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Taxonomy of Miocene Bryozoans from As Sahabi area, Ajdabiyah Trough, NE Sirt Basin, Libya

Ahmed M. Muftah[a,*] and Yasser A. El-Safori[b]

[a]*Department of Earth Sciences, Faculty of Science, University of Benghazi, P. O. Box 9480, Benghazi, Libya.*

[b]*Department of Geology, Faculty of Science, University of Ain Shams, P.O. Box 11566 Cairo, Egypt.*

Highlights

- **Bryozoan taxa have retrieved from the formation "M" in As Sahabi area of Sirt Basin, Libya.**
- **Fourteen species are classified and described in this study.**
- **The assemblage is closely similar to the equivalent sediments from Egypt and Libya.**
- **According to the assemblage, a shallow marine environment with low energy condition has been interpreted.**

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* Corresponding author:
E-mail address: ahmed59muftah@gmail.com
A. M. Muftah

ABSTRACT

The exposed Pre-Sahabi rock unit formation "M" at As Sahabi area in Sirt Basin is analyzed micro paleontologically for bryozoans. Fourteen species belonging to eleven genera of bryozoan have been identified, described for the first time. In addition, the importance of the present study is to determine the paleo environmental occurrences as is performed herein with particular attention to their paleo geographical distribution. A comparison with the coeval sites from Siwa Oasis, the Cairo-Suez Road section in Egypt, as well as the Maradah Formation from Sirt Basin in Libya, has been revealed some similarities between these sites.

1. Introduction

The As Sahabi study area is located in the northeastern part of Sirt Basin, covering an area of ≈375km². It is bounded by longitudes 20° 48' 08" to 20° 54' 45" E and latitudes 30° 10' 58" to 30° 17' 36" N within a tectonic province called the Ajdabiya Trough (Fig. 1).

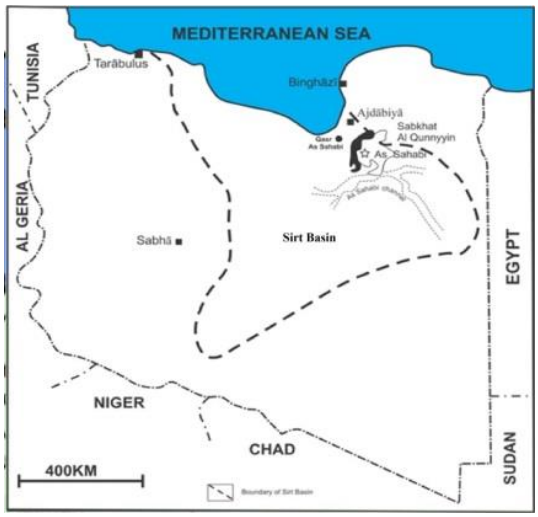

Fig. 1. Location of the As Sahabi area in Sirt Basin of Libya (Muftah, 2013).

The studied samples came from a small exposure profile at locality P53 called Inselberg Hill (Fig. 2). It is located at latitudes (30° 14' 5.78" N) and longitudes (20° 53' 54.18" E) along the western margin of the Sabkhat Al Qunnyyin. It is the oldest exposed rock unit in As Sahabi area and belongs informally to formation "M", which consists of clay and fossiliferous semi consolidated carbonates (Fig. 2).

Thirteen samples were collected from the locality P53 exposure (Fig. 2) which are prepared according to standard micropaleontological techniques and examined for their bryozoan content.

Fig. 2. Inselberg Hill (P53) located at the western edge of Sabkhat Al Qunnyyin (facing NW) (see Fig. 4 for lithology).

Selected bryozoan species are examined using a Jeol JSM 6360 Scanning Electron Microscope, at the University of Athens, Department of Historical Geology and Paleontology, for taxonomic and illustrative purposes. All materials (rock samples and micro paleontological slides) are stored in the micro paleontological section of the Earth Sciences Department of Benghazi University, Benghazi, Libya.

