EARLY MIOCENE BRYOZOA OF GEBEL GHARRA, NORTHWEST GULF OF SUEZ, EGYPT

Y.A. El Safori* and A.S. El-Sorogy**
* Department of Geology, Ain Shams University.
** Department of Geology, Zagazig University.

ABSTRACT:
Twenty-six bryozan species have been identified from the early Miocene sediments of Gebel Gharra (Gharra Formation). Among them five species are cyclostomes and twenty-one species are cheilostomes. Three species are believed to be new: *Membranipora gharranensis*, *Ramphonotous crenulata*, and *Schizoretepora hamzai*. Nearly two thirds of the recorded species have the encrusting zoarial growth-form. The paleoecological investigation of the studied bryozoans, and the accompanied microfacies has concluded reef to back-reef depositional environment. Also, water depth is shallow, with an estimating depth range of 20-40 m, moderate turbulence, and low rate of sedimentation.

Keywords: Miocene facies - bryozoan taxonomy - paleoecology - paleogeography.

1. INTRODUCTION

Earlier works on the Miocene bryozoans of the Cairo-Suez District include Canu (1904) and Souaya (1965). In the last decade, much investigation has revealed several species from Sadat and Hagul areas (Ziko et al. 1992 & 1994; El-Dera, 1991; El Safori, 1994; Ziko, 1996a). The present work deals with the Miocene bryozoans collected from marls, shales and coralline beds at Gebel Gharra (Gharra Formation, Ghorab and Marzouk, 1965) on the northwestern part of the Gulf of Suez (fig. 1 & pl. 1, fig. 1-3). Special focus is directed to the paleontological, paleoecological and paleobiogeographical aspects.

The Miocene rocks at Gebel Gharra unconformably overlie reddish brown Oligocene sands and gravels. The rock horizons selected in Gebel Gharra is rich in well preserved, less fragmented, abundant and relatively low diverse bryozoans.

The Miocene succession in the study area is represented by a succession of limestones with few marl interbeds. Some localities are coralline, and at others they are rich in oysters with coral and algal reefs in parts. The section is sandy at its basal part.

Gebel Gharra is one of many Miocene carbonate complexes exposed along the western side of the Gulf of Suez. The carbonates form a nearly flat plateau situated some 112 m above the surrounding coastal plain.

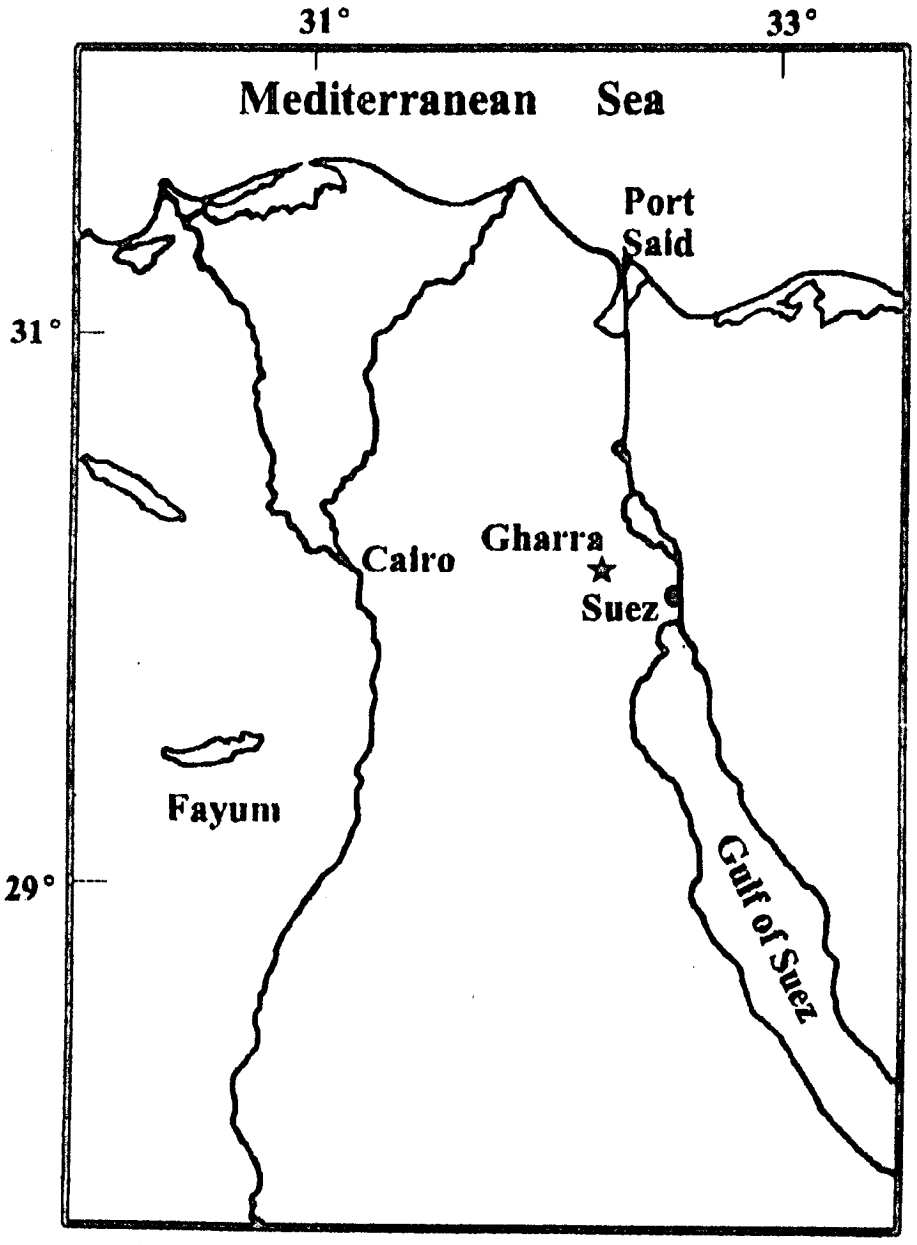
2. FACIES ANALYSIS

Field observations and facies analysis of the collected specimens help the authors to distinguish the following 4 superimposing facies associations.
Shore facies (Unit I): This Association is composed of basal pebbly, calcareous sandstones (32 m). It has several fossiliferous interbeds, with *Pycnodonte virleti*, pectinids, *Scutella* spp., erect zoaria of *Margretta ceroides*, *Retepora* sp., and large foraminifers.

Fore reef facies (Unit II): This association is made up of bioclastic limestone with branches of *Acropora* sp., *Porites* sp. (pl. 1, fig. 2), banks of *Pycnodonte virleti* and *Holloporella polythele* (pl. 1, fig. 3) as well as other bivalves and gastropods biolcasts (30 m). The microfacies is represented by fossiliferous packstone/grainstone, with biomorpha, bioclasts of *Operculina* sp. and *Amphistigina* sp. (pl. 1, fig. 4).

Reef core facies (Unit III): A reef-core facies (27 m), with coral floatstones, rudstones and local framestone, with amounts of foraminifers, mollusks, and peloids represent this coral sediment. It consisted of exclusively 20 m thick, massive bedded *Siderastrea* sp. (pl. 1, fig. 1).

Back reef facies (Unit IV&V)): This association is composed of sandy, coralline algal limestone, with red algae *Lithophyll..n* sp. (pl. 1, fig. 5), disseminated shells, and thin banks of *Pycnodonte virleti* (20 m). The b..al part is composed of thin calcareous sandstone (3 m).


31°
33°
Mediterranean Sea
Port Said
31°
Cairo
Gharra
Suez
Fayum
29°
Gulf of Suez

The Miocene carbonates at Gebel Gharra have been strongly affected by meteoric waters. Many of organic components ranging in size from small mollusk shells to large coral heads are now were totally totally dissolved. During meteoric alteration, dissolution as expected is mineralogically selective (James and Choquette, 1984), i.e. aragonitic particles and now represented by voids.

Lithologically, the Gebel Gharra is subdivided into five informal units their description and fossil associations are shown in figure 2.

3. TAXONOMIC DESCRIPTION

A taxonomic description of the recorded bryozoans is given, based principally on the classification of Bassler (1953) and other later modifications. Distribution in and outside Egypt, and habitat (when known) for each species are given. Full description and micrometric measurements are given only for the new-recorded species.

Abbreviations used in the micrometric dimensions are:
Lo = oral or opesial length, lo = oral or opesial width, lz = zooecial length, lz = zooecial width, Lav = avicularian length, lav = avicularian width.

Phylum Bryozoa Ehrenberg, 1831
Order Cyclostomata Busk, 1852

Family Crisiidae Johnston, 1847
***Crisia hornesi* Reuss, 1848**
(pl. 2, fig. 1)

1848 *Crisia hornesi* Reuss, p. 54, pl. 1, Fig. 28 & pl. 7, fig. 21.
1909 *Crisia hornesi*: Canu, p. 1103, pl. 12, fig. 12.
1920 *Crisia hornesi*: Canu & Bassler, p. 704, pl. 141, fig. 1, 2.
1974 *Crisia hornesi*: Debourle, p. 42, pl. 1, fig. 5.
1988 *Crisia hornesi*: Moissette, p. 42, pl. 5, fig. 5.
1992 *Crisia hornesi*: Pouyet & Moissette, p. 23, pl. 1, fig. 3.
Material: Three badly preserved zoarial fragments.
Zoarial growth-form: Erect; biserial; flexible; rooted; bifurcated, solid stems (Cellariiform).
Description: Frontal little convex, finely perforated. Zooecial tubes little distinct, biserially arranged in alternating manner. Orifice circular, peristome thin, little salient, rounded. Dorsal little convex. Ovicell not observed.
Occurrence: Bed No. 3, 11, 16.
Distribution: Eocene (France, Italy, and USA); Oligocene (Germany, Italy, and USA); Miocene (Egypt, Libya, France, and Italy); Pliocene-Quaternary (Italy).

Family Tubuliporidae Johnston, 1838
***Exidmonea atlantica* (Forbes in Johnston, 1847)**
(pl. 2, fig.2)

1847 *Idmonea atlantica* Fobres in Johnston, p. 278, pl. 48, fig. 2, 3.
1977 *Exidmonea atlantica*: Vavra, p. 25.
1994 *Exidmonea atlantica*: El Safori, p. 111, pl. 9, fig. 10.
1996 *Exidmonea atlantica*: El-Dera, p. 41, pl. 2, fig. 4, 5 & 7.
Material: Numerous badly preserved zoarial fragments, all lacking ovicells.
Zoarial growth-form: Erect; rigid; biserial; cemented; bifurcate, solid stems (Vinculariiform).
Description: Zooecia indistinct, relatively tubular. Frontal finally perforated. Zooecial tubes 4 to 5 grouped in alternated fascicles. Orifice subcircular, small. Peristomes thin, salient.
Occurrence: Bed no. 3, 11, 16.
Distribution: Eocene (Italy, Hungary, Romania, USA, and Argentina); Oligocene (Germany, Italy, and USA); Miocene (France, Italy, Austria, Poland, and Egypt); Pliocene (Tunisia, Morocco, Mexico, and Egypt); Pleistocene (Italy and Canada).
Habitat: Cosmopolitan, survive under variable temperature as cold as -8°C, variable depth (0-850 m) with optimum depth range of 10-100 m in the Mediterranean (Moissette, 1988).

