obesa *(Bolli, 1957). Section (A), sample 11, 12, 14, 45; section (B), sample 22; section (C), sample 22, 26; section (J), sample 8; section (K), sample 4; 5-Dorsal v.; X = 210, 6-Side v.; X = 154;* ***7-9:*** Globigerinoides altiaperturus *Bolli, 1957. Section (A), sample 11, 12, 14, 15, 45; section (B), sample 20, 28; section (C), sample 2, 5, 26; section (K), sample 11; 7-Ventral v., X = 154; 8- Side v., X = 154; 9-Dorsal v., X = 119;* ***10, 11:*** Globigerinoides bisphericus *Todd, 1954.Section (A),sample 45;10-Ventral v., X = 189; 11-Side v., X = 154;* ***12:*** Globigerinoides *cf.* parawoodi *Keller, 1981. Section (A), sample 12; dorsal v., X = 140.*



Globigerinoides primordius Blow and Banner, 1962 (Fig. 9: 4, 5)
Globigerinoides primordius Blow and Banner (1962, p. 15, pl. ix, figs. Dd-Ff).
Globigerinoides primordius Blow and Banner: Kennett and Srinivasan (1983, p. 54, pl. 11, figs. 1-3.).
Globigerinoides primordius Blow and Banner: Bolli and Saunders (1985, p. 195, figs. 20.6; 7, 9, 12).
Remarks: Test low trochospiral. Three and a half to four chambers in the final whorl, increasing rapidly in size as added. Umbilicus small, primary aperture a low to moderate arch, interiomarginal, umbilical. A single small supplementary aperture on the spiral side. It differs from its immediate ancestor *Globigerina* (*Gg.*) *praebulloides* by the single, small, supplementary aperture on its spiral side. It develops into *Globi-gerinoides altiaperturus* BOLLI which is distinguished by its larger, high-arched primary and supplementary apertures.
Stratigraphical distribution: Zone N4A (Latest Oligocene) to Zone N5 (Early Miocene).
Occurrence: Sample 12, 14, 15, 45, section (A); sample 20, 28, section (B); sample 11, section (K).

Globigerinoides cf. *quadrilobatus* (d'Orbigny, 1846) (Fig. 9: 6, 7)
Globigerina quadrilobata d'Orbigny (1846, p. 164, pl. 9, figs.7-10).
Globigerinoides quadrilobatus (d'Orbigny): Banner and Blow (1970, p. 17, pl. 4, figs. 3a-b).
Globigerinoides quadrilobatus (d'Orbigny): Kennett and Srinivasan (1983, p. 66, pl. 14, figs. 1-3).
Remarks: Test low trochospiral, chambers spherical, three and a half to four chambers in the final whorl, increasing moderately in size as added. Umbilicus, narrow, primary aperture interiomarginal, umbilical, a distinct arch bordered by a rim.
Stratigraphical distribution: Zone N6 (Early Miocene) to Recent.
Occurrence: Sample 11, 12, 14, 45, section (A); sample 6, section (B); sample 12, section (D).

Globigerinoides trilobus (von Reuss, 1850) (Fig. 9: 8, 9)
Globigerina triloba Reuss (1850, p. 374, pl. 47, figs. 11a-c).
Globigerinoides trilobus (Reuss): Kennett and Srinivasan (1983, p. 62, pl. 13, figs. 1-3).
Globigerinoides trilobus (Reuss): Bolli and Saunders (1985, p. 196, figs. 20.15; 7, 9, 11).
Remarks: Test trochospiral, chambers spherical, three in the final whorl, increasing rapidly in size as added. Primary aperture interiomarginal, umbilical, a low slit, supplementary aperture along spiral sutures in the form of an irregular slit.
Stratigraphical distribution: Zone N4B (Early Miocene) to Zone N22 (Pleistocene).
Occurrence: Sample 12, 14, 45, section (A); sample 20, 28, section (B); sample 9, 26, section (C); sample 8, section (J); sample 4, 8, 11, section (K).

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Figure 9. 1: Globigerinoides *cf.* parawoodi *Keller, 1981. Section (A), sample 12; ventral v., X= 140;* ***2, 3:*** Globigerinoides obliquus *Bolli, 1957. Section (A), sample 14, 45; 2-Dorsal v., X = 189, 3-Ventral v., X = 175;* ***4, 5:*** Globigerinoides primordius *Blow and Banner, 1962. Section (A), sample 12, 14, 15, 45; section (B), sample 20, 28; section (K), sample 11; 4- Dorsal v.; X = 140; 5-Ventral v.; X = 140;* ***6, 7:*** Globigerinoides *cf.* quadrilobatus *(D'orbigny, 1846). Section (A), sample 11, 12, 14, 45; section (B), sample 6; section (D), sample 12; 6-Dorsal v.; X = 175, 7- Ventral v.; X = 189;* ***8, 9:*** Globigerinoides trilobus *(von Reuss, 1850). Section (A), sample 12, 14, 45; section (B), sample 20, 28; section (C), sample 9, 26; section (J), sample 8; section (K), sample 4, 8, 11; 8- Dorsal v., X = 140; 9-Ventral v., X = 140.*

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