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2. Geological setting and Stratigraphy of As Sahabi

2.1 Tectonics

The Sirt Basin is the largest and youngest sedimentary basin in Libya, with an NW-SE trending pattern, covering an area of about 300.000 km2 (Fig. 3). It is bounded by the Hun graben to the west, a major fault of dip-slip nature including the Antelat uplift, which separates the basin from the Cyrenaica platform to the east, by the Mediterranean Sea to the north and by the major Tibisti Sirt uplift to the south (Fig. 3). Sirt Basin was formed in the Cenomanian, during which a series of NW-SE trending horsts and grabens were developed. The deeper part of the basin (troughs), including the Ajdabya (≈Agedabia) trough where As Sahabi area is located, is considered as the eastern graben of the horst - graben system of Sirt Basin complex (El-Arnauti and El Sogher, 2004). This trough has received more than 15.000 ft. thick sequences of Mesozoic and Tertiary marine sediments, as they are recorded in the subsurface drilled oil wells in this Basin.

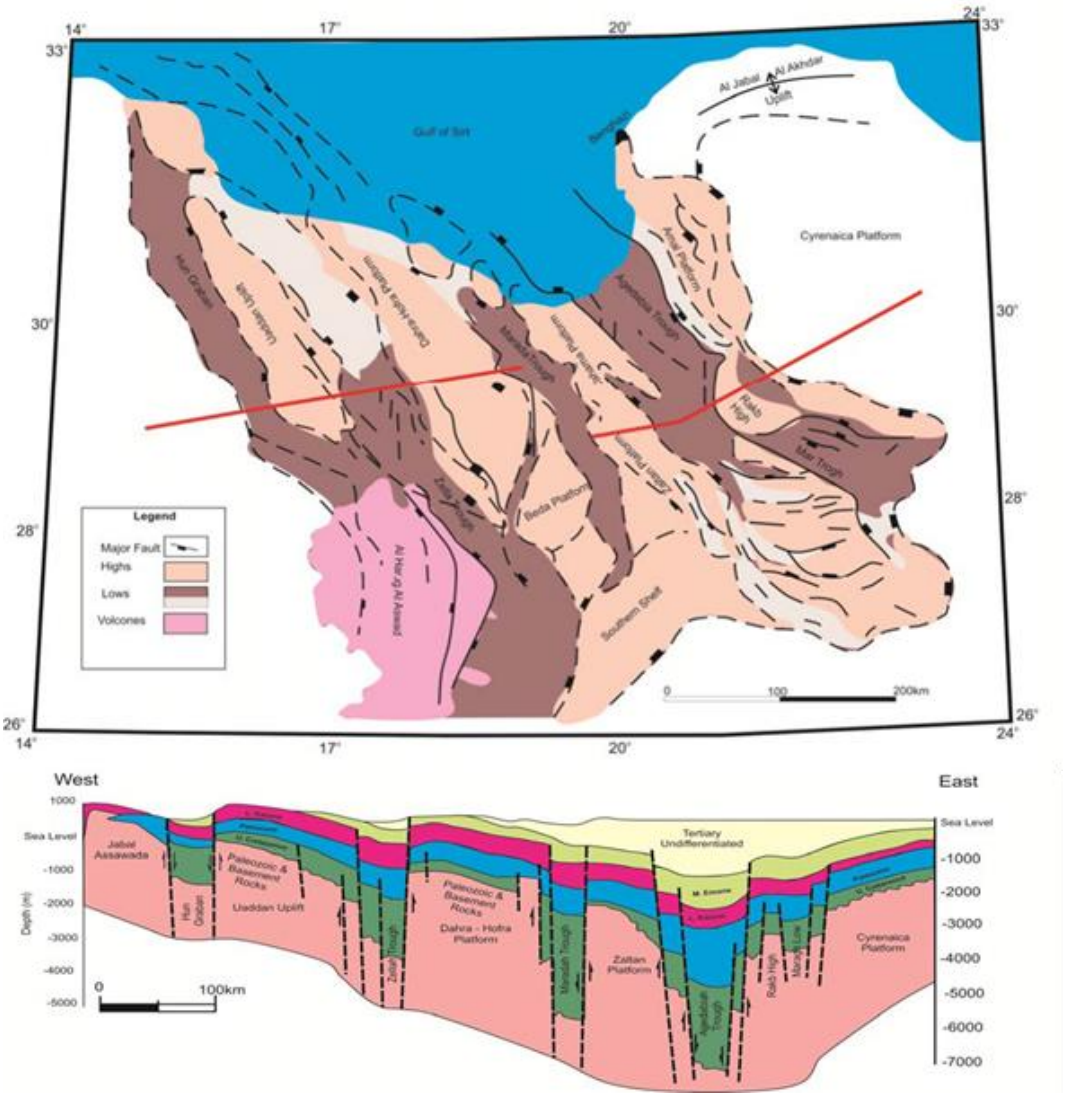

Fig. 3. Tectonic map of Sirt Basin shows the Ajdabya Trough and geological cross section through the Basin (after Roohi, 1993).