Family Plagioeciidae Canu, 1918
***Plagioecia sarniensis* (Norman, 1864)**
(pl. 2, fig. 3)

1864 *Diastopora sarniensis* Norman, p. 89, pl. 11, fig. 4-6.
1952 *Berenbicea sarniensis:* Lagaaij, p. 161, pl. 19, fig. 1.
1976 *Plagioecia sarniensis*: Harmlin, p. 136, pl. 9, fig. 3 & pl. 20, Fig. 6-11.
1988 *Plagioecia sarniensis*: Moissette, p. 58, pl. 8, fig. 1, 4.
1992 *Plagioecia sarniensis*: El Hajjaji, p. 60, pl. 2, fig. 7.
Material: Two preserved zoarial fragments encrusting on shells and shell fragments.
Zoarial growth-form: Encrusting unilaminate, cemented; flat, circular sheets (Lichenoporiform).
Description: Zooecia, cylindrical, radiated, arranged in regular erect rows in the distal half, widely separated. Opesia small, oval, terminal; Peristomes thin, oblique, oval. Ancestrular zooecia short, with peristomes slightly thicker than those of zooecia.
Occurrence: Bed no. 3, 8.
Distribution: Eocene (USA); Miocene (France, Morocco, and Algeria); Pliocene (Holland, Panama, and Italy).
Habitat: Mediterranean (25-80 m); Atlantic (23-30 m); Tropical Seas (23-150 m).

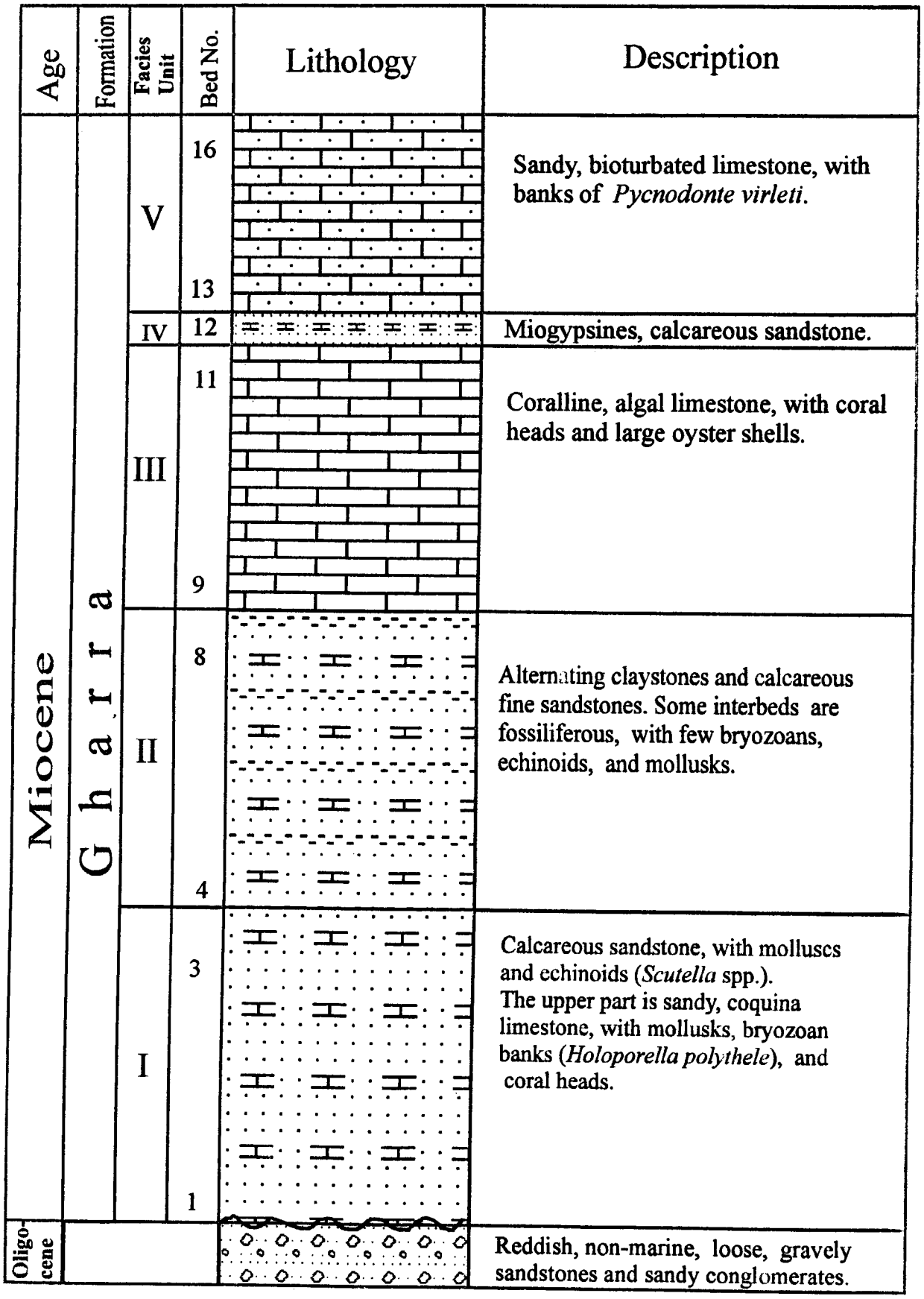


Figure 2. Stratigraphic log of the Gharra section.

0 10 m

Family Petaloporidae Canu, 1918
***Polyascosoecia sparsa* (Reuss, 1864)**
(pl. 2, fig. 4)

1864 *Hornera sparsa* Reuss, p. 201, pl. 3, fig. 3-5.
1972 *Reteproidea sparsa*: Mongereau, p. 344, pl. 8, fig. 7-8 & pl. 9, fig. 1, 2, 6.
1988 *Reteproidea sparsa*: Braga & Barbin, p. 51.
1992 *Polyascosoecia* aff. *sparsa*: El Hajjaji, p. 71, pl. 3, fig. 4, 5.

Material: Numerous badly preserved zoarial fragments.

Zoarial growth-form: Erect; rigid; cemented; bifurcated cylindrical stems. (Vinculariiform).

Description: Zooecial tubes arranged in transverse lateral rows, isolated , and irregularly arranged in the middle part. Orifice circular. Mesopores frequent, with smaller diameter than the zooecial tubes. Ovicell not observed.

Occurrence: Bed no.3.

Distribution: Eocene (Italy), Oligocene (Germany), and Miocene (Morocco).

Family Heteroporidae Waters, 1880
***Heteropora subreticulata* Reuss, 1869**
(pl. 2, fig. 5)

1869 *Heteropora subreticulta* Reuss, p. 288, pl. 36, fig. 7.
1963 *Heteropora subreticulta*: Braga, p. 54, pl. 5, fig. 16.
1988 *Heteropora subreticulta*: Braga & Barbini, p. 513, pl. 4, fig. 2, 2a.

Material: Three moderately preserved zoarial fragments.

Zoarial growth-form: Erect; rigid; cemented; bifurcate (Vinculariiform).

Description: Zooecial tubes irregular, subcircularly disseminated on the colony. Mesopores frequent, polygonal with different sizes.

Occurrence: Bed no. 3.

Distribution: Eocene and Oligocene (Italy and Germany). The species presented the first Miocene record in the world.

Family Membraniporidae Busk, 1854
***Membranipora gharanensis* n.sp.**
(pl. 3, fig. 1)

Holotype: Plate 3, figure 1.

Type locality: Cairo-Suez District, Egypt.

Stratotype: Gharra section (B. No. 3).

Diagnosis: *Membranipora* with beaded and wrinkled mural rims.

Material: Two well preserved colonies, encrusting on pelecypod shells.

Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia distinct, hexagonal to subhexagonal, alternatively arranged, separated by thin grooves between mural rims. Zooecial length slightly exceeds its width. Mural rim beaded, fine wrinkles, with spines. Opesia large, elliptical and subcircular, occupied nearly the total zooecial surface.

Measurements:
Lz 0.500–0.610 mm (0.550 mm)
Lo 0.380–0.550 mm (0.430 mm)
lz 0.440–0.640 mm (0.530 mm)
lo 0.360–0.550 mm (0.420 mm)

Remarks: This species is closely related to *Membranipora diadema* (Reuss, 1848), but it has hexagonal zooecia, and fewer spines on the mural rim. It is named after the locality (Gebel Gharra).

Occurrence: Bed no. 3

***Membranipora diadema* Reuss, 1848**
(pl. 3, fig. 2)

1848 *Membranipora diadema* Reuss, p. 98, pl. 11, fig. 21.
1912 *Membranipora diadema*: Canu, p. 197, pl. 10, fig. 14-15.
1974 *Membranipora diadema*: David & Pouyet, p. 97, pl. 2, fig. 5.
1988 *Membranipora diadema*: Moissette, p. 72, pl. 11, fig. 1.

Material: Numerous well-preserved colonies, encrusting pelecypod shells.

Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A")

Description: Zooecia distinct, oval, arranged alternatively in longitudinal rows. Mural rim relatively broad rounded salient, and ornamented with almost 12 spine traces. Opesia elliptical, quadrate. A serrate projection is observed in few zooecia at the proximal opesial margin.

Occurrence: Bed no. 3.

Distribution: Miocene (Austria, GSSR, Morocco, and Algeria).

***Membranipora savartii* (Audouin, 1826)**
(pl. 3, fig. 3)

1826 Flustra *savartii* Audouin, p. 240, pl. 10, fig. 10.
1912 *Membranipora savartii*: Canu, p. 192, pl. 10, fig. 1, 2.
1929 Acanthodesia *savartii*: Canu & Balsser, p. 13, pl. 1, fig. 1.
1985 Membranipora *savartii*: Ziko, p. 25, pl. 5, fig. 1-3.
1987 Membranipora *savartii*: Ziko & Hamza, p. 303, fig. 2.
1992 *Biflustra savartii*: El Hajjaji, p. 85, pl. 3, fig. 2.
1996a *Membranipora savartii*: Ziko, p. 128, fig. 2: 6, 7.
1996b *Membranipora savartii*: Ziko, p. 524, pl. 1, fig. 1& pl. 3, fig. 6.

