

STRATIGRAPHY, PALEONTOLOGY AND DEPOSITIONAL ENVIRONMENTS OF SOME EXPOSED MIOCENE SEDIMENTS IN CAIRO-SUEZ DISTRICT, EGYPT

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ABSTRACT

The transgressive-regressive Miocene succession exposed at gabals Geneife, Homeira and Gharra in Cairo-Suez District is unconformably underlain and overlain by continental sediments of Oligocene and post Miocene (?) respectively. It could be differentiated into two rock-units from base to top, Gharra Formation and Geneife Formation. Thirty eight macrofossil species (26 bivalves, 7 gastropods and 5 echinoids) have been identified and photographed. They belong to 19 genera and 15 families. The paleogeographic and biogeographic distribution of the majority indicated an Atlantic-Mediterranean affinity with few Indo-Pacific one. The studied marine Miocene sequence in the study areas was divided into two sedimentary facies: the lower one is a clastic-dominated facies, which is represented by the Gharra Formation while the upper one is a carbonate-dominated and is represented by the Geneife Formation. Based on microfacies associations, sedimentary structures and fossil content the studied Miocene succession was deposited in an environment ranged from tidal flat, typical reef flank to shelf lagoons with open circulation.

Key words: Stratigraphy, paleontology, depositional, environments, miocene, Cairo-Suez.

INTRUCTION

The Cairo-Suez area lies to the east of Cairo and extends in its long about 120 km till Suez City. The topography of the area is largely controlled by its structure and the relief within the area is generally low except for few hills and small mountains.

Topographically, the area is subdivided into three ridges crossing the district in a more or less E-W alignment; between these ridges there are two depressions (Abou Khadrah et al. 1993). The oldest exposed rocks in the area are of Cretaceous age while the youngest rocks belong to the Quaternary age of synrift sedimentary sequence (Bruce and Hotzl, 1988).

The Miocene rocks of Cairo-Suez district were currently differentiated into marine and non-marine deposits (Shukri and Akmal 1953; Said and Yallouze 1955 and Said and Metwalli 1964).

The main target of the present work is to study the stratigraphy, macropaleontology and depositional environments of the Miocene successions exposed in the eastern part of Cairo-Suez District.

Material and methods

Throughtout several geologic field trips in the eastern part in the whole study area, three geologic surface sections were selected, measured and sampled at Gabal Geneifa, Gabal Gharra, and Gabal Homeira (Fig. 1). The rock samples were taken at every change in lithology while the macrofossils were gained from the beds as can as possible. Among the collected rock samples up to 30 representative

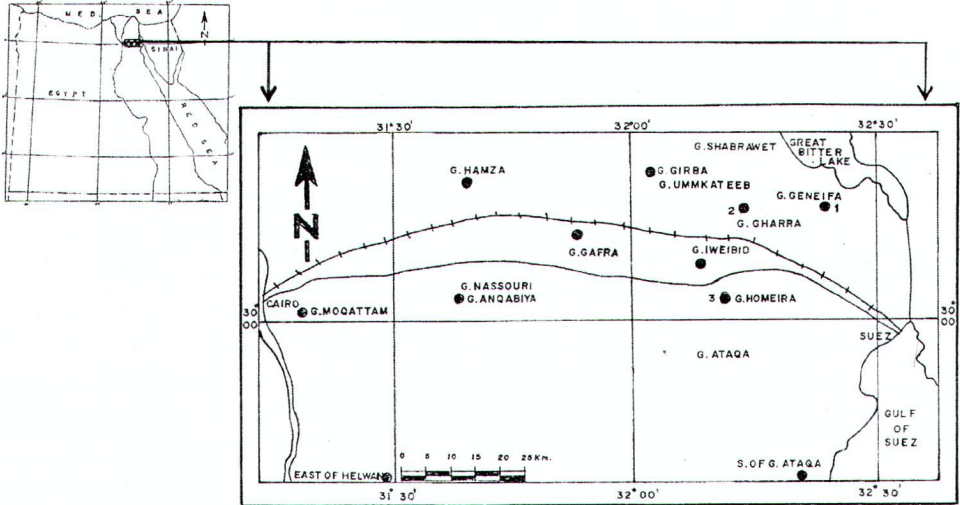


Fig. 1: Location map of the studied section. 1) Gabal Geneifa, 2) Gabal Gharra, 3) Gabal Homeira.

samples were prepared for microfacies investigation. Macrofossils (bivalves, gastropods and echinoids) were cleaned, labeled, photographed by camera and systematically arranged and their paleogeographic and biogeographic distribution (if present) are done.

STRATIGRAPHY

The stratigraphic subdivisions which were carried out by different authors for the Miocene rocks exposed in Cairo-Sukhna area are summarized in table 1. The lower Miocene sediments in the study areas consist of sandstone and mudstone with minor intercalations of sandy limestone. They differ from the algal limestone of the Sadat Formation (Abdallah and Abdel-Hady 1966). Thus it is possible to use the Gharra Formation of Said (1971) to the studied lower Miocene sediments. On the other hand the middle Miocene rocks consist mainly of algal, reefal, oyster banks, limestones with minor mudstone and sandstone intercalations. These facies are different from the clastic facies of the Hommath Formation (Abdallah and Abdel-Hady 1966) and similar to the facies of Geneife Formation of Said (1990), so it is applied in the present study.

Gabal Geneifa section

This section is found between the exposed Eocene limestones of Gabal Geneifa to the west and Suez-Port Said asphaltic road to the east. The base of the succession is unexposed. The scarp of Geneifa gets gradually low and low southwards. To the south of Geneifa succession, the surface of the wadi is a flat plain, covered by alluvial gravels which extends to the foot of the high escarpment of Gabal Ataqqa. The lowermost rock samples of this section are available to be collected from a mine near the asphaltic road, south of Geneifa town. The succession measures a total thickness of 97.1m (Fig. 2).

Gabal Homeira section

Gabal Homeira lies to the north of Gabal Ataqqa and to the southeast of Gabal Iweibid. The lower part of the Miocene succession there is represented mainly by

clastic deposits, unconformably overlying the Oligocene sands and gravels, while its upper part is represented mainly by non-clastic sediments. This succession measures a total thickness of 110.9 m (Fig. 2).

Gabal Gharra section

Gabal Gharra lies about 13 km to the west of Gabal Geneifa and about 13 km to the northeast of Gabal Iweibed. The base of the Miocene succession there is exposed and unconformably overlies the Oligocene sands and gravels. As in the previous two sections, the lower part is represented mainly by clastic deposits, and the upper part is made up of non-clastic sediments. The studied section measures a total thickness of 141.7m (Fig. 2).

SYSTEMATIC PALEONTOLOGY

Phylum: Mollusca Cuvier, 1795

Class: Bivalvia Linné, 1758

Order: Pterioida Newell, 1965

Family: Pectinidae Rafinesque, 1815

Genus : *Chlamys* Röding, 1798

Chlamys gentoni (Fontannes 1882)

(Pl. 1, Fig. 1)

1939 *Chlamys gentoni* (Fontannes); Roger, 142, pl. 16, figs. 17a, b.

1976 *Chlamys gentoni* (Fontannes); Metwally, 139, pl. 5, figs. 5a, b.

Material: Six left valves.

Remarks: Shell of small size, auricles triangular with 5-6 fine scaly costules, the first four are more prominent; valve ornamented by 18-20 rounded costae, separated by equally concave interspaces; costae ornamented by 2-3 very fine regularly spaced scaly costules, more developed near the margin.

Occurrence: Gabal Geneifa (beds 5 and 11); Gabal Gharra (beds 6, 8 and 13).

Distribution: Salum area, Wadi Umm Ashtan section (Metwally 1976).

Chlamys malvinae (Dubois)

(Pl. 1, Fig. 2)

1883 *Pecten malvinae* (Dubois); Fuchs, 59, pl. 21, fig. 3.

1939 *Chlamys malvinae* (Dubois); Roger, 145, pl. 18, figs. 3, 4.

1968 *Chlamys malvinae* (Dubois); El Gamal, 148, pl. 14, fig. 3.

1976 *Chlamys malvinae* (Dubois); Metwally, 147, pl. 6, fig. 4.

Material: Two right valves.

Remarks: Valve of moderate size; auricles unequal, anterior one wing-shaped, with acute, deep byssal notch, ornamented with 6 costules; posterior one triangular with 7-8 fine costules; surface ornamented with 22-24 costae, subrounded in cross section, separated by slightly narrow, flat concave interspaces; costae with 4-5 scaly costules; interspaces with 2-3 fine scaly costules.

Occurrence: Gabal Homeira (bed 11) and Gabal Gharra (bed 15).

Distribution: Miocene in Egypt (El-Gamal 1968, Metwally 1976).

Chlamys radians (Nyst)
(Pl. 1, Fig. 3)

1939 *Chlamys radians* (Nyst); Roger, 134, pl. 16, figs. 8-12; pl. 17, fig. 9.

1976 *Chlamys radians* (Nyst); Metwally, 153, pl. 7, fig. 4.

Material: Four right valves.

Remarks: Valve of small to moderate size; auricles subequal, anterior one more developed, wing-shaped with 6 fine radial scaly costules, posterior one triangular with 8 fine costules; surface crossed by concentric lamellae, ornamented with 17-19 high costae, radiated, rounded, separated by rather narrow, flat intercostal spaces which occupied by 1-2 fine costules; muscle scar is subrounded, deep.

Occurrence: Gabal Geneifa (bed 11); Gabal Gharra (bed 12).

Distribution: Salum area and Kom El Shellul section (Metwally 1976).

Chlamys scabrella Lamarck
(Pl. 1, Fig. 4)

1939 *Chlamys scabrella* Lamarck; Roger, 104, pl. 12, figs. 8, 9, 9a, 10, 10a; pl. 13, figs. 3-13.

1972 *Chlamys scabrella* Lamarck; Hamza, 93, pl. 2, figs. 5, 5a, 5b; pl. 3, figs. 1, 1a, 1b.

1976 *Chlamys scabrella* Lamarck; Metwally, 157, pl. 7, fig. 6; pl. 8, fig. 1.

Material: One complete shell.

Remarks: Shell of moderate size; auricles unequal; anterior one of the right valve longer than posterior one, wing-shaped, ornamented with 5 slightly strong costules; posterior one triangular, with 8 fine radial costules; surface ornamented with 16-18 costae, equal, rounded in cross section, separated by equal width; the intercostal spaces with 2 fine costules.

Occurrence: Gabal Gharra (bed 12).

Distribution: Pliocene and Neogene of Egypt (Hamza 1972, Metwally 1976).

Chlamys senatoria Gmelin
(Pl. 1, Fig. 5)

1927 *Chlamys senatoria* Gmelin; Cox, 45, pl. 7, figs. 1-3.