2. 2. Stratigraphy of As Sahabi area

The Neogene strata in the As Sahabi area are exposed along the western edge of the Sabkhat Al Qunnyyin. The stratigraphy of these rocks has been introduced by De Heinzelin and El Arnauti (1982, 1983, and 1987); Giglia (1984) and Muftah *et al*. (2008b) from several surface exposures in As Sahabi area (Fig. 3). The exposed rock units are named informally, from bottom to top: formation "M", formation "P", and the Sahabi Formation. The latter is subdivided into five informal members (T, U1, UD, U2 and V) and formation "Z" as the topmost rock units at some localities (De Heinzelin and El-Arnauti, 1987; Muftah, 2013, Muftah *et al*., 2013). However, El-Shawaihdi *et al*. (2014), El-Shawaihdi, *et al*. (2016) and El-Shawaihdi, *et al*. (2019) amended the lithostratigraphic nomenclatures of the As Sahabi area based on stable isotopes dating of few samples to modify formation "M" and regional correlation to introduced new "lower member" and "upper member" of Sahabi Formation, Qarrat Waddah Formation and formation "Z" (Fig. 3). The present study focuses only on the formation "M".

Formation "M" composes of semi-consolidated lithofacies with maximum exposed thickness reaching up to 13 meters, among which the main bryozoan-productive horizon is accommodated (*i.e.* the lower two units) (Fig. 4). It is highly fossiliferous with most common invertebrate fossil groups, including echinoids, pelecypods, gastropods, corals and bryozoans in addition to several microfossils groups such as foraminifera, calcareous nannofossils and ostracods (De Heinzelin and El-Arnauti, 1983; Willems and Meyrick, 1982; and Muftah *et al*., 2008a, b). Petrographically formation "M" is differentiated into the following five units, (Fig. 4), on the basis of the lithology, texture and fossil content; from bottom to top they are: i) Foraminifera-echinodermal packstone unit; ii) Sandy-pelletal packstone unit; iii) Gypsiferous dolostone unit; iv) Clay unit; and v) Fossiliferous limestone unit.

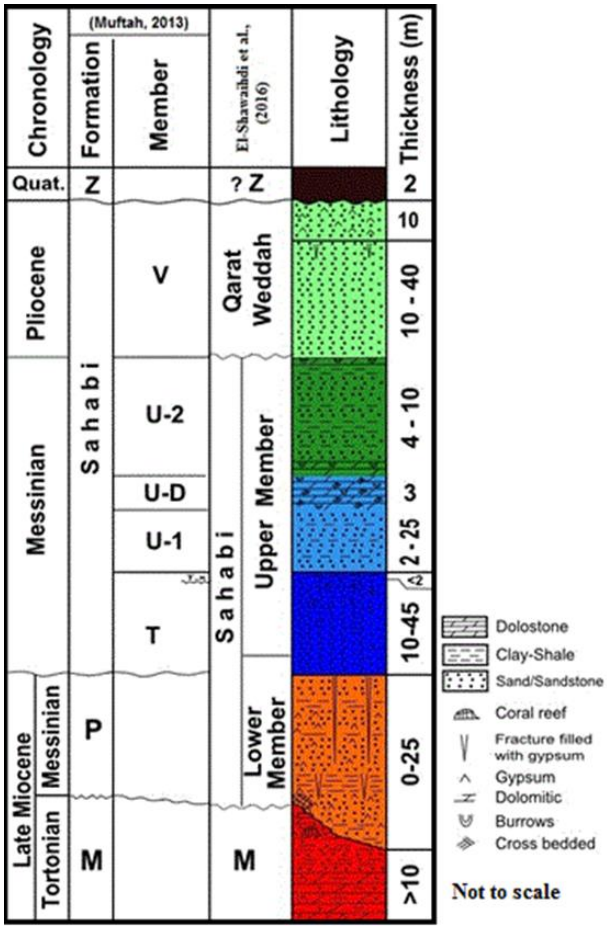

Fig. 3. Stratigraphic column of exposed rock units in As Sahabi area (Muftah *et al.*, 2019, *in press*).