Material: Numerous well-preserved colonies, encrusting on other adeoniform bryozoans or pelecypod shell fragments.

Zoarial growth-from: Encrusting; unilaminate; cemented, flat sheet (Membraniporiform "A").
Description: Zooecia distinct, elongate, rectangular, arranged on parallel alternating longitudinal rows, separated by thin salient grooves. Mural rim distally projected and granulated. Opesia often with proximal margins straight and distal ones rounded. Avicularian zooecia long, proximally pointed, and distally rounded.
Occurrence: Bed no.3.
Distribution: Eocene (Egypt, France, Belgium, and North America); Oligocene (Germany); Miocene (Egypt, Tunisia, Algeria, Morocco, Spain, USA, Portugal, France, and Austria); Post- Pliocene (Egypt); Pleistocene (Egypt, Algeria, Italy, Argentina, USA, and China).
Habitat: Equatorial and tropical zones of the Atlantic, Pacific, Indian, Red Sea and Arabian Gulf (Shore areas with a depth range of 10-15 m).

Family Calloporidae Norman, 1903
***Callopora lineata* (Linné, 1758)**
(pl. 3, fig. 5)

1758 *Flustra lineata* Linné, p. 1301.
1949 *Callopora lineata*: Vigneaux, p. 34, pl. 2, fig. 1.
1985 *Callopora lineata*: Ziko, p. 33, pl. 7, fig. 7-5.
1992 *Callopora lineata*: Pouyet & Moissette, p. 35, pl. 3, fig. 8.
1996a *Callopora lineata*: Ziko, p. 129, fig. 4:7.
1996 *Callopora lineata*: El-Dera, p. 80, pl. 8, fig. 7.
Material: Two zoarial fragments, encrusting other bryozoans and pelecyped shells.
Zarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").
Description: Zooecia distinct arranged in longitudinal rows, elongate, elliptical, separated by distinct furrows, regular in shape, length less than twice width. Mural rim thick, raised, finely crenulated, ornamented by spines. Gymnocyst well developed, proximally placed, smooth, flat, bearing one very small avicularium. Opesia large, with sub-circular distal margin.
Occurrence: Bed no. 3.
Distribution: Eocene (Egypt); Miocene (Egypt, France, Italy, and Poland); Pliocene (Italy and Spain); Quaternary (Italy).
Habitat: North Atlantic; Mediterranean; Pacific; Indian, with variable depth.

***Ramphonotus crenulata* n. sp.**
(pl. 3, fig. 4)

Holotype: Plate 3, figure 4.
Type locality: Cairo-Suez District, Egypt.
Stratotype: Gharra section (Bed no. 3).
Diagnosis: *Ramphonotus* species with crenulated mural rim.
Material: Five zoarial colonies encrusting pelecypod shell fragments.
Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").
Description: Zooecia distinct, subhexagonal or rhomboid, separated by faint furrows. Opesia large, occupied almost the surface of frontal, with pyriform and a crenulated mural rim. Cryptocyst finely granulated. Gymnocyst reduced, visible at the base of few zooecia. Avicularia small, oval placed at the center of the proximal margin of gymnocyst.
Affinity: This species is closely related to *Ramphonotus appendiculata* (Reuss, 1848) but differs in having narrow zooecial width, the fine furrow separating the adjacent zooecia and the crenulated mural rim.
Measurements:
Lz 0.380-0.437 mm (0.399 mm)
lz 0.209-0.230 mm (0.220 mm)
Lo 0.133-0.190 mm (0.160 mm)
Io 0.114-0.133 mm (0.120 mm)
Lav 0.095-0.114 mm (0.105 mm)
Iav 0.057- 0.076 mm (0.65 mm)
Occurrence: Bed no. 3.

Family Microporellidae Hincks, 1880
***Micropora lozengia* Ziko Hamza & El Safori, 1994**
(pl. 4, fig. 1)

1994 *Micropora lozengia* Ziko, Hamza & El Safori, p. 28.
Material: Many zoarium encrusting *Porella cervicornis* and *Pycnodonte virleti.*
Zoarial growth-form: Encrusting ; unilaminate; cemented; flat sheet (Membraniporiform "A").
Description: Zooecia distinct, lozenge-form, arranged alternatively on parallel longitudinal rows, separated by faint grooves. Mural rim salient, finely granulated. Cryptocyst shallow, just below the level of the mural rim, slightly convex. Opesiules large, oval to orbicular placed disto-laterally and just below the proximal borders of the opesia. Opesia semi-circular, terminal, slightly straight, proximal border rounded in the distal margin.
Occurrence: Bed no. 3.
Distribution: Miocene of Egypt (Gulf of Suez).

Family Aspidostomotidae Jullien, 1888
***Rhagasostoma stenostomata* (Reuss, 1848)**
(pl. 4, fig. 2)

1848 *Cellepora stenostomata* Reuss, p.93, pl. 11, fig. 11.
1974 *Rhagasostoma stenostomata*: David & Pouyet, p. 186, pl. 2, fig. 7.
1988 *Rhagasostoma stenostomata*: Moissette, p.102, pl. 17, fig. 11-12.

1992 *Rhagasostoma stenostomata*: El Hajjaji, p. 123, pl. 6, fig. 6.
Material: four zoarial colonies, incrusting pelecypod shells.
Zoarial growth-form: Encrusting ; unilaminate; cemented; flat sheet (Membraniporiform "A").
Description: Zooecia distinct, hexagonal, separated by faint furrows, arranged in relatively parallel longitudinal rows, with raised margins, polypidian tubes with marginal flanges and opesiules as narrow incisions in aperature. Cryptocyst flat, distally represented, finely granulated. Opesia terminal, small, trapezoidal, transverse, distal margin rounded but the proximal border straight, with two small opesiules. Avicularian zooecia smaller than autozooecia, asymmetrical, wide proximally and narrow distally. Cystocyst less developed than autozooecia. Opesia small, oval shape.
Occurrence: Bed no.3.
Distribution: Miocene (Austria and Morocco).

Division: Cellolarina Smith, 1867
Family: Farciminariiade, Busk, 1884.
***Nellia tenella* (Lamarck, 1816)**
(pl. 4, fig.3)
1816 *Cellaria tenella* Lamarck, p. 135.
1949 *Nellia oculata*: Vigneaux, p. 32, pl. 1, fig.10-12.
1963 *Nellia tenella*: Cheetham, p. 59, pl. 1, fig. 14.
1985 *Nellia tenella*: Ziko, p.57, pl. 13, fig. 4-6.
1996 *Nellia tenella*: El Safori, p.117, fig. 4: 6.
Material: Many zoarial fragments.
Zoarial growth-form: Erect; flexible; rooted; quadrate (Cellariiform).
Description: Zooecia distinct, elongate, separated by thin grooves. Gymnocyst smooth, slightly convex, short, extending about nearly one third of the zooecial length. Mural rim smooth, slightly raised, elliptical. Opesia narrow, elliptical. Avicularia small, adventitious, paired, placed on gymnocyst at the proximal-lateral corners of zooecia, oval shape. Ovicell endozooecial, discernible as a slight swelling under gymonocyst of distal zooecium.
Occurrence: Bed no. 3, 11, 16.
Distribution: Eocene (Egypt, France, and USA); Oligocene (USA); Miocene (Egypt, Jamaica, and Australia); Plio-Pleistocene (USA).
Habitat: Tropical and warm-temperate zones of all oceans.

Family: Scrupocellariidae Levinsen, 1909
***Scrupocellaria elleptica* (Reuss, 1848)**
(pl. 4, fig. 4)
1848 *Bactridium elle ticum* Reuss, p. 56, pl. 9, fig. 7-8.
1965 *Scrupocellaria elleptica*: Souaya, p. 1137, pl. 137, fig. 7-8
1974 *Scrupocellaria elleptica*: David & Pouyet, p. 130, pl. 2, fig. 3.
1988 *Scrupocellaria elleptica*: Moissette, 106, pl. 16, fig. 5, 8.
1989 *Scrupocellaria elleptica*: Schmid, p. 23, pl 5, fig. 1-7.
1992 *Scrupocellaria elleptica*: El Hajjaji, p. 131, pl. 6, fig. 8.
Material: Numerous zoarial fragments.
Zoarial growth from: Erect; rooted; flexible, biserial (Cellariiform).
Description: Zooecia distinct, elongate, elliptical. Mural rim salient, thick, elliptical shape. Opesia large, sub-circular, Avicularia interzooecial. Ovicell hyperstomial, but ill preserved.
Occurrence: bed no.10, unit II, Gebel Gharra.
Distribution: Eocene (Spain, Italy, Hungary, and France); Oligocene (Italy and France); Miocene (France, Austria, Poland, Romania, Portugal, Egypt, Libya, Algeria, and Morocco); Pliocene (Tunisia, Spain, Italy, and Portugal); Pleistocene (Italy and Egypt).

***Figularia figularis* (Johnston, 1847)**
(pl. 4, Fig. 5)
1874 *Lepralia figularis* Johnston, p. 34, fig.2.
1920 *Figularia figularis*: Canu & Bassler, p. 313, p. 87, fig. 1.
1966 *Figularia figularis*: Buge, 17, pl. c, fig. 5, 6.
1979 *Figularia figularis*: Hayward & Ryland, p. 70, fig. 20.
1988 *Figularia figularis*: Moissette, p. 11, pl.18, fig. 2, 3.
1992 *Figularia figularis*: Pouyet & Moissette, p. 49, pl. 6, fig. 8
Material: Three zoarial colonies, encrusting pelecypod shells.
Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").
Description: Zooecia distinct, elongate, rectangular to hexagonal, with smooth borders, arranged in alternating longitudinal rows radiating form a central ancestrula, separated by thin furrows. Frontal little convex, formed of 10-15 pairs of closed costules separated by a row of very fine lacuna. Opesia terminal, small subquadrangular, proximal borders concave, with two cardeles. Avicularia interzooecial, large, spatulate. Ovicell hyperstomial, globular, smooth.
Occurrence: Bed no. 3, 11.
Distribution: Miocene (Italy, Morocco, New Zealand, Algeria); Pliocene (England, Italy); Pleistocene (Italy).
Habitat: Atlantic (England); Mediterranean with optimum depth range of 30-90 m (Moissette, 1988).

***Puellina (Cribrilaria) picardi* Harmelin, 1988**
(pl. 4, fig. 7)

1988 *Puellina (Cribrilaria) picardi* Harmelin, 27, figs. 3, 6-8.
1992 *Puellina (Cribrilaria) picardi*: El Hajjaji, 137, pl. 7, fig. 7.