1974 *Chlamys senatoria* Gmelin; Ghonima, 166, pl. 12, figs. 7, 8.

1976 *Chlamys senatoria* Gmelin; Metwally, 162, pl. 8, figs. 3a, b.

Material: Two left valves

Description: Valve of moderate size; auricles unequal, posterior one longer; cardinal line straight; costae 19-21, rounded with 3-4 thread-like costules separated by rather narrow, flat interspaces with 2-3 thread-like costules.

Occurrence: Gabal Gharra (beds 13 and 15).

Distribution: Lower Miocene of Zinzibar. Karpatian of Salum area in Wadi Umm Ashtan section. (Cox 1927, Metwally 1976).

Chlamys (Chlamys) costai (Fontannes, 1884)

(Pl. 1, Fig. 6)

1939 *Chlamys costai* Fontannes; Roger, 160, pl. 22, fig. 8; pl. 23, fig. 6.1966 *Chlamys costai* (Fontannes); Cherif, pl. 11, fig. 2.1972 *Chlamys costai* (Fontannes); Cherif, 100, pl. 5, fig. 12.1976 *Chlamys costai* Fontannes; Metwally, 134, pl. 5, fig. 2.1992 *Chlamys (Chlamys) costai* (Fontannes); Abdel-Moneim, 101, pl. 2, fig. 2.**Material:** Three right valves**Remarks:** Valve of medium size; auricles relatively large, anterior auricle of right valve wing-shaped, with 6 fine costules; surface ornamented with 19-21 costae, rounded, divided to 2 fine scaly costules on the umbonal area and 3-4 near the ventral margin; costae separated by slightly smaller interspaces, divided by 2 scaly costules.**Occurrence:** Gabal Geneifa (bed 11).**Distribution:** Burdigalian of Portugal and Vienna Basin. Helvetian or Tortonian of France; Burdigalian and Helvetian of Gabal Geneifa and Sadat areas. Vindobonian of Salum area (Roger 1939, Sadek 1959, Cherif 1966 and 1972, Metwally 1976, Abdel-Moneim 1992).*Chlamys (Aequipecten) scabriuscula* (Matheron, 1842)

(Pl. 1, Fig. 7)

1939 *Chlamys scabriuscula* Matheron; Roger, 58, pl. 6.1976 *Chlamys scabriuscula* (Matheron); Metwally, 160, pl. 8, fig. 2.1992 *Chlamys (Aequipecten) scabriuscula* (Matheron); Abdel-Moneim, 102, pl. 2, fig. 4a, b.**Material:** One right valve.**Remarks:** Valve of moderate size, auricles equal, anterior one wing-shaped, with 4 well developed costules, posterior one triangular with 6 fine costules; surface ornamented with 21 rounded costae, sharp near umbonal region, separated by rather narrow concave interspaces, costae with 6 fine radial costules, interspaces with 3 fine costules; surface crossed by regularly spaced concentric lamellae increasing in number near ventral margin.**Occurrence:** Gabal Homeira (bed 11).**Distribution:** Helvetian and Tortonian of France, North and Central Italy and Sardinia. Vindobonian of Matruh area. Serravalian of Sadat area (Roger 1939, Metwally 1976, Abdel-Moneim 1992)*Chlamys (Argopecten) macrotis* (Sowerby, 1847)

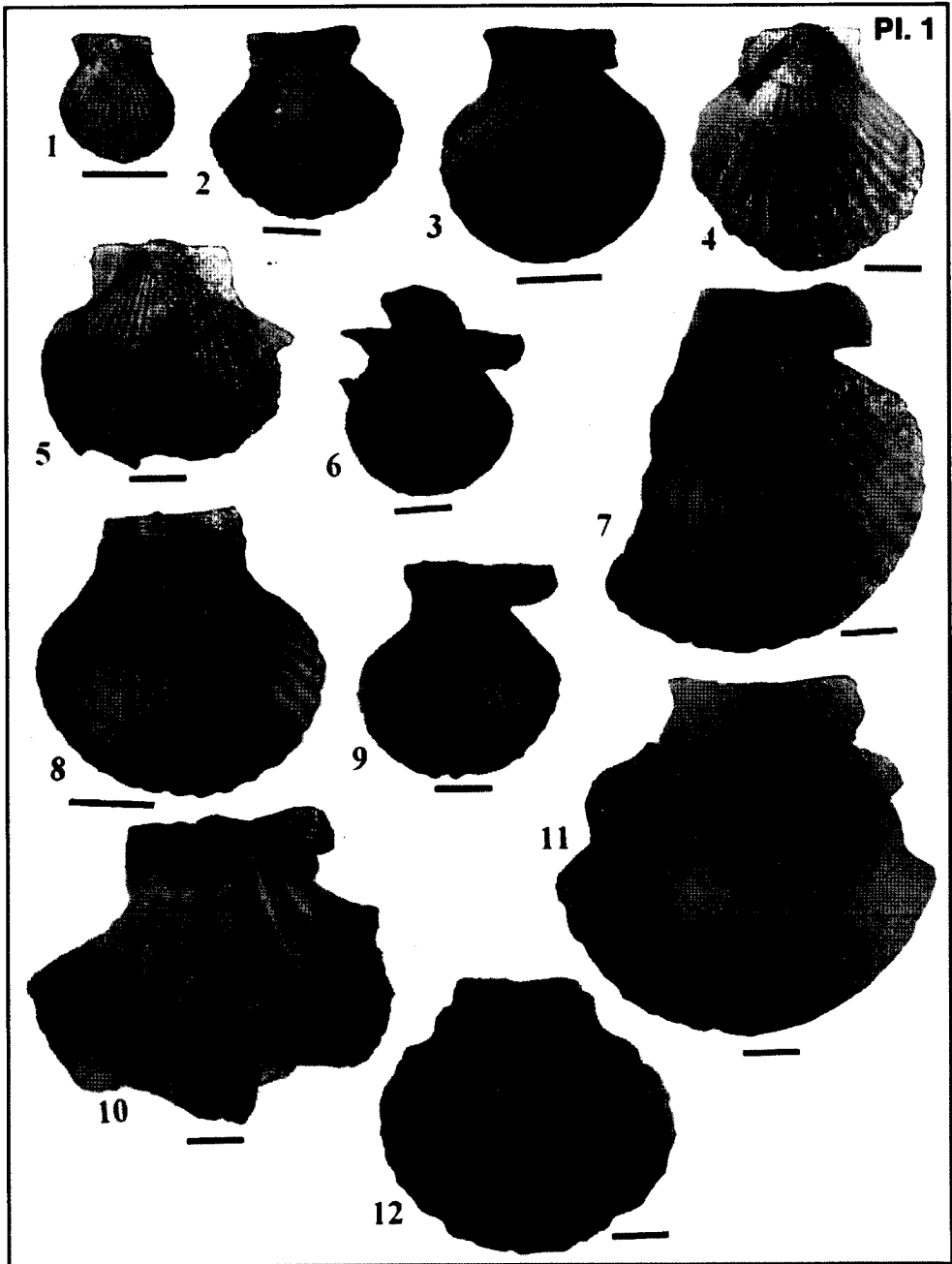
(Pl. 1, Fig. 8)

1939 *Chlamys macrotis* (Sowerby); Roger, 114, pl. 14, figs. 7-10; pl. 15, figs. 7, 8.1968 *Chlamys macrotis* (Sowerby); El-Gamal, 143, pl. 14, fig. 13.1976 *Chlamys macrotis* (Sowerby); Metwally, 145, pl. 6, figs. 2a-d.1992 *Chlamys (Argopecten) macrotis* (Sowerby); Abdel-Moneim, 103, pl. 2, fig. 5.

1999 *Chlamys macrotis* (Sowerby); El-Shazly and Saber, 325, pl. 2, fig. 3.

Material: Three left valves.

Remarks: Valve of moderate size; auricles unequal, relatively large, the two auricles subtriangular, with 3-4 fine radial costules; surface ornamented with 19-21 equally salinet subrounded costae with 2-3 scaly costules, separated by rather narrow concave interspaces; having the same number of costules.



Occurrence: Gabal Geneifa (bed 11); Gabal Gharra (beds 13, 15).

Distribution: Burdigalian of Aquitan province, France and Italy; Helvetian of Vienna basin. Tortonian of the European basins and in the Atlantic province of Portugal; Late Burdigalian and Serravallian of Salum, Matruh and Sadat areas (Cossmann and Peyrot 1914, Ugolini 1906, Roger 1939, El-Gamal 1968, Metwally 1976, Abdel-Moneim 1992, El-Shazly and Saber 1999).

Chlamys (Argopecten) submalvinae (Blanckenhorn, 1901)

(Pl. 1, Fig. 9)

1939 *Chlamys sub-malvinae* Blanckenhorn; Roger, 118, pl. 15, figs. 5, 6; pl. 16, figs. 13-16.

1955 *Chlamys sub-malvinae* (Blanckenhorn); Said and Yallouze, 68, pl. 3, fig. 12.

1980 *Chlamys (Aequipecten) sub-malvinae* (Blanckenhorn); Abed and Metwally, 307, pl. 4, figs. 4a-c.

1992 *Chlamys (Argopecten) submalvinae* (Blanckenhorn); Abdel-Moneim, 104, pl. 2, fig. 6.

1999 *Chlamys sub-malvinae* (Blanckenhorn); El-Shazly and Saber, 325, pl. 2, figs. 2, 7.

Material: Ten right valves and eleven left valves.

Occurrence: Gabal Geneifa (bed 11); Gabal Homeira (bed 11) and Gabal Gharra (bed 15).

Remarks: *Chlamys sub-malvinae* (Blanckenhorn) differs from *Chlamys malvinae* (Dubois) in being less convex and with fewer number of ribs. On the other hand, it has more ribs and more dense ornamentation than *Chlamys scabrella* (Lamarck).

Distribution: Miocene of Mediterranean regions as in Egypt, Syria and Cyprus. Miocene of the Western Desert, Cairo-Suez district and Sinai (Roger 1939, El-Shazly, 1987, Abdallah and Abdel-Hady 1966, El-Shazly and Saber 1999).

Chlamys sardoa Ugolini, 1906

(Pl. 1, Fig. 10)

1939 *Chlamys sardoa* Ugolini; Roger, 46, pl. 19, fig. 3a.

1976 *Chlamys sardoa* Ugolini; Metwally, 155, pl. 7, figs. 5a, b.

Material: One double-valved shell, one right valve and one right mold.

Explanation of Plate 1

Fig.