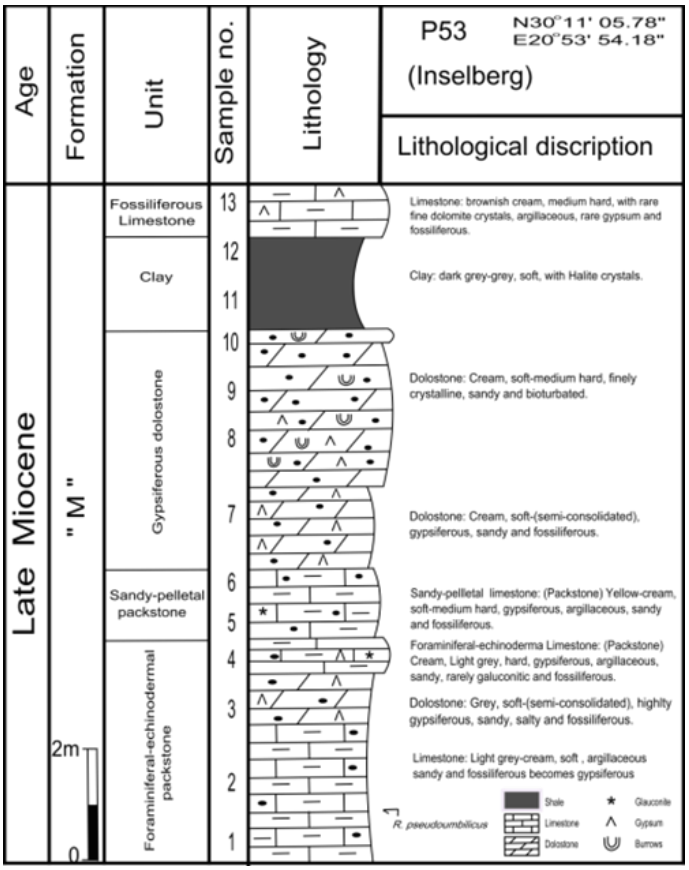

Fig. 4. Columnar section of Pre-Sahabi rock unit at P53 As Sahabi area (Muftah, 2013).

3. Taxonomy

Taxonomic study of all recorded species is based primarily on the classification of Bassler (1953) with modifications. In addition, description, micrometric measurements, distribution, and habitat for each species are given. The parameters, statistics and abbreviations, as well as the form in which are presented, are as follows:

Parameter	No. of measured (Zoaria, Zooecia)	Range (mm)	Standard deviation	Mean (mm)
X*	(4, 8)	0.125–0.301	0.021	0.332

*Dz= Zoarial diameter; Dp= Peristomes diameter; Do= Orifice diameter; Lz= Aurozooidal length; lz= Aurozooidal width; Lo= Apertural or Opesial length; lo= Apertural or Opesial width; Lov= Ovicell length; Iov= Ovicell width; Lav= Avicularian length; Iav= Avicularian width. The bryozoan suite in the formation "M" is in general of very low diversity and is represented by fourteen species (Fig. 5).

Age	Formation	Samole No.	*Crisia eburnea*	*Crisia elongata*	*Crisia hornesi*	*Tretocycloecia dichotoma*	*Steginoporella iberica reussi*	*Calpensia nobilis*	*Thalamoporella zaltaniensis*	*Cellaria salicornioides*	*Nellia tenella*	*Scrupocellaria elleptica*	*Margretta cereoides*	*Celleporaria desioi*	*Celleporaria polythele*	*Schedocleidochasma incisa*
Late Miocene (Tortonian)	"M"	8-13	BARREN													
		7	R	R					R	R	R		R			C
		6									R					
		5		R		R	R				R	R	R	F	R	R
		4		C						R	F					
		3		C	R			R		A	C	R				
		2		C				C			F					
		1		F				C		C	F	F				R

Fig. 5. Bryozoans distribution chart of the P53 section at As Sahabi area.

(R: Rare 1-2; C: Common 3-5; F: Frequent: 6-10; A: Abundant >10)

Phylum: Bryozoa Ehrenberg, 1831
Order: Cyclostomata Busk, 1852
Family: Crisidae Johnston, 1847
Crisia eburnea (Linnaeus, 1758)

Sertularia eburnea Linnaeus, 1758: 810.