Material: One well preserved zoarium, encrusts the inner surface of an oyster shell fragment.

Zoarial growth-form: Encrusting; unilamellar; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia distinct, oval, elongate, with crenulating outline, separated by areolar pores and wide furrows. Frontal pericyst convex, bearing 10-12 radial costules which separated from each other by 3-5 fine circular lacauna. Costae don't reaching central part of the frontal. Opesia terminal, D-shape, aperture bars triangular, with median reniform lacuna, peristome salient, thin, with 5 oral spines (traces). Avicularia interzooecial, small, narrow distally. Ovicell hyperstomial, large, globular, smooth, with median carina.

Occurrence: Bed no. 3.

Distribution: Miocene (Morocco).

Habitat: Atlantic and Mediterranean (70 m optimum depth).

Family Schizoporellidae Jullien, 1903
***Escharina vulgaris* (Moll, 1803)**
(pl. 4, fig. 6)

1803 *Eschara vulgaris* Moll: p. 55, pl. 3, fig. 10.
1970 *Eschara vulgaris*: David, Mongereau & Pouyet, p. 130, pl. 6, fig. 6 & pl. 8, fig. 7.
1988 *Escharina vulgaris*: Moissette, p. 132, pl. 21, fig. 8.
1992 *Escharina vulgaris*: El Hajjaji, p. 202, pl. 12, fig. 11.
1996 *Escharina vulgaris*: El-Dera, p. 112, pl. 13, fig. 1.

Material: Two well preserved zoaria encrust pelecypod shell fragments.

Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia distinct, separated by deep grooves, ovoid with smooth hexagonal borders. Frontal calcified, convex, formed of tremocyst with tremopores and two avicularia. Aperture terminal, semi-lunar, with interior border rimule. Peristome salient, thick, with numerous traces of spines. Avicularia small, erect, oval, paired, placed on the proximo-lateral corners of the peristome. Ovicell hyperstomial, globular, small.

Occurrence: bed no. 3.

Distribution: Miocene (Germany, France, Tunisia, Austria, Romania, Egypt, Italy, Morocco, and Algeria); Pliocene (Algeria, Spain, and Italy); Pleistocene (Italy and USA).

Habitat: Mediterranean; Atlantic 30-200 m, with an optimum depth range of 40-80 m.

Family Schizeporellidae Jullien, 1903
***Hippodiplosia miocenica* Moissette, 1988**
(pl. 5, fig. 1)

1988 *Hippodiplosia miocenica*: Moissette, p. 135, pl. 21, fig. 11 & pl. 22, fig. 1.
1992 *Hippodiplosia miocenica*: El Hajjaji, p. 167, pl. 9, fig. 5.

Material: Two well preserved zoaria, encrusting the inner surface of oyster shell,

Zoarial growth-form: Encrusting; unilamellar; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia distinct, elongate, fusiform, arranged in irregular longitudinal rows, separated by thin threads. Frontal slightly convex, formed of a thick tremocyst, with small tremopores. Aperture large, . subcircular, terminal, with cardeles; peristomes salient, thick, garnished, with spines and one or two small circular avicularia. Avicularia small, lies on edges of zooecia; rostrum open, short, distally directed. Ovicell hyperstomial.

Occurrence: bed no. 3.

Distribution: Miocene of Algeria and Morocco.

Remarks: This species is smaller in its micrometric dimensions than that described in Algeria and Morocco.

Family: Microporellidae Hincks, 1880
***Microporella (Microporella) ciliata* (Pallas, 1766)**
(pl. 5, fig. 2)

1766 *Eschara ciliata* Pallas, p. 38.
1953 *Microporella (M.) ciliata*: Bassler, p. 207, fig. 155, Fig. 9.
1974 *Microporella ciliata*: David & Pouyet, p. 182, pl. 7, fig. 5.
1977 *Microporella ciliata*: Vavra, p. 134.
1988 *Microporella ciliata*: Moissette, p. 150, pl. 24, fig. 7-9.
1991 *Microporella ciliata*: Schmid, p. 406, pl. 2, fig. 1, 2.
1995 *Microporella ciliata*: Ziko & El-Sorogy, p. 89, fFig. 5: 2, 3.
1996a *Microporella (M.) ciliata*: Ziko, p. 135, fig. 4: 6.

Material: One well preserved zoarium, encrusts *Pecten* shell fragment.

Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia elongated flask shape with hexagonal outlines, arranged in alternating longitudinal rows, radiating from a central ancestrula, separated by deep furrows. Frontal convex, termocyst, with numerous pores; ascophore median, suboral, subcircular, small, little salient. Aperture terminal, semicircular, proximal border straight, with fine axial striations; peristome thin, little salient, with 5-6 distal oral spines. Avicularia laterally located at one side of each zooecium and approximately at the same level of ascopore, oblique

small, oval, distally salient, with short rostrum, oval opesia and straight pivot. Ovicell, hyperstomial, globular, inflated, finely perforated with fine marginal costules.

Occurrence: Bed no. 3.

Distribution: Miocene (Germany, Portugal, Austria, Italy, Morocco, Russia, Czechoslovakia? (CSSR), New Zealand, USA, and Algeria); Pliocene (England, Pays-bas, Spain, Italy, Rhode, Tunisia, Algeria, and New Zealand); Pleistocene (Italy and USA).

Habitat: Cosmopolitan, temperate (between 80° north and 70° south, at a depth range of 0-660 m). In Mediterranean, it survives down to 500 m. Pacific? (Buge, 1957). Optimum depth is less than 100 m and low rate of sedimentation (Schmid, 1991).

Family: Microporellidae Hincks, 1880
***Calloporina decorata* (Reuss, 1848)**
(pl. 5, fig. 3)

1848 *Cellepora decorata* Reuss, p. 89, pl. 10, fig. 25.
1974 *Calloporina decorata*: David & Pouyet, p. 184, pl. 7, fig. 2.
1988 *Calloporina decorata*: Moissette, p. 152, pl. 24, fig. 10.
1989 *Calloporina decorata*: Schmid, p. 51, pl. 15, fig. 1-3.
1992 *Calloporina decorata*: El Hajjaji, p. 221, pl. 11, fig. 6.

Material: Two badly preserved zoaria encrusting pelecypod shell fragments.

Zoarial growth-form: Encrusting; unilaminate; cemented; flat sheet (Membraniporiform "A").

Description: Zooecia hexagonal, separated by wide furrows. Frontal convex, with lateral areolar pores, pleurocyst, costules, semi-circular ascopore. Aperture terminal, semi-circular, peristome salient, thick, with 5-8 trace spines. Ascopore medium, semi-circular, exist in the middle part of the frontal. Avicularia small adventitious, with mandible, pointed distally and wide proximally, frontal almost on the right side of the ascopore. Ovicell large, hyperstomial, globular, finally perforated, with cresentric orifice.

Occurrence: Bed no. 3.

Distribution: Miocene (Tunisia, Austria, Poland, Italy, Romania, Morocco, and Algeria); Pliocene (Algeria, Spain, and Italy); Pleistocene (Italy).

Habitat: West Mediterranean and Atlantic (10-150 m), with an optimum depth range of 50-70 m.

Family: Mucroporollidae Levinsen, 1902
***Porella cevicornis* (Pallas, 1766)**
(pl. 5, fig. 4)

1766 *Millepora cervicornis* Pallass: p. 252.
1949 *Porella cervicornis*: Vigneaux, p. 94, pl. 10, fig. 3,4.
1965 *Porella cervicornis*: Souaya, p. 1138, pl.37, fig. 11.
1974 *Porella cervicornis*: Debourle, p. 189, pl. 21, fig. 1.
1988 *Porella cervicornis*: Moissette, p. 160, pl. 26, fig. 6.
1989 *Porella cervicornis*: Schmid, p. 35, pl. 10, fig. 1-3.
1994 *Porella cervicornis*: Ziko, Hamza & El Safori, 228. pl. fig.
1996a *Porella cervicornis*: Ziko p. 135, Fig. 3: 4, 5 & fig. 4: 6, 8, 9 & fig. 5: 1, 6.

Material: Numerous badly preserved zoaria.

Zoarial growth-form: Erect rigid; cemented; bilaminate; bifurcated solid stems (Adeoniform).

Description: Zooecia elliptical, arranged in alternating longitudinal rows separated by shallow furrows. Frontal convex, thick, tremocyst with numerous, large pores. Aperture subterminal, subcircular, proximal borders concave; peristome thick, short. Avicularia peristomial, median, small, elongate, oval, sometimes not observed.

Occurrence: Bed no. 3, 8, 11.

Distribution: Oligocene (Italy); Miocene (Egypt, Morocco, France, Italy, Portugal, Austria); Pliocene (Bays-Bas, Portugal, Spain, Italy, Tunisia, and Algeria); Pleistocene (Italy).

Habitat: Mediterranean with 30-120 m depth range, and 40-60 m optimum depth (Gautier, 1962); Atlantic (30-400 m depth range); Red Sea.

***Porella erecta* David, Mongereau & Pouyet, 1972**
(pl. 5, Fig. 5)

1972 *Porella erecta* David, Mongereau & Pouyet, p. 70, pl. 1, Fig. 5-6.

Material: Numerous well-preserved zoaria.

Zoarial growth-form: Encrusting; cemented; multilaminate; flat sheet (Membraniporiform "A").

Description: Zooecia distinct, elongate, rectangular, with rounded distal and straight proximal margins, length almost twice the width, distal wider than proximal, distal part of the zooecia is elevated and rest over the next zooecia, arranged in longitudinal rows radiating from the ancestrular region. The zooecia of the ancestrular region short, erect. Frontal thick, tremocyst, with rounded tremopores. Orifice rounded, with simple lyrule, deeply seated in peristome. Peristomes rounded, thick, salient perforated by very fine trace spines.

Occurrence: Bed no. 3.

Distribution: Miocene of France.

Family: Margarettidae Harmer, 1956
***Margaretta cereoides* (Ellis & Solander, 1786)**
(pl. 6, fig. 1)

1786 *Cellaria cereoides* Ellis & Solander, p. 26, pl. 5, Fig. B-E.
1977 *Margaretta cereoides*: Vavra, p. 143.