- 1: *Chlamys gentoni* (Fontannes 1882), external view of left valve.
- 2: *Chlamys malvinae* (Dubois), external view of right valve.
- 3: *Chlamys radians* (Nyst), external view of right valve.
- 4: *Chlamys scabrella* Lamarck, external view of left valve.
- 5: *Chlamys senatoria* Gmelin, external view of left valve.
- 6: *Chlamys (Chlamys) costai* (Fontannes, 1884), external view of right valve.
- 7: *Chlamys (Aequipecten) scabriuscula* (Matheron, 1842), external view of right valve.
- 8: *Chlamys (Argopecten) macrotis* (Sowerby, 1847), external view of left valve.
- 9: *Chlamys (Argopecten) submalvinae* (Blanckenhorn, 1901), external view of right valve.
- 10: *Chlamys sardoa* Ugolini, 1906, external view of right valve.
- 11: *Pecten beudanti* Basterot, external view of right valve.
- 12: *Pecten erythraensis* Sowerby, external view of left valve.

Bar scale = 1cm

Remarks: Shell of medium size, anterior auricle subtriangular to wing-shaped, ornamented by fine lamellae and show well formed radial costulations; posterior auricle is right angled triangle, ornamented by fine lamellae. Right valve convex, with 9 ribs, 5 of which are prominent, rectangular in cross-section, interspaces between ribs slightly less than the rib width, ribs ornamented with 3-4 riblets.

Occurrence: Gabal Geneifa (bed 13); Gabal Homeira (bed 19) and Gabal Gharra (bed 14).

Distribution: Late Miocene of Sardinia; late Burdigalian to Langhian of Gabal Geneifa and Salum area (Roger 1939, Metwally 1976).

Genus: *Pecten* Müller, 1776

Pecten beudanti Basterot

(Pl. 1, Fig. 11)

1902 *Pecten beudanti* Basterot; Depéret and Roman, 19, pl. 2, figs. 1, 1a, 2.

1914 *Pecten beudanti* Basterot; Cossmann and Peyrot, 274, pl. 13, figs. 8-11.

Material: Five right valves and four left valves.

Remarks: Valve of medium to large size, auricles incurved, subequal; anterior one very slightly smaller, wing-shaped, with 5-7 low radial costules; posterior one right angle triangle, with 5-7 low radial costules; 15 radial costae, 12 of them strong, equal, become broad and slightly flattened near the ventral margin; the lateral costae feebly narrow; costae separated by slightly narrow, flaty, rounded interspaces; surface crossed by fine regular closely spaced concentric lamellae.

Occurrence: Gabal Homeira (bed 13); Gabal Gharra (bed 10).

Distribution: Miocene of the Mediterranean basin (Depéret and Roman 1902 and Cossmann and Peyrot 1914).

Pecten erythraensis Sowerby

(Pl. 1, Fig. 12)

1902 *Pecten erythraensis* Sowerby; Depéret and Roman, 36, pl. 4, figs. 6, 7.

1972 *Pecten erythraensis* Sowerby; Hamza, 89, pl. 2, figs. 3, 3a.

1976 *Pecten erythraensis* Sowerby; Metwally, 112, pl. 2, fig. 2.

Material: Two left valves.

Occurrence: Gabal Homeira (bed 13).

Remarks: *Pecten erythraensis* Sowerby can be easily differentiated from *Pecten benedictus* (Lamarck) by its highly convex umbonal region, also the costae are more strong and well formed at the ventral margin.

Distribution: Neogene of Matruh-Salum areas (Metwally 1976).

Pecten fuchsi Fontannes

(Pl. 2, Fig. 1)

1902 *Pecten fuchsi* Fontannes; Depéret and Roman, 13, pl. 1, figs. 6-7.

1939 *Pecten fuchsi* Fontannes; Roger, 238.

1976 *Pecten fuchsi* Fontannes; Metwally, 115, pl. 2, figs. 3a, 3b.

Material: Three left valves.

Remarks: Left valve of moderate size, auricles unequal, anterior longer, each ornamented with 5 concentric lamellae; cardinal line straight; resilial pit triangular; surface ornamented with 18 well developed radial ribs as well as about four small ones on the anterior and posterior lateral sides.

Occurrence: Gabal Homeira (beds 11, 13).

Distribution: Lower Miocene of Italy; Helvetian of Spain; Burdigalian of Tunisia and Austria; Vindobonian of Syria; Burdigalian of the Salum area (Roger 1939, Metwally 1976).

Pecten (Pecten) cristato-costatus Sacco, 1897
(Pl. 2, Fig. 2)

1902 *Pecten cristato-costatus* Sacco; Depéret and Roman, 14, pl. 1, figs. 11, 12.

1908 *Pecten cristato-costatus* Sacco; Ugolini, 72, pl. 24, figs. 6, 7

1929 *Pecten cristato-costatus* Sacco; Desio, 228, pl. 33, fig. 8.

1966 *Pecten cristato-costatus* Sacco; Cherif, pl. 11, figs. 7, 9.

1972 *Pecten cristato-costatus* Sacco; Cherif, 98, pl. 6, figs. 22, 24.

1992 *Pecten (Pecten) cristato-costatus* Sacco; Abdel-Moneim, 108, pl. 3, fig. 2.

Material: Two right valves and four left valves.

Remarks: Valve of medium size, auricles equal, triangular; with 5-7 weak radial costules, crossed by concentric lamellae; surface ornamented by 19-20 strong radial costae, triangular in cross-section, separated by interspaces less than their width, flat base; concentric lamellae appear on the ribs as well as on the interspaces.

Occurrence: Gabal Geneifa (bed 11); Gabal Gharra (beds 10, 12 and 13).

Distribution: Miocene of many Egyptian localities as north Western Desert, Cairo-Suez district and Sinai (Abdallah and Abdel-Hady 1966, Abdel-Moneim 1992 El-Shazly and Saber 1999).

Pecten (Pecten) fraasi Fuchs, 1883
(Pl. 2, Fig. 3)

1883 *Pecten Fraasi* Fuchs, 41, pl (21) 16, figs. 7, 8.

1902 *Pecten Fraasi* Fuchs; Depéret and Roman, 26, pl. 2, figs. 7-9.

1992 *Pecten Fraasi* Fuchs; Abdel-Moneim, 110, pl. 3, fig. 3.

Material: Two right valves and four left valves.

Remarks: Valve of medium size, auricles incurved, subequal, anterior one very slightly smaller, wing-shaped, with 4-5 low radial costules; posterior one right angled triangle, with 4-5 low radial costules; cardinal line very slightly incurved; costae 15-16 radial, larger than interspaces, 12 of them are strong and equal, separated by rounded interspaces; surface crossed by fine regular closed space concentric lamellae.

Occurrence: Gabal Geneifa (bed 11); Gabal Gharra (bed 10).

Distribution: Miocene of Gabal Geneifa. Helvetian of France; late Burdigalian of

Sadat area (Fuchs 1883, Depéret and Roman 1902, Abdel-Moneim 1992).

Pecten (Pecten) zizinae Blanckenhorn, 1901
(Pl. 2, Fig. 4)

1901 *Pecten zizinae* Blanckenhorn; 132.

1955 *Pecten zizinae* Blanckenhorn; Said and Yellouze, 69, pl. 3, fig. 9.

1966 *Pecten zizinae* Blanckenhorn; Hamam, pl. 9, figs. 8, 10.

1987 *Pecten zizinae* Blanckenhorn; El-Shazly, 180, pl. 1, fig. 7.

1992 *Pecten (Pecten) zizinae* Blanckenhorn; Abdel-Moneim, 111, pl. 3, fig. 5.

1999 *Pecten zizinae* Blanckenhorn; El-Shazly and Saber, 323, pl. 2, figs. 4, 10.

Material: One right valve and eight left valves.

Occurrence: Gabal Geneifa (bed 9); Gabal Homeira (beds 11 and 13) and Gabal Gharra (bed 10).

Remarks: *Pecten (Pecten) zizinae* Blanckenhorn differs from *Pecten blanckenhorni* Depéret and Roman in having fewer number of ribs of wider interspaces.

Distribution: Miocene of Cairo-Suez, Sadat area, central Sinai and Western Desert (Depéret and Roman 1902, Blanckenhorn 1901, Abdel-Moneim 1992 El-Shazly and Saber 1999).

Pecten (Oppenheimerpecten) benedictus Lamarck, 1819
(Pl. 2, Fig. 5)

1883 *Pecten benedictus* Lamarck; Fuchs, 35, pl. 20 (15), figs. 3-6.

1902 *Pecten benedictus* Lamarck; Depéret and Roman, 33, pl. 4, figs. 1-5.

1972 *Pecten benedictus* Lamarck; Hamza, 87, pl. 2, figs. 1, 2.

1976 *Pecten benedictus* Lamarck; Metwally, 106, pl. 1, figs. 4a-d.

1989 *Pecten (Oppenheimerpecten) benedictus* Lamarck; El-Bedewy, 221, pl. 12, fig. 5

1992 *Pecten (Oppenheimerpecten) benedictus* Lamarck; Abdel-Moneim, 115, pl. 3, fig. 9.

Material: Four right valves

Remarks: Valve of medium to large-sized, auricles subequal, anterior one triangular, slightly smaller, rounded outline, with 6-8 feebly radial costules; posterior auricle slightly larger, crossed by concentric lamellae; surface ornamented with 12 prominent radial costae, wide, become low and broad near the ventral margin, subrounded, separated by rather narrow flat interspaces; surface crossed by close space of fine concentric lamellae.

Occurrence: Gabal Homeira (bed 13) and Gabal Gharra (bed 10).

Distribution: Burdigalian to Late Miocene of Rhone Valley; Pliocene of Italy, Spain and Algeria; late Burdigalian, Serravallian and Pliocene of Sadat area (Fuchs 1883, Depéret and Roman 1902, Hamza 1972, Abdel-Moneim 1992).

Table 1: Different rock units proposed by different authors for the Miocene rocks in the Cairo-Suez District.