Crisia eburnea Winston, 1982: 155, fig. 91; Hayward and Ryland, 1985: 49, fig. 13a-c; Dulai *et al.*, 2010: 37, pl. 3, Fig. 2.

Measurements:

Dz (3) 0.253-0.260 (0.022) 0.267 mm,
Lz (1, 3) 0.342-0.371 (0.043) 0.364 mm
Do (1, 10) 0.062-0.064 (0.021) 0.063 mm
Dp (1, 10) 0.078-0.085 (0.042) 0.083 mm

Description. Zoarium erect, flat, internodes short and composed of 5–7 Autozooids, ornamented by dark common slit-like and few circular pseudopores and annual lines. Autozooids with a definite little salient, gently and frontally curved peristome and circular orifice. Gonozooid not observed. Non-cellular surface, gently curved, ornamented by the same pseudopores as the cellular one.

Occurrences: Sirt Basin, Sahabi area, locality P53 formation "M", Sample no. 7 (Fig. 4).

Distribution: Common in the cold waters of Europe and America, western Atlantic, Mediterranean Sea and West Africa.

Habitat: It is always dominant at 50 m, with a maximum depth of 300 m (Hayward and Ryland, 1985).

Crisia elongata Milne-Edwards, 1838

(Pl. I, Fig. 1)

Crisia elongata Milne-Edwards, 1838: 203, pl. 7, Fig. 2; Braga and Barbin, 1988: 505, pl. 1, Fig. 2; Ziko and Hamza, 1987: 320, Fig. 2-4; Ziko and El-Sorogy, 1995: 82, Fig. 3: 1-2.

Description: Zoarium free, erect, articulated cylindrical stems with a tapering initial part, circular cross section and slightly depressed lateral parts, cellariiform (Crisiid). Autozooidal tubes cylindrical, only obvious near apertures, biserially arranged in alternating manner. Frontal convex. Orifice circular; peristome thin, little salient. Distance between peristomes exceeds the internode distance. Dorsal convex, smooth. Ovicell subglobular located between nodes.

Measurements:

Dz (4) 0.223-0.257 (0.021) 0.243 mm
Lz (1, 10) 0.402-0.432 (0.025) 0.418 mm
Do (2, 10) 0.060-0.073 (0.020) 0.062 mm
Dp (2, 10) 0.065-0.082 (0.019) 0.079 mm
Lov (2, 2) 0.490-0.510 (0.018) 0.498 mm
Iov (2, 2) 0.275-0.302 (0.012) 0.286 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos. 1- 5, 7 (Fig. 4).

Distribution: Eocene (France, and North America); Oligocene (France, Germany, and Italy); Miocene (Egypt, CSSR, France, Hungary, Italy, and Austria); Pliocene (Italy), Pleistocene (Egypt).

Habitat: Atlantic, Mediterranean, Red Sea, Japan, with a depth range of 0-59 m (Vavra, 1977).

Crisia hornesi Reuss, 1847

(Pl. 1, Fig. 2)

Crisia hornesi Reuss,1847: 54, Pl. 7, Fig. 21; Canu and Bassler, 1923: 704, pl. 141, Figs. 1-4; Vavra, 1977: 14; Ziko, 1994: 224; Ziko *et al.*, 2000: 1465, Pl. 1, Fig. 1; El Safori. 2002: 426, Pl. 2, Fig. 3; Dulai et al., 2010: 40, pl. 3, Fig. 4.

Description: Zoarium free, erect, subcylindrical stem, cellariiform (crisiid). Frontal little convex, finely perforated. Autozooidal tubes little distinct, biserially arranged in an alternating manner. Orifice circular; peristome thin, little salient, rounded. Dorsal little convex, Ovicell not observed.

Measurements:

Dz (3) 0.503-0.522 (0.015) 0.513 mm
Lz ((1, 3) 0.362-0.394 (0.020) 0.374 mm
Do (2, 10) 0.065-0.078 (0.012) 0.071 mm
Dp (2, 10) 0.083-0.089 (0.006) 0.085 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample no. 3 (Fig. 4).

Distribution: Middle Miocene north of Western Desert and the western side of the Gulf of Suez; Eocene of France, Italy and North America; Oligocene of Germany, France, Italy and USA; Miocene of CSSR, Greece, Italy, Poland, Romania, Hungary, Portugal, Egypt; Pliocene – Pleistocene of Italy (Ziko, 1973; Vavra, 1977; El-Dera, 1996; El-Sorogy *et al.*, 2001).