1979 *Margaretta cereoides*: Vavra, p. 603, pl. 1, fig. f.
1987 *Margaretta cereoides*: Ziko & Hamza, p. 305, fig. 77.
1989 *Margaretta cereoides*: Schmid, p. 52, pl. 15, fig. 4, 5, 7, 8.
1994 *Margaretta cereoides*: Ziko, Hamza & El-Safori, p. 228.
1996a *Margaretta cereoides*: Ziko, p. 136, fig. 4: 5.
Material: Numerous badly preserved zoaria.
Zoarial growth-form: Erect; flexible; cemented; cylindrical (Cellariiform).
Description: Zooecia distinct, indistinct in calcified parts, tubular, thick elongate, fusiform. Frontal inflated, tremocyst, with numerous tremopores and large ascopore, placed just below the peristome. Orifice orbicular, it have a neck. Peristome salient, slightly thick. Ovicell large, hyperstomial, perforated.
Occurrence: Bed no. 3, 8, 11.
Distribution: Eocene (Spain, Italy, France, and Egypt); Oligocene (Italy, Germany, Austria, Poland, and USA); Miocene (Italy, France, Egypt, Austria, Poland, Romania, Libya, Algeria, and Morocco); Pliocene (Italy, North Africa, and Central America).
Habitat: Adriatic, Mediterranean, Pacific, and Red Sea; Atlantic (in tropical and subtropical regions).

Family: Reteporidae Smith, 1867
***Schizoretepora hamzai* n. sp**
(pl.6 , fig. 2)

Holotype: Plate 6, figure 2.
Type locality: Cairo-Suez District, Egypt.
Stratotype: Gharra section (Bed no. 3).
Diagnosis: *Schizoretepora* species with areolated zooecia and scattered frontal pores.
Material: Numerous well preserved zoaria.
Zoarium growth-form: Erect; rigid; cemented; bilaminate; reticulate (Reteporiform).
Description: Zooecia indistinct surrounded by areoles. Frontal granulated slightly convex, perforated with few scattered pores. Aperture circular to elliptical, with small lyrule on the proximal part of orifice peristome thick, with specimen in the proximal part. Ovicell widely open, with semi-circular slit.
Measurements:
Lz 0.350–0.490 mm (0.450 mm)
lz 0.250–0.325 mm (0.278 mm)
Lo 0.108–0.170 mm (0.140 mm)
lo 0.120–0.180 mm (0.160 mm)
Remarks: The frontal pores are common and very characteristic that the colony is looked perforated.
Occurrence: Bed. no. 3, 11.

Family Adeonidae
***Schizostomella dubia* (Busk, 1859)**
(pl. 6, fig. 3)

1859 *Flustra dubia* Busk, p. 132, pl. 1, fig. 3.
1988 *Schizostomella dubia*: Moissette, p. 176, pl. 28, fig. 8.
1992 *Schizostomella dubia*: El Hajjaji, p. 227, pl. 14, fig. 8.
Material: One preserved zoarium.
Zoarial growth-form: Erect; rigid; cemented; bilaminated, fragmented stems (Adeoniform).
Description: Zooecia distinct, elliptical, separated by thin furrows between mural rims, thin, relatively, salient, perforated, with fine spines. Opesia large, occupied the large area of the zooecia, rounded in the distal and convex in the proximal margins. Avicularian zooecia, large elongated, asymmetrical, wide in the distal part and in the proximal. Mural rim as in the autozooecia. Opesia terminal, large, wide and rounded distally narrow, pointed proximally. Ovicell small, hyperstomial, globular, granulated.
Occurrence: Bed no. 3.
Distribution: Miocene (France, Algeria, and Morocco); Pliocene (England).

Family: Celleporariidae Harmer, 1957
***Holoporella polythele* (Reuss, 1848)**
(pl. 6, fig. 4)

1848 *Cellepora polythele* Reuss, p. 77, pl .9 , fig. 18.
1912 *Holoporella polythele*: Canu, p. 217, pl. 8, fig. 6.
1965 *Holoporella polythele*: Souaya, p. 1141, pl. 139, fig. 1,2.
1992 *Holoporella polythele*: Ziko, Hamza & El-Dera, p. 313, pl. 5, fig. 5.
1996a *Holoporella polythele*: Ziko, p. 139, fig. 5: 4, 5.
Material: Abundant zoarial fragments.
Zoarial growth-form: Erect; rigid; cemented; multilaminate; massive, bifurcated (Celleporiform).
Description: Zooecia arranged in irregular manner, slightly distinct, flask shape, separated by thin and deep furrows. Frontal olocyst, thick, smooth, inflated, raised spaces and rounded areolar pores. Apertures large, rounded to subrounded, steeply inclined distally, oral avicularia small, interzooecial avicularia large, elliptical and rounded. Ovicell hyperstomial, globular, slightly large and smooth.
Occurrence: Bed no. 3, 8, 11.
Distribution: Miocene: Egypt, Austria, Bay Bass, France, CSSR, Hungary, and Italy.
Habitat: Mediterranean with an optimum depth range of 10-20 m.
Remarks: *Holoporella polythele* played an important role in the studied formation (area) where it acts as essential reef builders.

4. PALEOECOLOGICAL REMARKS

The ecological parameters effecting bryozoan diversity and their growth-form distributions are nature of substrate, depth, water turbulence, and rate of sedimentation. The relation between zoarial morphology and the surrounding environments have been discussed by several authors (Stach, 1936; Lagaaij and Gautier, 1965; Schopf, 1969, Moissette 1989). Hageman et al. (1998) provide eleven tentative growth habit characteristics according to the zoarial attachements, zooecial arrangements, construction, bifurcation and connections.

In the study area pelecypod shells provide an excellent attachment of the encrusting bryozoans. Encrustation took place mostly in the inner surfaces of pelecypods and upon some adeoniform bryozoans. The inner surfaces of pelecypods provide strong attachment of the encrusting colonies, which suggest living in agitated water, above the wave base. The external surfaces of these pelecypods were rarely encrusted by bryozoans owing to their rugged and fluted nature. This conclusion is supported by the data of the optimum depth ranges of the Recent counterparts of the studied taxa (40-50 m). Some erect bryozoans are rooted on unconsolidated substrates especially in the back reef sediments (Unit VI & V) i.e. < 40 m.

Depth is directly impresses the zoarial growth-form, where the encrusting forms increase in shallow depths, while erect ones are gradually increase as depth increases (> 35 m). Also, bryozoan diversity increases with depth, and reach maximum at a depth of 80 m (Schopf, 1969). Bryozoans diversity is marked at the lower part of the section (Unit I) which may indicate its deepening (50 m). Also, the adeoniform zoaria attain sizable percentage only on the sandy corralligenous rocks between 40 and 50 m depth (Lagaaij and Gautier, 1965). This depth range could mark the lower units (I & II) of the studied section where the erect forms are abundant.

Moderate water turbulence is favored by most bryozoans especially encrusters. Flexible forms are adapted for living in high water turbulence, while rigid forms are more adapted for low water turbulence. Also, low rate of sedimentation is favored by most bryozoans especially the encrusters. However, flexible forms can be adapted for living i higher rate of sedimentation. Out of the twenty-si studied bryozoan species, seventeen are encrusting (63.0%) and the rest are erect. Free living colonies are not represented in the studied assemblage (Table 1). The encrusting species are of two groups: Membraniporiform "A" (16 species) and only one Celleporiform (*Holloporella polythele*) which acted as a considerable bryozoan build up in the study area (Unit III). It is worth to mention that the higher percentage of the Membraniporiform "A" species could be the result of biased fossilization, because the total attachment of the unilaminate colony to the solid substratum offers better fossilization. Generally, the scope of the encrusting forms indicate turbulent waters but moderate and low rate of sedimentation.

The erect group of zoorial growth-form may be flexible (articulated) or rigid (fixed). In the studied collection the flexible forms are *Nellia tenella, Crisia hornesi, Magaretta cereoides,* and *Scrupocellaria elleptica* (15%). The erect rigid bryozoans are *Exidmonea atlantica, Heteropora subreticulata,* (Viculariiform); *polyascosoecia sparsa* and *Porella cervicornis, Schizostomella dubia* (Adeoniform); *Schizoretepora hamzai* (Reteporiform). They represent 23% of the studied materials. These species are ecologically of small role of interest except *Magaretta cereoides* because of its abundant occurrences, which point to moderate turbulence.

Extant Bryozoans:
Eleven of the studied bryozoans are found in the present seas (Table 2). They are cosmopolitan, but endemic Mediterranean species with a representative percentage 35 %. Non of Indo-pacific fauna is represented. Also, the studied living bryozoans are flourished in warm to warm temperate conditions. The optimum depth-ranges of the abundant *Margaretta cereoides* (10-45 m) can be used as estimating depth.

In conclusion the paleoecological investigation of the studied species and the associated fossils (mollusks, corals, algae, and foraminifers) and microfacies analysis has revealed the deposition of Miocene rocks in the study area in reef to back-reef-zone. A depth range of 20-40 m is suggested with low rate of sedimentation and moderately water turbulence. This condition beside its free of Indo-pacific fauna is correlated with the bryofauna of the equivalent Sadat Formation (Ziko et al., 1994).