Oligocene	Marine Miocene				Non Marine Miocene	Shukry & Akmal (1953) Shukr & Ayoub (1984)
Oligocene	Lower Miocene	Middle Miocene		Upper Miocene		Said (1962)
	Marine Miocene			Non Marine Miocene		
Oligocene	Sandy Unit		Calcareous Unit			
	Burdigalian	Helvetian				Metwalli (1963)
Oligocene	Unit I		Unit II			
	Gharra Formation				Iweibid Fm	
Sukhna Member		Reishi Member	Abbasia Member	Garfa Member	Geneffe Member	El-Hamza Member
Oligocene	Burdigalian	Helvetian				Hamam (1966)
	Unit I	Unit II	Unit III			
Oligocene	Burdigalian	Helvetian		Upper Miocene		Farag & Sadek (1966)
	Marine Miocene			Non Marine Miocene		
Oligocene	Burdigalian	Vindobonian		Upper Miocene		Barakat & About Ela (1970)
	Marine Miocene			Non Marine Miocene		
Upper Eocene	Lower Miocene	Middle Miocene		Upper Miocene		Stratigraphic Sub Committee (1974)
	Sadat Formation	Hommath Formation		Hagul Formation		
		Reishi Member	Abbasia Member	Garfa Member	Geneffe Formation	
Oligocene	Gharra Formation					Abbass (1977)
	Sadat Member	Reishi LST Member	Hommath Sandy Limestone Member	Geneffe Chalky LST Member		
Basal Miocene	Burdigalian	Middle Miocene		Messinian	Plioc.	El-Helmy (1982)
	Abu Zabaal FM	Sadat Formation	Hommath Formation	Geneffe Fm	Hamzi Fm	
	Aquitanian-Burdigalian	Langhian		Late Pliocene		Said (1990)
	Gharra Formation	Geneffe Formation		Hagul Fm	Hamzi Fm	
Upper Eocene	Early Miocene	Middle Miocene		Late Miocene		Abdel-Moneim (1992)
	Sadat Formation		Hommath Fm	Hagul Fm	Ghewelba Fm	
	Early Miocene	Middle Miocene		Late Miocene		El Shazly & Saber (1999)
	Gharra Formation	Geneffe Formation		(?)		
Eocene	Early Miocene	Middle Miocene				Elattar (2003)
	Sadat Formation					
Oligocene	Early Miocene	Middle Miocene		POST MIDDLE MIOCENE		Present Work
	Gharra Formation	Geneffe Formation				

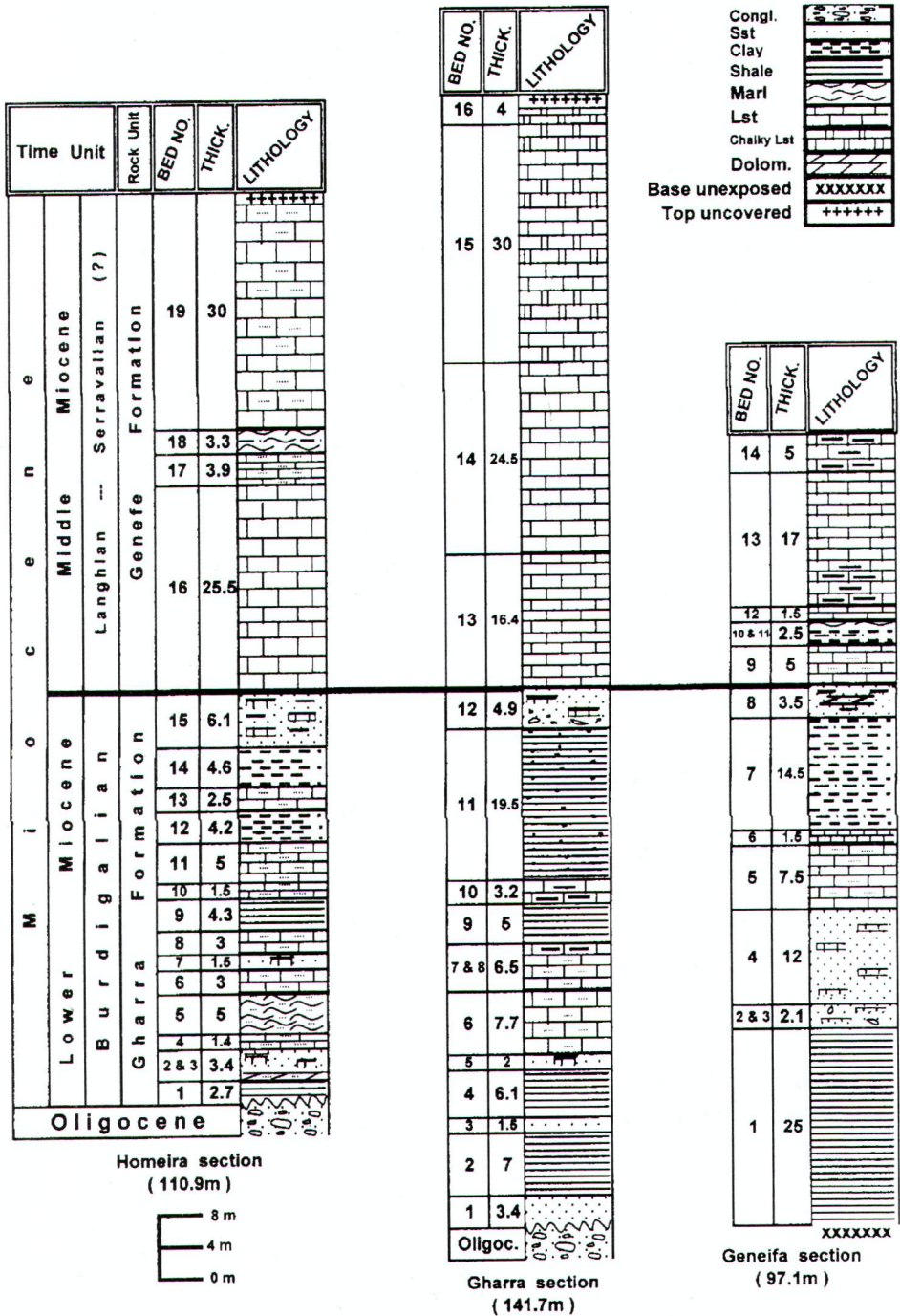


Fig. 2: Lithostratigraphic correlation chart for the three studied Miocene sections in the Cairo-Suez District.

Pecten (Oppenheimopecten) convexo-costatus Abich, 1857

(Pl. 2, Fig. 6)

1883 *Pecten convexo-costatus* Abich; Fuchs, 40, pl. 21 (16), figs. 1, 2.1902 *Pecten convexo-costatus* Abich; Depéret and Roman, 55, pl. 6, fig. 7.1976 *Pecten convexo-costatus* Abich; Metwally, 109, pl. 1, fig. 6.1992 *Pecten convexo-costatus* Abich; Abdel-Moneim, 116, pl. 3, fig. 1.**Material:** Five right valves**Remarks:** Valve of medium to large size, auricles equal, triangular, with smooth concentric growth lines; surface ornamented with 13-14 primary ribs in addition to 3-4 less prominent ribs at the anterior and posterior margins, ribs semi-circular in cross-section; primary ribs separated by slightly narrow concave interspaces.**Occurrence:** Gabal Geneifa (bed 13).**Distribution:** Burdigalian of Arminia and Azrabigan; Middle Miocene of Geneifa; Burdigalian of the Salum, Matruh and Sadat area (Depéret and Roman 1902, Metwally 1976, Abdel-Moneim 1992)

Family: Ostreidae Rafinesque, 1815

Genus : *Crassostrea* Sacco, 1897*Crassostrea crassissima* (Lamarck, 1819)

(Pl. 2, Fig. 7)

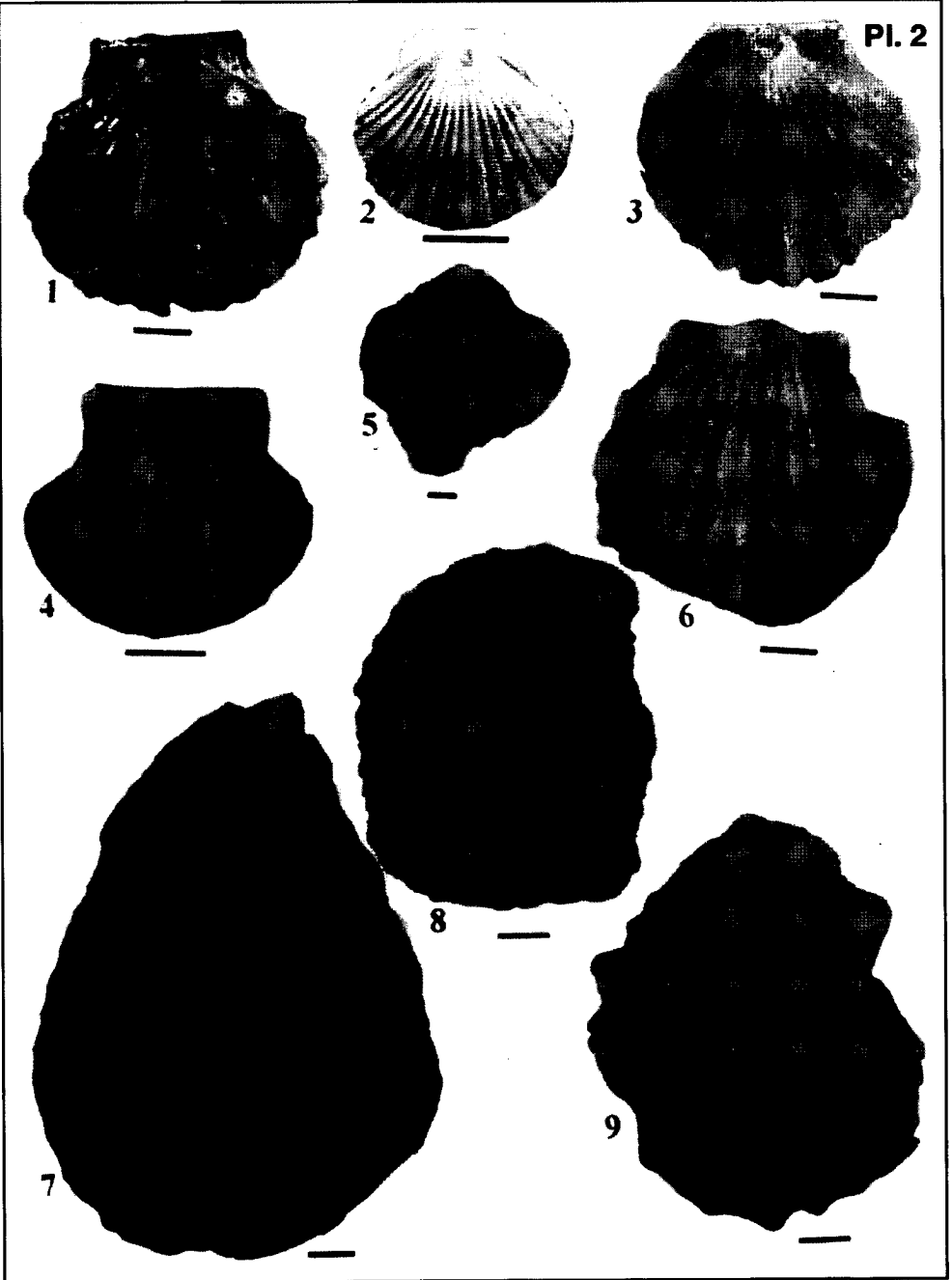
1910 *Crassostrea crassissima* (Lamarck); Schaffer, pl. 8, figs. 1, 2; pl. 9, figs. 1, 21992 *Crassostrea crassissima* (Lamarck); Abdel-Moneim, 121, pl. 4, figs. 4a, b**Material:** One left valve and three right valves.**Remarks:** Left valve of large size, nearly parallel anterior and posterior sides, very thick; broad ligamental area, nearly rectangular, with broad nearly rectangular reselium pit; large, deep, half circular adductor muscle scar; surface ornamented with concentric growth laminae.**Occurrence:** Gabal Homeira (bed 13) and Gabal Gharra (bed 6).**Distribution:** Miocene of Eggenberg; Helvetian of Algeria; Vindobonian and Serravallian of the area south of G. Ataqa and Sadat area (Schaffer 1910 and Abdel-Moneim 1992).*Crassostrea frondosa* (De Serres)

(Pl. 2, Fig. 8)

1966 *Ostrea frondosa* var. *rohlfsi* Fuchs; Cherif, pl. 8, fig. 5; pl. 6, figs. 1, 3.1966 *Ostrea frondosa* var. *rohlfsi* Fuchs; Hamam, pl. 9, fig. 3.1968 *Ostrea frondosa* De Serres var. *rohlfsi* Fuchs; El-Gamal, 161, pl. 16, figs. 1-3, 6, 7.1972 *Ostrea frondosa rohlfsi* Fuchs; Cherif, 105, pl. 2, figs. 4, 8, 10; pl. 3, fig. 51992 *Crassostrea frondosa* (De Serres) subsp. *rohlfsi* Fuchs; Abdel-Moneim, 122, pl. 4, fig. 7.**Material:** Eight double-valved shells, 58 right valves and 35 left valves.**Remarks:** Shell of medium size, slightly incurved posteriorly; subtriangular

ligamental area, with shallow, posteriorly incurved reselium pit; semi-circular, shallow adductor muscle scar; outer surface ornamented with 19-20 crenulated radial ribs radiating from the umbonal area.