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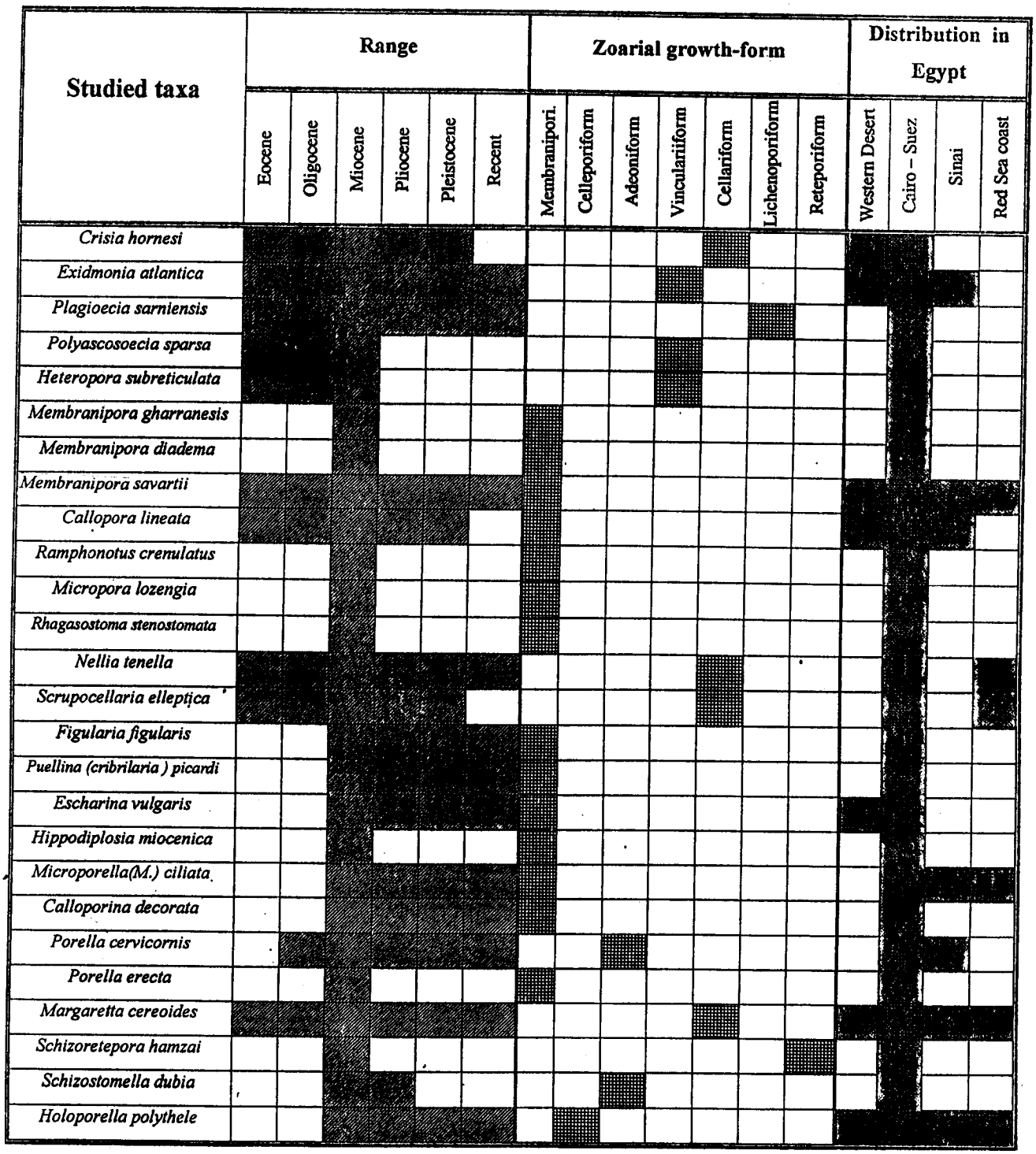


Table 1 . Geological range, Zoarial growth – forms and distribution in Egypt of the studied taxa

Table 2. Living bryozoans of Gharra section.

Species	Depth Range	Optimum Depth-Range	Remarks
Exidmonea atlantica (Forbes in Johnston,1847)	10-840 m	40-100 m	Cosmopolitan, different temperatures.
Plagioecia sarniensis (Norman, 1864)	25-300 m	80 m	Cosmopolitan, Temperate to Warm Temperate.
Biflustra savartii (Audouin, 1826)		0-40 m	Cosmopolitan, Tropical to Subtropical Seas.
Nellia tenella (Lamarck, 1816)	10-450 m	30 m	Cosmopolitan, Warm Temperate.
Figularia figularis (Johnston, 1847)	30-90 m		Mediterranean, Warm Temperate.
Puellina (Cribrilaria) picardi Harmelin, 1988	120-180 m	70 m	Mediterranean.
Escharina vulgaris (Moll, 1803)	30-200 m	40-80 m	Cosmopolitan (Pacific?)
Microporella (Microporella) ciliata (Pallas, 1766)	0-600 m	200 m	Cosmopolitan, cold waters.
Calloporina decorata (Reuss, 1848)	10-150 m		Cosmopolitan.
Porella cevicornis (Pallas, 1766)	10-150 m		Mediterranean.
Margaretta cereoides (Ellis & Solander, 1786)		10-45 m	Mediterranean & North Atlantic.

PLATE 1

Fig. 1: Coralline limestone (Reef-core facies) is formed of a coral head of *Siderastrea* sp., unit III, Gebel Gharra.
Fig. 2: Coral heads and branches as well as large oysters, unit V, Gebel Gharra.
Fig. 3: Oyster banks, with well preserved double valved *Pycnodonte virleti*, unit III, Gebel Gharra.
Fig. 4: Foraminiferal packstone, with bi..morpha of *Amphistigina* sp. and *Heterostigina* sp. all cemented with microsparite, unit I, Gebel Gharra.
Fig. 5: Algal rudstone, with well preserved *Lithphyllum* sp. embedded in sparitic cement, unit V, Gebel Gharra.
Fig. 6: Recrystallization of aragonite forming the coral wall to blocky calcite by diagenesis, unit V, Gebel Gharra.

PLATE 2

Fig. 1: *Crisia hornesi* Reuss, 1847.
Fig. 2: *Exidmonea atlantica* (Forbes in Johnston, 1877).
Fig. 3: *Plagioecia sarniensis* (Norman, 1864).
Fig. 4: *Polyascoecia sparsa* (Reuss, 1861).
Fig. 5: *Heteropora subreticulata* Reuss, 1869.
Bar scale= 200 *u*m

PLATE 3

Fig. 1: *Membranipora gharanensis* n. sp.
Fig. 2: *Membranipora diadema* Reuss, 1848.
Fig. 3: *Membranipora savartii* (Audouin, 1826).
Fig. 4: *Callopora lineata* (Linné, 1758).
Fig. 5: *Ramphonotus crenulata* n. sp.
Bar scale= 200 *u*m

PLATE 4

Fig. 1: *Micropora lozengia* Ziko, Hamza & El Safori, 1994.
Fig. 2: *Rhagasostoma stenostomata* (Reuss, 1848).
Fig. 3: *Nellia tenella* (Lamarck, 1816).
Fig. 4: *Scrupocellaria elleptica* (Reuss, 1848).
Fig. 5: *Figularia figularis* (Johnston, 1848).
Fig. 6: *Escharina vulgaris* (Moll, 1803).
Fig. 7: *Puellina (Cribrilaria) picardi* Harmelin, 1988.
Bar scale= 200 *u*m

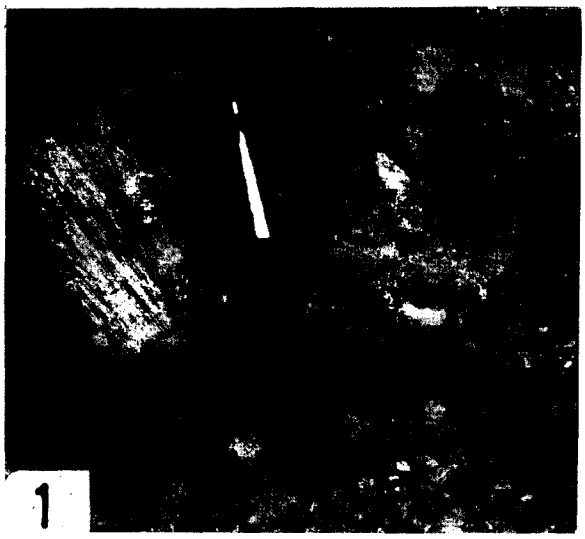
PLATE 5

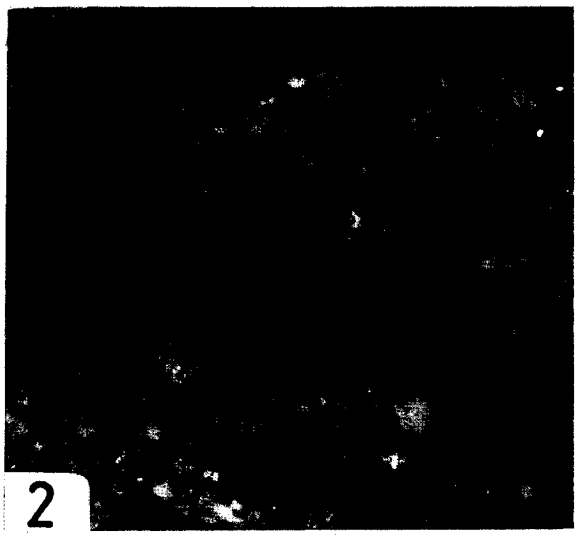
Fig. 1: *Hippodiplosia miocenica* Moissette, 1988.
Fig. 2: *Microprella (M.) ciliata* (Pallas, 1766).
Fig. 3: *Calloporina decorata* (Reuss, 1848).
Fig. 4: *Porella cervicornis* (Pallas, 1766).
Fig. 5: *Porella erecta* David, Mongereau & Pouyet, 1972.
Bar scale= 200 *u*m

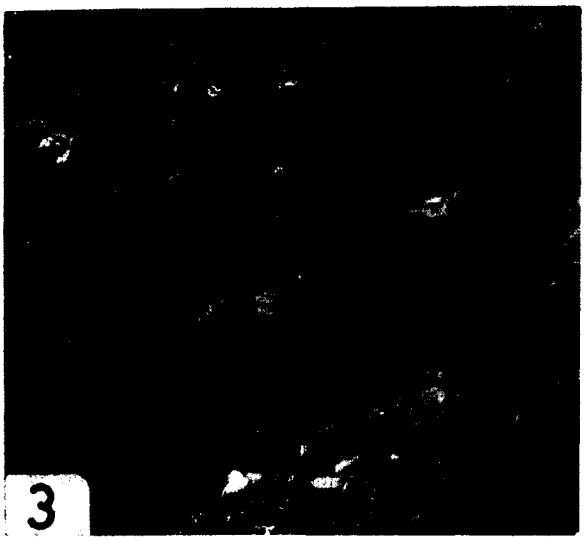
PLATE 6

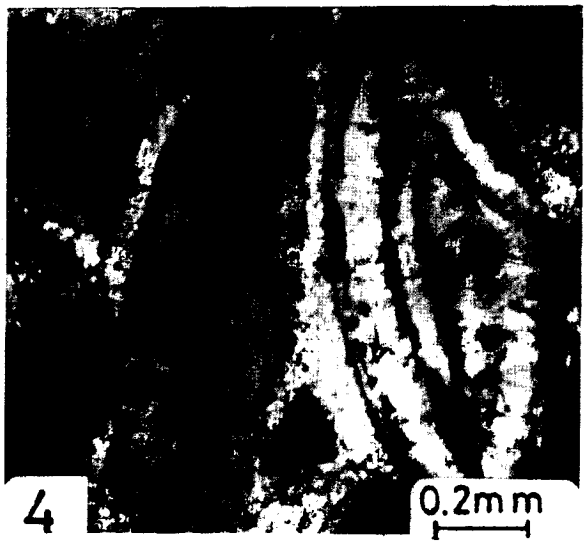
Fig. 1: *Margaretta cereoides* (Ellis & Solander, 1786).
Fig. 2: *Schizoretepora hamzai* n. sp.
Fig. 3: *Schizostomella dubia* (Busk, 1859).
Fig. 4: *Holoporella polythele* (Reuss, 1848).
Bar scale= 200 *u*m

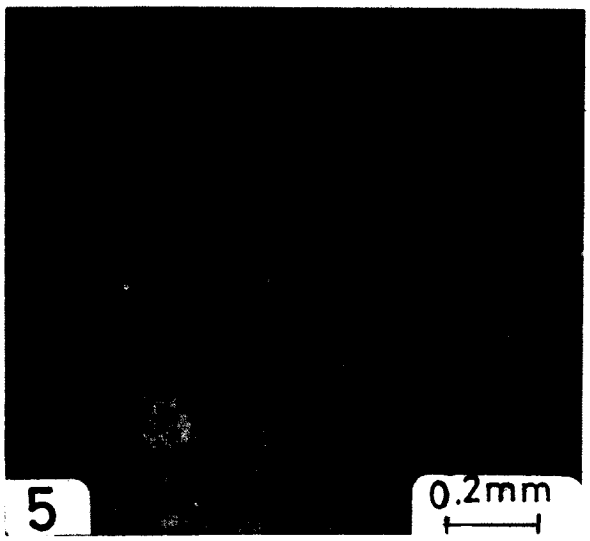
PL. 1

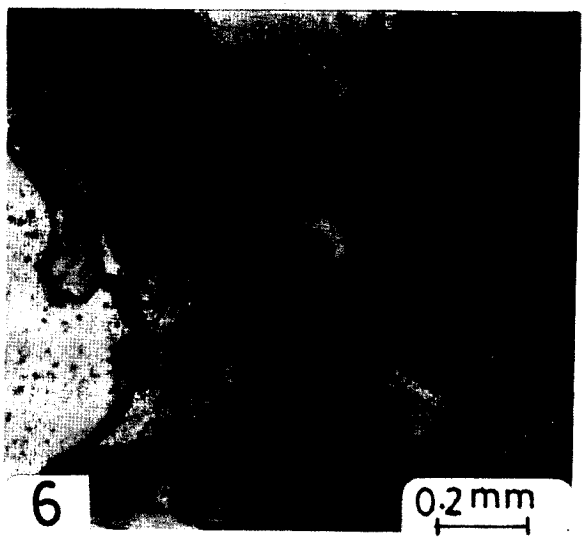




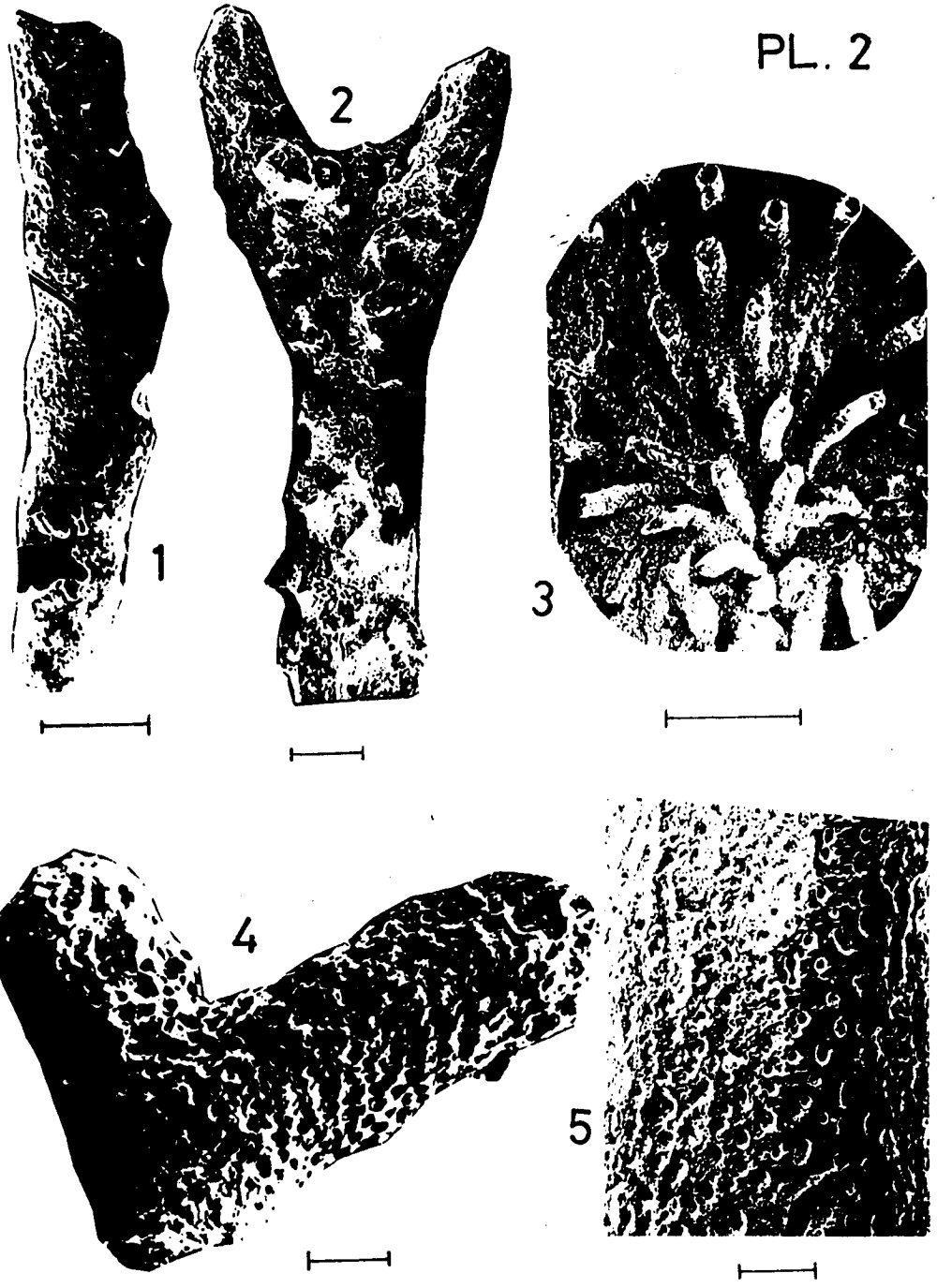








PL. 2



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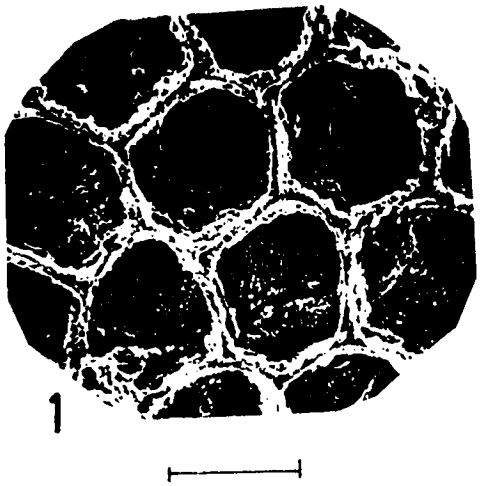