Occurrence: Gabal Geneifa (beds 5, 9, 13 and 14); Gabal Homeira (beds no. 11, 13, 16 and 18) and Gabal Gharra (beds 6, 12, 13, 14 and 15).



Distribution: Miocene of the north Western Desert and Cairo–Suez district. Pliocene of Pyramids Plateau; (Fuchs 1883, El-Gamal 1968, Abdel-Moneim 1992).

Genus: *Alectryonella* Sacco in Bellardi and Sacco, 1897

Alectryonella plicatula (Gmelin)

(Pl. 2, Fig. 9)

1883 *Ostrea virleti* Deshayes; Fuchs, 43, pl. 9(4), figs. 1-6; pl. 10(5), figs. 1-4.

1966 *Ostrea (Lopha) plicatula* var. *virleti* Deshayes; Cherif, pl. 8, figs. 1, 3; pl. 10, figs. 1, 3, 7

1972 *Ostrea (Lopha) plicatula* var. *virleti* Deshayes; Cherif, 108, pl. 2, figs. 1, 3, 7; pl. 3, figs. 1, 3.

Alectryonella plicatula (Gmelin) subsp. *virleti* Dshayes; Abdel-Moneim, 124, pl. 5, figs. 2a, b.

1999 *Ostrea virleti* Deshayes; El-Shazly and Saber, 327, pl. 3, fig. 3.

Material: Nine double-valved shells, 56 right valves and 41 left valves.

Remarks: Shell of medium to large size, slightly dorsally-ventrally elongated, truncated posterior margin; subtriangular ligamental area; posteriorly incurved reselium pit; deep, semi-circular, medium to large size adductor muscle scar. outer surface of each ornamented with 10-12 crenulated radial ribs radiating from the umbonal area.

Occurrence: Gabal Geneifa (beds 5 and 13); Gabal Homeira (beds 11, 13, 16 and 18) and Gabal Gharra (beds 6, 10, 12, 13 and 14).

Distribution: Middle Miocene of Siwa Oasis, Gabal Geneifa, along the Red Sea Coast, south of Gabal Ataqa, Gabal Fayed and Cairo-Suez district; Pliocene of Zanzibar (Fuchs 1883, Cherif 1966, 1972, El-Shazly and Saber 1999).

Order: Veneroida H. Adams & A. Adams, 1856

Family: Lucinidae Fleming, 1828

Genus: *Linga* De Gregorio, 1884

Linga (Linga) columbella (Lamarck, 1819)

(Pl. 3, Fig. 1)

1870 *Lucina columbella* Lamarck; Hörnes, pl. 33, fig. 4.

1909 *Lucina (Linga) columbella* Lamarck; Dollfus and Dautzenberg, 251, pl. 17, figs. 12-15.

1992 *Linga (Linga) columbella* (Lamarck); Abdel-Moneim, 128, pl. 6, fig. 3.

Explanation of Plate 2

Fig.

1: *Pecten fuchsi* Fontannes, external view of left valve.

2: *Pecten (Pecten) cristato-costatus* Sacco, 1897, external view of left valve.

3: *Pecten (Pecten) fraasi* Fuchs, 1883, external view of left valve.

4: *Pecten (Pecten) ziziniæ* Blanckenhorn, 1901, external view of right valve.

5: *Pecten (Oppenheimopecten) benedictus* Lamarck, 1819, external view of right valve.

6: *Pecten (Oppenheimopecten) convexo-costatus* Abich, 1857, external view of right valve.

7: *Crassostrea crassissima* (Lamarck, 1819), external view of left valve.

8: *Crassostrea frondosa* (De Serres), external view of left valve.

9: *Alectryonella plicatula* (Gmelin), external view of left valve.

Bar scale = 1cm

Material: One moderately preserved internal mold.

Remarks: Internal mold of medium size, subrounded to oval, inequilateral; hinge line slightly curved, with two cardinals; peak prosogyrate; valves ornamented by concentric growth lines.

Occurrence: Gabal Homeira (bed 13).

Distribution: Miocene of Vienna basin and France; Middle Miocene of the north Western Desert; Burdigalian of Gabal Geneifa; Helvetian of Kabrit and Vindobonian of south Ataqa area; Serravallian of Sadat area (Hörnes 1870, Dollfus and Dautzenberg 1909, Abdel-Moneim 1992).

Family: Cardiidae Lamarck, 1809

Genus: *Acanthocardia* Gray, 1851

Acanthocardia (Acanthocardia) paucicostata (Sowerby, 1839)

(Pl. 3, Fig. 2)

1912 *Cardium paucicostatum* Sowerby; Cossmann and Peyrot, 478, pl. 20, fig. 30.

1986 *Acanthocardia (Acanthocardia) paucicostata* (Sowerby); Studencka, 65, pl. 10, figs. 1-2.

1992 *Acanthocardia (Acanthocardia) paucicostata* (Sowerby); Abdel-moneim, 130, pl. 10, fig. 6.

Material: One moderately preserved internal mold.

Remarks: Mold of medium size, semicircular to oval, higher than long, equivalve, subequilateral, umbo median, prosogyrate; hinge line nearly straight; mold has prints for 14-16 radial ribs in its lower half which reflect the inner ornamentation of the valves.

Occurrence: Gabal Homeira (bed 11).

Distribution: Middle Miocene of France and South Poland; Serravallian of Sadat area (Cossmann and Peyrot 1914, Studencka 1986, Abdel-Moneim 1992).

Family: Veneridae Rafinesque, 1815

Genus : *Clementia* Gray, 1842

Clementia (Clementia) cf. ungeri Rolle

(Pl. 3, Fig. 3)

1883 *Venus (Clementia) cf. ungeri* Rolle.; Fuchs, pl. 1, fig. 9.

1968 *Clementia (Clementia) cf. ungeri* Rolle.; Moore, 681, fig. E147/2

Material: One internal mold.

Remarks: Mold of medium size, equivalve, inequilateral, ovate to inflated; prosogyrate; antero-lateral side is shorter and more steep than the postero-lateral side; surface sculptured with concentric growth lines.

Occurrence: Gabal Gharra (bed 12).

Distribution: Miocene in Australia, India, West Pakistan, Burma, east Africa, Egypt, Indonesia, Iran, Austria and widespread in warm seas (Fuchs 1883, Moore 1968).

Genus : *Callista* Poli, 1791

Callista (Costacallista) erycina (Linne' 1758)

(Pl. 3, Fig. 4)

1870 *Cytherea erycina* Lamarck; Hörnes, 137, pl. 19, figs. 1,2.

1883 *Cytherea erycina* Lamarck; Fuchs, 39.

1910 *Callista erycina* Linné; Schaffer, pl. 36, figs. 6-9.

1992 *Callista (Costacallista) erycina* (Linne'); Abdel-Moneim, 135, pl. 7, fig. 2.

Material: Two moderately preserved internal molds.

Remarks: Mold of medium size, equivalve, inequilateral, ovate to trigonal, not very elongated; prosogyrate; antero-lateral side short.

Occurrence: Gabal Gharra (bed 13).

Distribution: Miocene in Indo-Pacific, Europe, Mediterranean, Egypt, Zanzibar, west Pakistan, India, Burma and Indonesia (Hörnes 1870, Schaffer 1910, Abdel-Moneim 1992).

Order: Pholadomyoidea Newell, 1965

Family: Clavagellidae d'Orbigny, 1843

Genus : *Clavagella* Lamarck, 1818

Clavagella (Stirpulina) coronata Deshayes, 1830

(Pl. 3, Fig. 5)

1969 *Clavagella (Stirpulina) coronata* Deshayes; Moore, 858, fig. 32/2.

Material: Three moderately preserved internal molds.

Remarks: Moderately preserved mold reflects a left valve fixed to siphonal tube with extended end, right valve free, anterior end with tubules formed only in terminal corona.

Occurrence: Gabal Homeira (bed 19).

Distribution: Upper Eocene, Paris basin (Moore 1969)

Class: Gastropoda Cuvier, 1797

Order: Mesogastropoda

Family: Turritellidae Clark, 1851

Genus : *Turritella* Lamarck, 1799

Turritella (Turritella) clevelyi Abbass, 1977

(Pl. 3, Fig. 6)

1977 *Turritella (Turritella) clevelyi* Abbass; 114, pl. 2, figs. 7-9.

Material: Two internal molds.

Remarks: Mold of small size, turriculate; spire high, narrow, consisting of numerous whorls; whorl outline strongly convex with deep sutures.

Occurrence: Gabal Homeira (bed 11).

Distribution: Vindobonian of Geneifa area (Abbass 1977)

Turritella (Eichwaldiella) fouadi Abbass, 1977

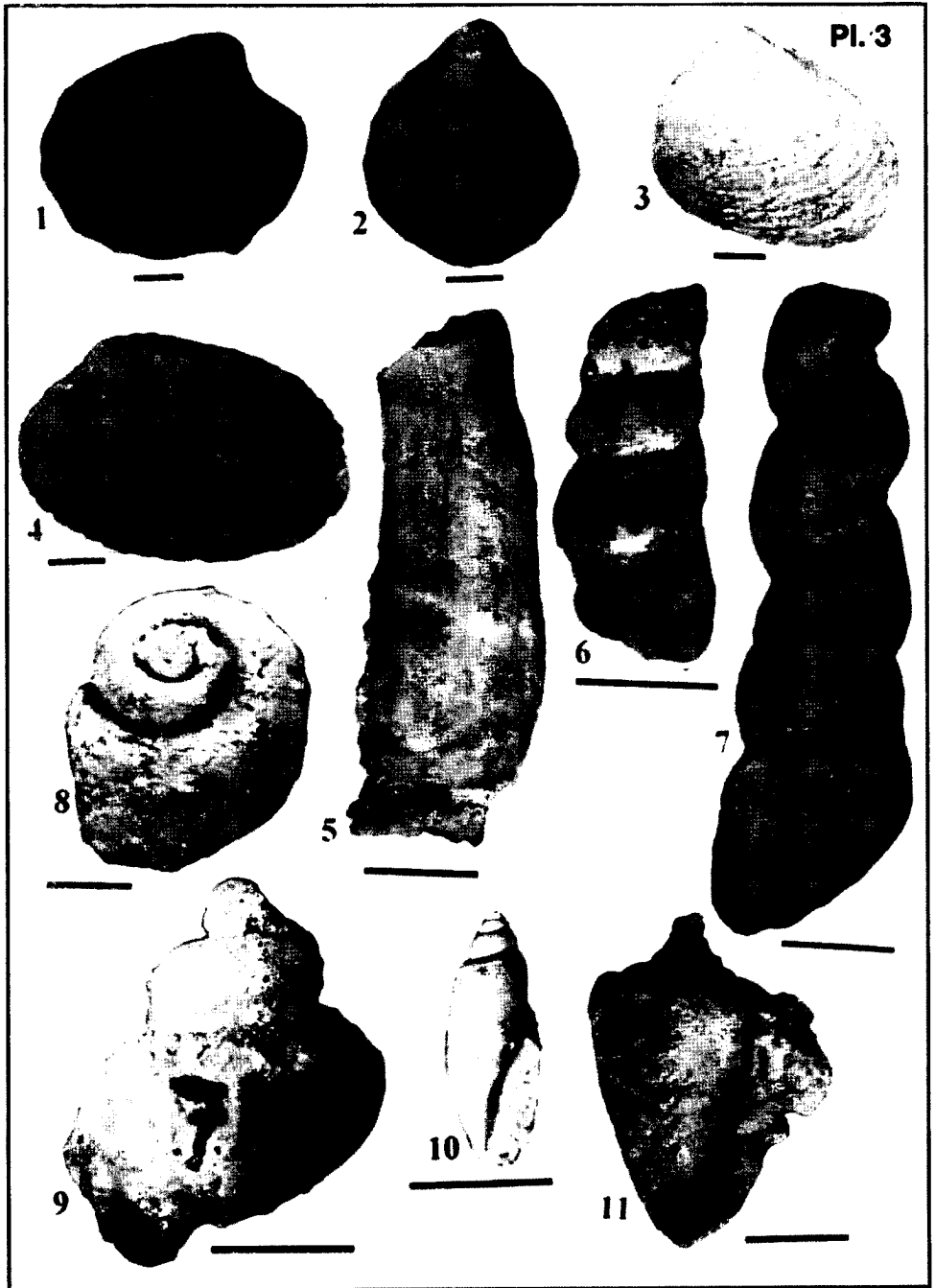
(Pl. 3, Fig. 7)

1977 *Turritella (Eichwaldiella) fouadi* Abbass; 115, pl. 2, figs. 6, 12, 13.

1992 *Turritella (Eichwaldiella) fouadi* Abbass; Abdel-Moneim, 141, pl. 7, fig. 10.

Material: One internal mold.

Remarks: Mold of medium size, turriculate; spire narrow, consists of many whorls; whorl outline convex with two carina, separated by wider interspaces; suture linear,



deep.

Occurrence: Gabal Homeira (bed 11).

Distribution: Helvetian of Ramlyia area; Serravalian of Sadat area (Abbass 1977, Abdel-Moneim 1992).

Family: Naticidae

Natica millepunctata Lamarck, 1822

(Pl. 3, Fig. 8)

1856 *Natica Millepunctata* Lamarck; Hornes, pl. 47, figs. 1, 2.

1966 *Natica Millepunctata* Lamarck; Cherif, pl. 13, figs. 3, 6.

1966 *Natica Millepunctata* Lamarck; Hamam, pl. 10, fig. 21.

1972 *Natica Millepunctata* Lamarck; Cherif, 112, pl. 6, figs. 3, 6.

Material: Four internal molds.

Remarks: Internal mold of small size, naticoid, trochoid, spire with 2-3 whorls, sutures depressed.

Occurrence: Gabal Gharra (bed 6).

Distribution: Middle Miocene of Siwa Oasis; Burdigalian of Gabal Geneifa and Agrud area; Helvetian of Kabrit; Vindobonian of south Ataq; Tortonian and Serravallian of Sadat area (Hamam 1966, Cherif 1966 & 1972).

Family: Bursidae

Genus : *Bursa* (Bolten) Röding, 1798

Bursa faizae Abbass, 1977

(Pl. 3, Fig. 9)

1977 *Bursa faizae* Abbass; p. 132, pl. 6, figs. 12, 13.

Material: One internal mold.

Remarks: Mold of medium size, fusiform; spire short, small, consisting of three whorls; whorl outline convex, strongly curved posteriorly; suture deep; body whorl large, strongly inflated posteriorly with side curving anteriorly into short peak.

Occurrence: Gabal Homeira (bed 11).

Distribution: Burdigalian of Agrud area (Abbass 1977).

Explanation of Plate 3

Fig.

1: *Linga (Linga) columbella* (Lamarck, 1819), internal mold.

2: *Acanthocardia (Acanthocardia) paucicostata* (Sowerby, 1839), internal mold.

3: *Clementia (Clementia) cf. ungeri* Rolle, internal mold.

4: *Callista (Costacallista) erycina* (Linné 1758), internal mold.

5: *Clavagella (Stirpulina) coronata* Deshayes, 1830, internal mold.

6: *Turritella (Turritella) clevelyi* Abbass, 1977, internal mold.

7: *Turritella (Eichwaldiella) fouadi* Abbass, 1977, internal mold.

8: *Natica millepunctata* Lamarck, 1822, internal mold.

9: *Bursa faizae* Abbass, 1977, internal mold.

10: *Oliva (Neocylindrus) wagihi* Abbass, 1977, internal mold.

11: *Conus (Conolithus) melficus* Desio, 1929, internal mold.

Bar scale = 1 cm

Order: Neogastropoda Thiele, 1925

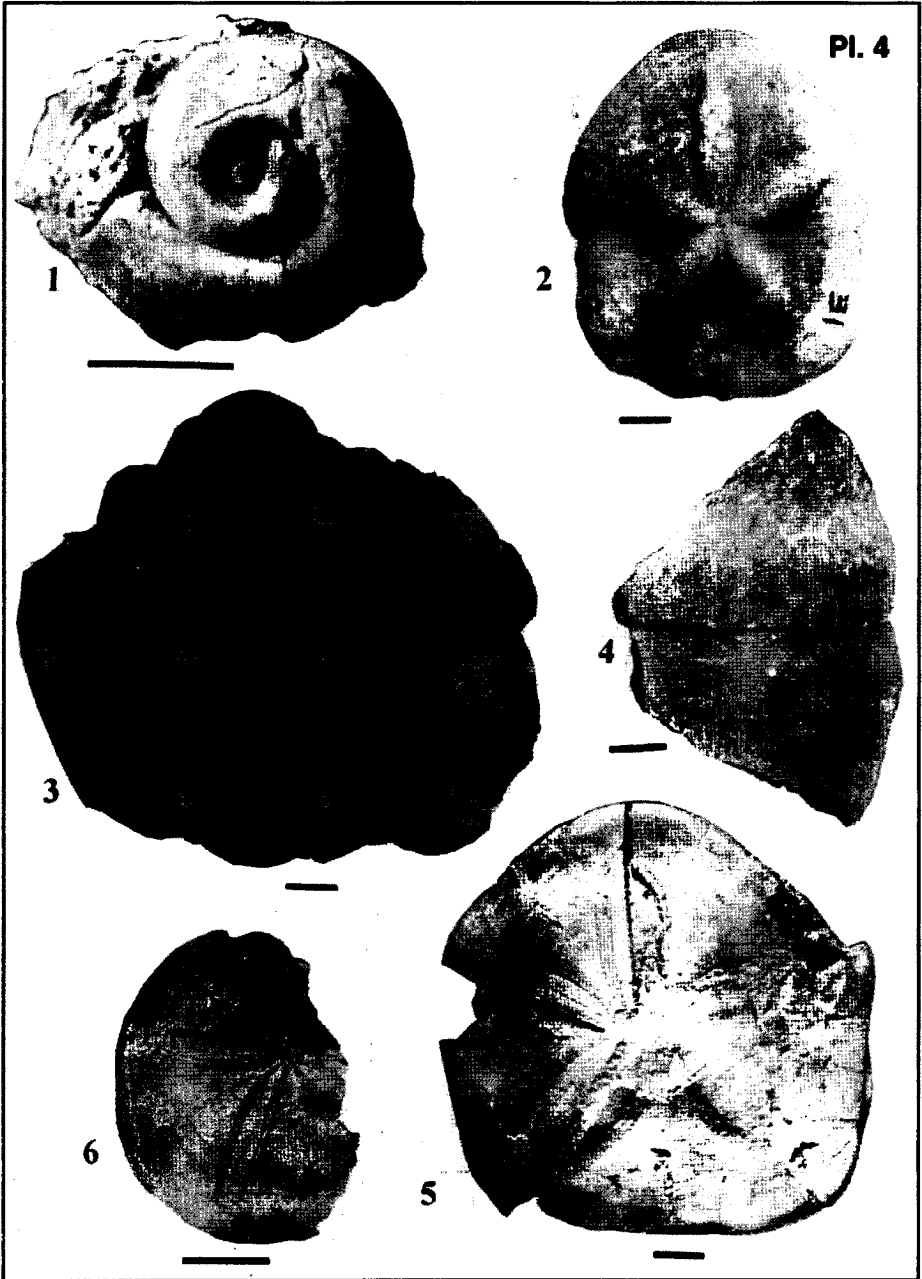
Family: Olividae

Genus : *Oliva* Martyn, 1786

Oliva (Neocylindrus) wagihi Abbass, 1977

(Pl. 3, Fig. 10)

1977 *Oliva (Neocylindrus) wagihi* Abbass; 143, pl. 7, figs. 7, 8.



Material: One internal mold.

Remarks: Mold of small size; spire short, conical, consisting of three whorls; whorls low with nearly straight sides; sutures almost superficial; aperture long, narrow, angular posteriorly, wide anteriorly, thickened at the margin.