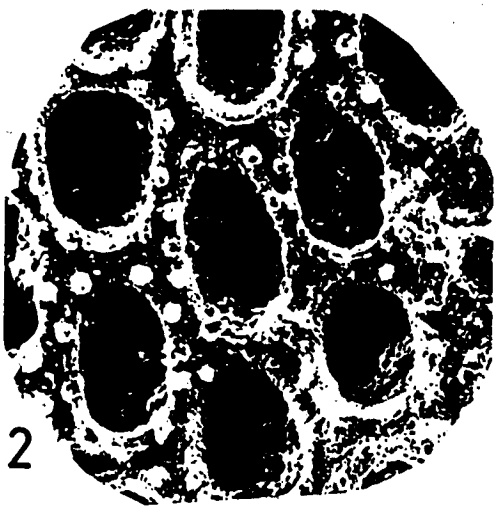

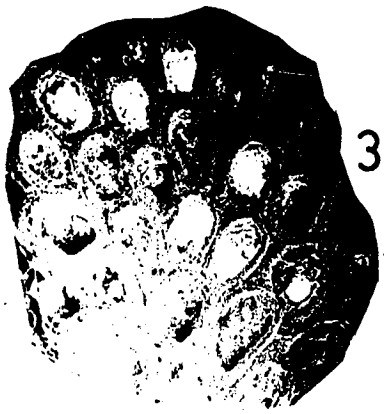

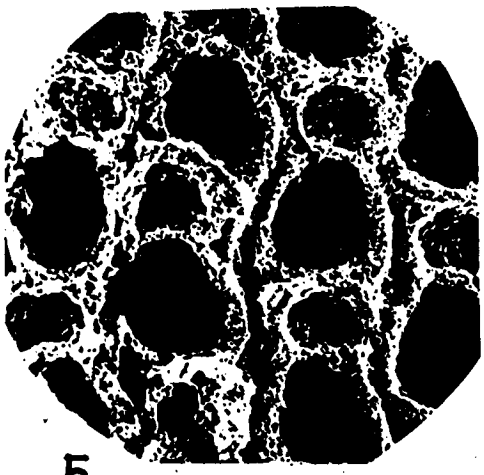

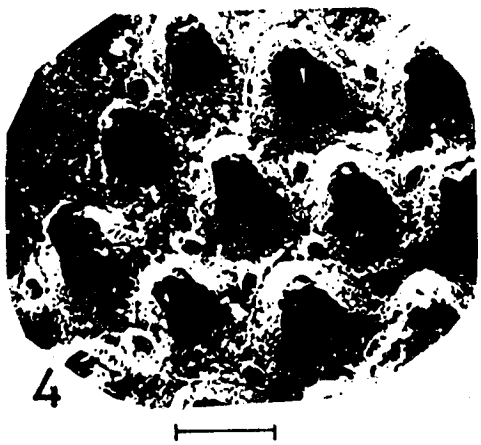

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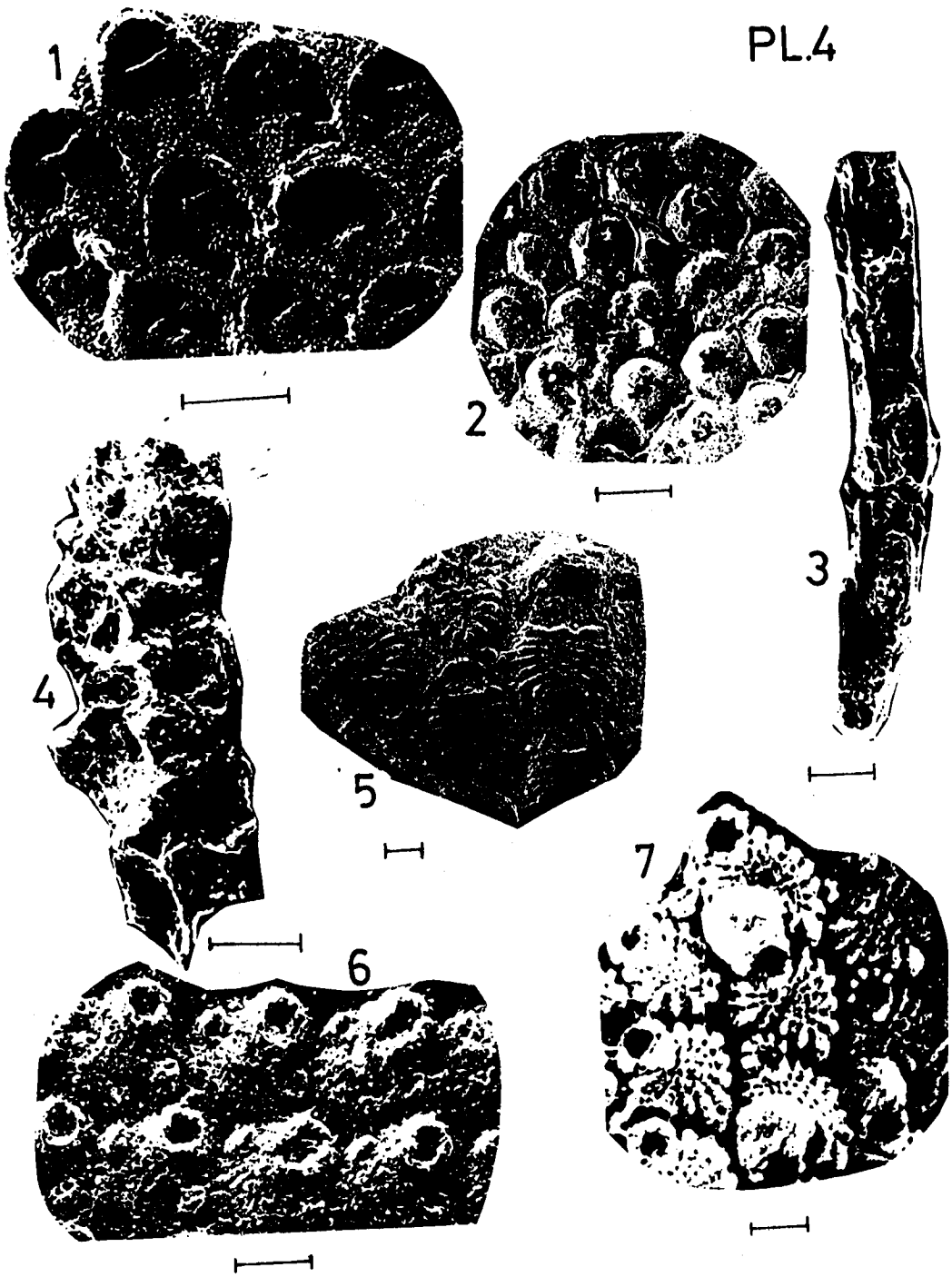
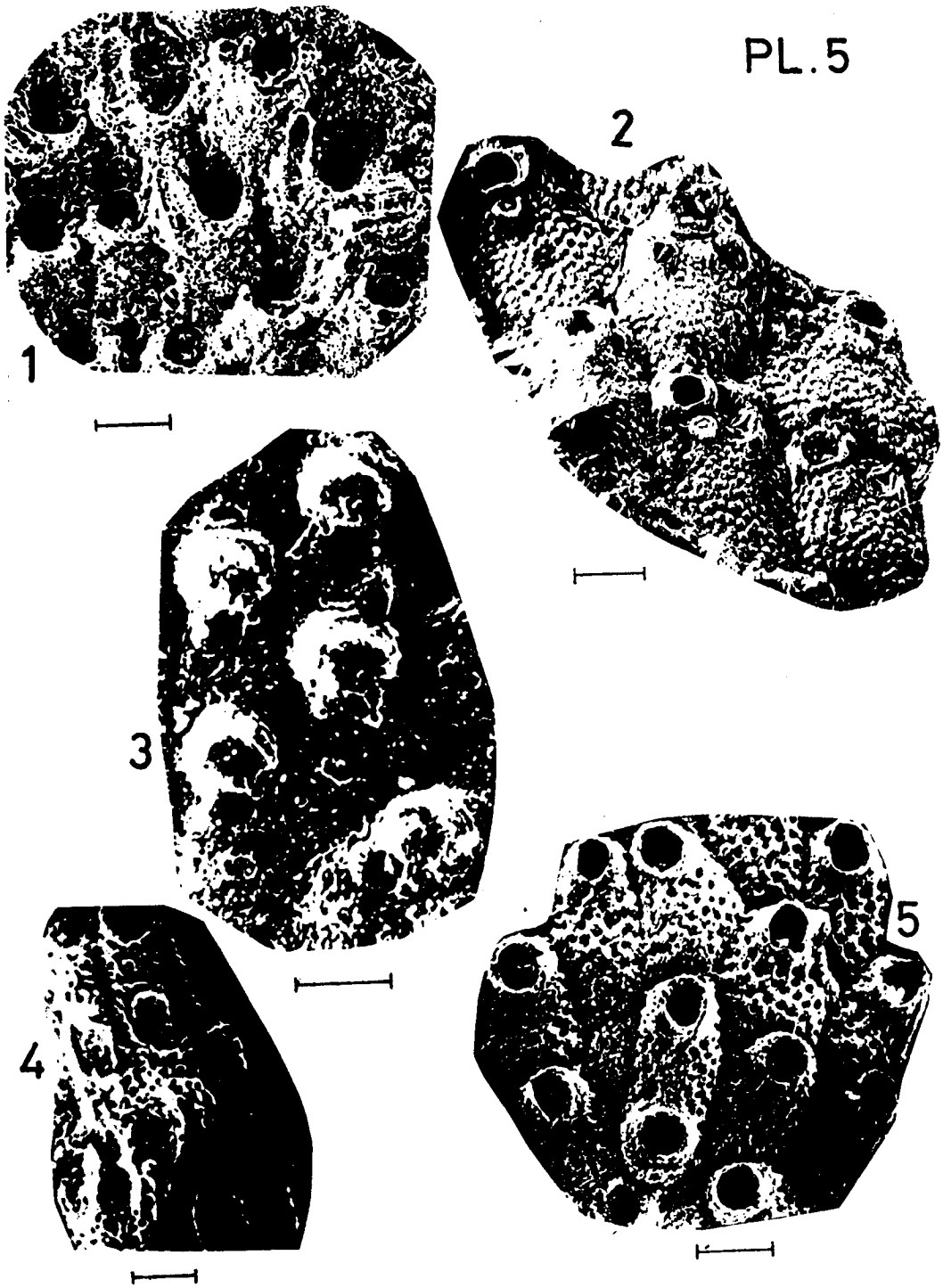
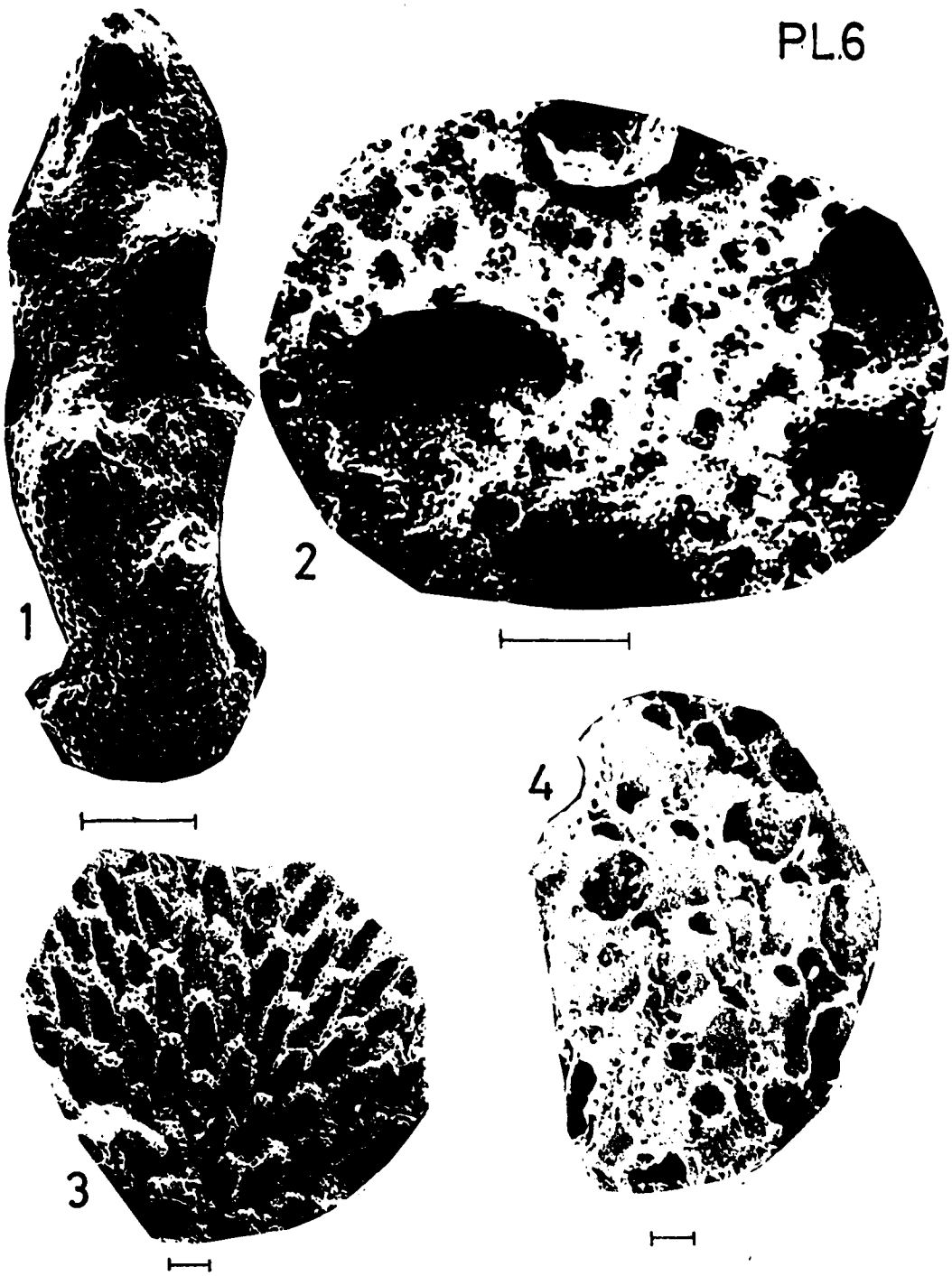


PL. 5



PL.6



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