Occurrence: Gabal Homeira (bed 19).

Distribution: Helvetian of Geneifa area (Abbass 1977).

Family: Conidae

Genus : *Conus* Linné 1758

Conus (Conolithus) melficus Desio, 1929

(Pl. 3, Fig. 11)

1929 *Conus (Dendroconus) melficus* Desio, 279, pl. 37, fig. 4.

1966 *Conus melficus* Desio; Hamam, pl. 10, fig. 9.

1992 *Conus (Conolithus) melficus* Desio; Abdel-Moneim, 149, pl. 8, fig. 6.

Material: One internal mold.

Occurance: Gabal Homeira (bed 13).

Remarks: *Conus (Conolithus) melficus* Desio is more cylindrical than *Conus mercati*, Brocchi and has a prominent conical spire.

Distribution: Miocene of the north Westren Desert; Burdigalian of Agrud and Sadat areas (Desio 1929, Hamam 1966, Abdel-Moneim 1992)

Order: Pulmonata

Family: Planorbidae

Genus : *Planorbis* Muller, 1774

Planorbis (Planorbis) nakanoi Abbass, 1977

(Pl. 4, Fig. 1)

1977 *Planorbis (Planorbis) nakanoi* Abbass; 152, pl. 3, figs. 9-11.

Matrial: One internal mold.

Remarks: Mold of small size, planispiral; dextrally coiled; with shallow apical umbilicus, deeper basal umbilicus, basal umbilicus wider than apical one; 3-4 whorls with convex dorsal sides; suture deep; last whorl subcircular in cross section with concave inner side; aperture nearly parallel to shell axis.

Occurrence: Gabal Homeira (bed 19).

Distribution: This species was recorded in Egypt as a new specie from the Ramlyia area in the Helvetian-Tortonian beds (Abbass 1977)

Explanation of Plate 4

Fig.

1: *Planorbis (Planorbis) nakanoi* Abbass, 1977, internal mold.

2: *Clypeaster intermedius* Desmouliins, 1837, aboral view.

3: *Clypeaster marginatus* Lamarck, 1816, aboral view.

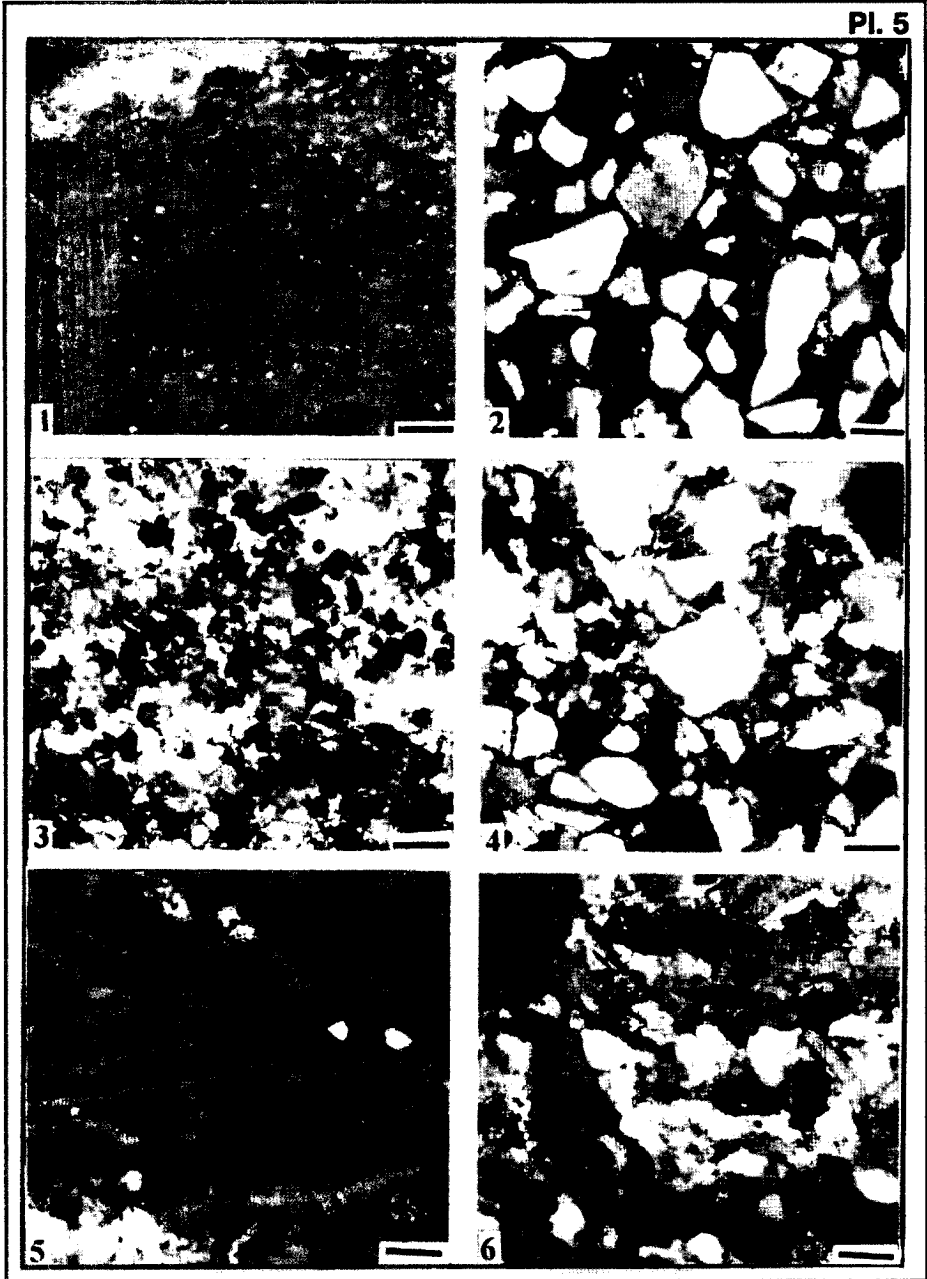
4: *Scutella ammonis* Fuchs, 1883, view of a fragment.

5: *Parascutella stefaninii* (Desio, 1929), aboral view.

6: *Echinolampas amplius* Fuchs, 1883, aboral view.

Bar scale = 1cm

Phylum: Echinodermata
Class: Echinoidea Leske, 1778
Order: Clypeasteroidea Agassiz, 1872
Family: Clypeasteridae Agassiz, 1835
Genus : *Clypeaster* Lamarck, 1801
Clypeaster intermedius Desmoulins, 1837
(Pl. 4, Fig. 2)



1920 *Clypeaster intermedius* Desmoulins; Fourtau, 50.

1966 *Clypeaster intermedius* Desmoulins; Cherif, pl. 14, fig. 7.

1972 *Clypeaster intermedius* Desmoulins; Cherif, 118, pl. 1, fig. 11.

1992 *Clypeaster intermedius* Desmoulins; Abdel-Moneim, 152, pl. 9, figs. 1a, 1b.

Material: Four moderately preserved tests.

Remarks: Test of medium size, elongated, of pentagonal outline; aboral surface slightly convex; oral surface flate, highly depressed toward peristome; ambulacral areas are short, wide, swollen at petal areas, nearly equal, not reaching the margin; peristome central, pentagonal; periproct submarginal and rounded.

Occurance: Gabal Geneifa (bed 12); Gabal Gharra (bed 14).

Distribution: Miocene of France, Algeria, Spain, Italy, Sardinia; Vindobonian of Gabal Geneifa. Burdigalian of Sadat area (Fourtau 1920, Cherif 1966 and 1972, Abdel-Moneim 1992)

Clypeaster marginatus Lamarck, 1816
(Pl. 4, Fig. 3)

1920 *Clypeaster marginatus* Lamarck; Fourtau, 51, pl. 8, fig. 1.

1975 *Clypeaster marginatus* Lamarck; Ali, 210, pl. 5, figs. 1-4.

1987 *Clypeaster marginatus* Lamarck; El-Shazly, 196, pl. 5, fig. 2.

1992 *Clypeaster marginatus* Lamarck; Abdel-Moneim, 153, pl. 9, fig. 3a, b.

Material: Three moderately preserved tests.

Remarks: *Clypeaster marginatus* Lamarck, 1816 differs from *Clypeaster intermedius* Desmoulins, 1837 since the former is characterized by its larger size, more broad width, slightly swollen petals and the interporiferous zones are less swollen and wider.

Occurance: Gabal Geneifa (bed 13); Gabal Homeira (bed 11) and Gabal Gharra section (bed 13).

Distribution: Miocene of France, Portugal, Malta, Sicile and Italy; Vindobonian of west Sinai; Helvetian of Matruh area, west Sinai and Sadat area (Fourtau 1920, Ali 1975, El-Shazly 1987, Abdel-Moneim 1992).

Explanation of Plate 5
Clastic-dominated facies of the Gharra Formation

Fig.

1: Sandy - silty ferruginous shale. Gabal Gharra, bed 9, C.N.

2: Calcareous quartz arenite, cemented with calcareous materials. Gabal Geneifa, bed 3, C.N.

3: Calcareous ferruginous quartz arenite. Gabal Gharra, bed 3, C.N.

4: Dolomitic calcareous quartz arenite, cemented by sparite and dolomite rhombs. Gabal Geneifa, bed 8, C.N.

5: Foraminiferal packstone, with *Operculina* and *Heterostegina* tests. Gabal Gharra, bed 10, P.P.L.

6: Sandy bioclasts packstone with foraminiferal and echinoidal fragments. Gabal Gharra, bed 7, C.N.

Bar scale = 0.44mm

Suborder: Scutellina Haeckel, 1896

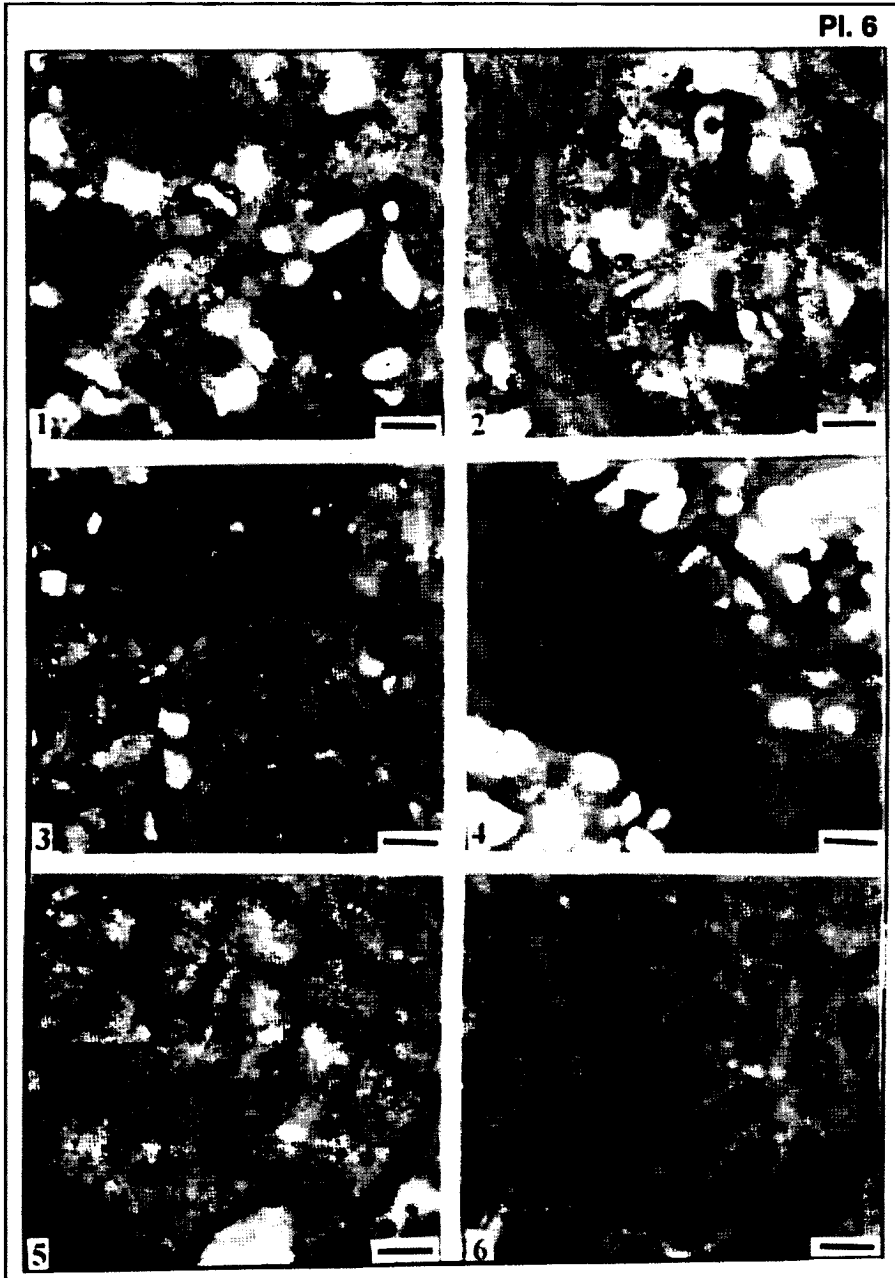
Family: Scutellidae Gray, 1825

Genus : *Scutella* Lamarck, 1816

Scutella ammonis Fuchs, 1883

(Pl. 4, Fig. 4)

1883 *Scutella ammonis* Fuchs; p. 48, pl. 14 (9), figs. 1-4.



1962 *Scutella ammonis* Fuchs; Said, pl. 9, fig. 5.

1968 *Scutella ammonis* Fuchs; El-Gamal, p. 232, pl. 22, fig. 1.

1975 *Scutella ammonis* Fuchs; Ali, p. 246, pl. 14, fig. 4-9.

1992 *Scutella ammonis* Fuchs; Abdel-Moneim, 154, pl. 9, fig. 4.

Material: One complete test and other incomplete tests.

Remarks: Test of medium to large size, subrounded, thin aboral surface, nearly flate; oral surface slightly depressed toward peristome; apical system central; ambulacral areas pateloid, medium, wide; peristome central, rounded; periproct in half way between margin and peristome, rounded.

Occurance: Gabal Homeira (bed 17); Gabal Gharra (beds 6, 12, 13).

Distribution: Burdigalian of Gabal Geneifa and Agrud area; Helvetian of Salum area and Siwa Oasis. Serravallian and Tortonian of Sadat area (Said 1962, El-Gamal 1968, Cherif 1972, Ali 1975, Abdel-Moneim 1992)

Genus: *Parascutella*

Parascutella stefaninii (Desio, 1929)

(Pl. 4, Fig. 5)

1929 *Scutella stefaninii* Desio; pl. 40, fig. 3.

1968 *Parascutella stefaninii* (Desio); El-Gamal, 238, pl. 23, figs. 4, 5.

1975 *Scutella stefaninii* Desio; Ali, p. 252, pl. 16, fig. 7.

1992 *Parascutella stefaninii* (Desio); Abdel-Moneim, 155, pl. 9, fig. 5.

Material: One complete test and other incomplete tests.

Remarks: Test of medium to large size, subrounded, thin; aboral surface nearly flate; oral surface flate; apical system central; ambulacral areas petaloid, wide, extending to $\frac{3}{4}$ of the half length; peristome central.

Occurence: Gabal Homeira (bed 17); Gabal Gharra (beds 6, 12).

Distribution: Burdigalian of Western Desert; Middle Miocene of Cairo-Suez District; Serravallian of Sadat area (El-Gamal 1968, Ali 1975, Abdel-Moneim 1992)

Order: Cassiduloida Claus, 1880

Family: Echinolampadidae Gray, 1825

Genus : *Echinolampas* Gray, 1825

Echinolampas amplus Fuchs, 1883

(Pl. 4, Fig. 6)

Explanation of Plate 6

Carbonate dominated-facies of the Geneife Formation

Fig.

1: Sandy bioclastic packstone with algal, foraminiferal and echinoidal fragments. Gabal Geneifa, bed 11, P.P.L.

2: Sandy molluscan grainstone. Gabal Geneifa, bed 9, P.P.L.

3: Foraminiferal packstone with red algal fragments. Gabal Geneifa, top part of bed 13, C.N.

4: Sandy algal grainstone with micritized red algae (*Lithothamnium* sp.). Gabal Gharra section, bed 15, P.P.L.

5: Bioclastic bryozoan packstone with ideoniform bryozoans. Gabal Geneifa, bed 11, P.P.L.

6: Coralline framestone. Skeleton is recrystallized and spaces are filled with micrite matrix. Gabal Gharra, bed 13, P.P.L.

Bar scale = 0.44mm

1883 *Echinolampas amplus* Fuchs; 27, pl. 14 (9), figs. 5-8.

1955 *Echinolampas amplus* Fuchs; Said and Yallouze, 77, pl. 5, fig. 2.

1968 *Echinolampas amplus* Fuchs; El-Gamal, pl. 24, fig. 7; pl. 25, figs. 3, 4.

1973 *Echinolampas amplus* Fuchs; Ali, 174, pl. 13, figs. 1, 2.

1992 *Echinolampas amplus* Fuchs; Abdel-Moneim, 156, pl. 10, figs. 2a, b.

Material: Ten moderately preserved tests and other broken parts.

Remarks: Test of medium to large size, ovoidal to discoidal; aboral surface slightly depressed, uniformly convex; oral surface almost flate, slightly depressed around peristome; ambulacral areas are flush; petals long, more or less narrow; anterior and antero-lateral petals reach margin; anterior petal the shortest and narrowest; postero-lateral petals the longest, broadest, peristome relatively large, pentagonal, excentric anteriorly.

Occurrence: Gabal Geneifa (beds 5, 13); Gabal Homeira (bed 11) and Gabal Gharra (beds 13, 14).

Distribution: Middle Miocene of north Westren Desert and Gabal Geneifa; Vindobonian of the Isthmus, between Gabal Ataqa, Northern Galala and Gabal Oweibid; Burdigalian of Cairo-Suez district; Helvetian of Salum area; (Fuchs 1883, Cherif, 1966 and 1972, El-Gamal, 1968; Ali 1973, Abdel-Moneim 1992).

DEPOSITIONAL ENVIRONMENTS

Selley (1978) defined the sedimentary facies as "a mass of sedimentary rocks", which can be defined and distinguished from others by its geometry, lithology, sedimentary structures, paleocurrent pattern and fossils.

The recognition and interpretation of the recorded sedimentary facies are based on a number of megascopic and microscopic features and guided with the facies model of Wilson (1975) as well as the environmental criteria and case histories described by Flugel (1982).

The marine Miocene sequence in the study areas could be divided into two sedimentary facies: The lower one is a clastic-dominated facies, whichs represented by the Gharra Formation, while the upper one is a carbonate-dominated represented by the Genefe Formation.

Clastic-dominated facies:

The lower segment of this facies is an erosional base with extra-and intraformational clasts, followed upward by cross-bedded sandstones and terminated by thinly laminated mudstone. The upper segment of this facies consists mainly of sandy limestone, oyster banks intercalated with mudstone and sandstone.

The sandstone is composed mainly of fine to coarse grained, subrounded to subangular, calcareous, fossiliferous with molluscan fragerments (mainly pectinids and other bivalves), echinoids (*Scutella* sp. and *Clypeaster* sp.) and molds of gastropods. The mudstones are of medium to thick bedded, non-fossiliferous, moderately compact, jointed, and ferruginous,

The limestones are mainly thin to medium bedded, compact, massive, jointed, rich in macrofossils mainly of molluscs (especially pelecypods), gastropod molds, badly preserved echinoderms. Oysters of large size are common.

This sedimentary facies is characterized by the following microfacies associations: calcareous quartz arenite, dolomitic calcareous quartz arenite, calcareous fossiliferous quartz arenite, calcareous ferruginous quartz arenite, sandy echinoidal foraminiferal grainstone, sandy dolomitic wackestone, sandy fossiliferous grainstone, sandy echinoidal packstone, sandy algal grainstone, sandy bioclasts packstone, and sandy foraminiferal bryozoan packstone, plate 5.

Based on the microfacies associations, sedimentary structures and fossil content the lower part of the Gharra Formation was deposited in an environment ranging from tidal flat, while the upper part indicates deposition on typical reef flank with some intervals of high energetic shoaling.

Carbonate-dominated facies:

This sedimentary facies consists essentially of limestones, sandstones and claystones. The limestones are thick-bedded, compact, massive, chalky, jointed, fractured, bioturbated and highly fossiliferous with coralline red algae, *Amphistigina* sp., *Miogypsina* sp. and oysters. Sandstone is characterized by abundance of *Scutella* sp. and large *Pecten* forms. Claystone is thinly laminated, moderately compact, nonfossiliferous, with lenticular beds of fine sandstone.

In the study area the carbonate-dominated facies is characterized by the following microfacies associations: sandy bioclasts packstone, sandy foraminiferal bryozoan packstone, sandy molluscan grainstone, foraminiferal algal wackestone, sandy bioclasts packstone, sandy echinoidal foraminiferal grainstone, sandy algal grainstone, algal coralline framestone and coralline framestone, plate 6.

The microfacies associations, fossil content and sedimentary structures stated that the environment of deposition was reefal environment for the lower part, due to the presence of abundance of coralline red algae, oysters, *Amphistigina* sp. and *Miogypsina* sp. to shelf lagoons with open circulation and an intertidal environment with low energy conditions for the deposition of mudstones in the topmost part of Genefe Formation.

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