Habitat: Red Sea, Philippines at depth from 100 to 300m, temperature: 11.2ºC (Canu and Bassler, 1929; Ziko *et al.*, 2000; El-Sorogy *et al.*, 2001).

Family: Heterocycloeciidae, Canu, 1919
Tretocycloecia dichotoma (Reuss, 1848)

(Pl. I, Fig. 3)

Heteropora dichotoma Reuss, 1848: 35, pl. 5, Fig. 20.

Tretocycloecia dichotoma Vavra, 1977: 65; Vavra, 1979: 388, pl. 2, Fig. 2, Ziko, 1996: 69, pl. 7, Figs. 3, 4, 6, 7, 8, El Safori, 2002: 431, pl. 3, Fig. 3; Ziko *et al.*, 2010: 92, pl. 4, Fig. 12, pl. 5, Fig. 1.

Description: Zoaria free, globular, vesicular, multilamellar, adeoniform. Autozooidal orifices subcircular, branching. Kenozooids very abundant arranged around autozooidal apertures in an irregular quincuncial pattern. Gonozooecium not observed. numerous separated by smaller polygonal mesopores, no peristome.

Measurements:

Dz (2) 1.356-1.510 (0.083) 1.433 mm
Do (1, 10) 0.084-0.095 (0.003) 0.087 mm
Dp (1, 10) 0.096-0.145 (0.088) 0.122 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample no. 5 (Fig. 4).

Order Cheilostomata Busk, 1852
Suborder: Anasca Levinsen, 1909
Family: Steginoporellidae Bassler, 1953
Steginoporella iberica reussi Pouyet and David, 1979.

Steginaporella iberica reussi, Poyet and David, 1979: 780, pl. 4, Fig. 3, text Fig. 3; Vavra, 1980, 55.

Description: Zoarium encrusts a fragment of *Pecten* sp., often represented by fragmented parts. Unilamellar, membraniporiform. Autozooids elongated hexagonal, arranged in alternating longitudinal rows, separated by thin furrows. Mural rim convex, thick, salient, finely granulated. Cryptocyst almost flat, perforated; the distal part, elevated, imperforated, grooved by two subsymmetrical, subcircular opesiules, placed just below the proximal border. Opesia large, subterminal, semicircular, transverse, with rounded distal and slightly concave proximal border; peristome thick, raised. B-zooids rarely observed.

Measurements:

Lz (1, 8) 0.856-1.047 (0.065) 0.875 mm
Iz (1, 8) 0.643-0.716 (0.048) 0.664mm
Lo (1, 8) 0.124-0.2336 (0.093) 0.225 mm
Io (1, 8) 0.335-0.390(0.013) 0.382 mm

Distribution: Miocene (Vienna Basin-Austria, Rhone Basin).

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos 1, 5 (Fig. 4).

Family: Calpenciidae Canu and Bassler, 1923
Calpensia nobilis (Esper, 1796)

Cellepora nobilis Esper, 1796: 145.

Calpensia nobilis Zabala and Maluquer, 1988 : 90; Moissette, 1988: 96, pl. 4, Fig. 8; pl. 16, Figs. 11, 12; Hayward and McKinney, 2002: 31, Figs. 13 A-C.

Description: Colony encrusting unilamellar, multiserial. Autozooids distinct, elongated rectangular, arranged in alternating longitudinal rows, separated by thin furrows. Mural rim convex, thin, salient, granulated. Cryptocyst deep, little convex to flat, perforated and granulated, pierced by two small, rounded opesiules, placed at a little distance of opesium and close to mural rim. Opesia elliptical, transverse with rounded distal and concave to the little convex proximal border; peristome thick, salient. Ovicell not recognized.

Measurements:

Lz (1, 10) 0.598-0.702 (0.024) 0.657 mm
Iz (1, 10) 0.390-0.464 (0.015) 0.438 mm
Lo (1, 10) 0.090- 0.110 (0.010) 0.104 mm
Io (1, 10) 0.130- 0.200 (0.010) 0.148 mm

Occurrence: Sirt Basin, Sahabi area, locality P53 formation "M", Sample nos. 1, 2, 3 (Fig. 4).

Distribution: Miocene (Egypt, France, Italy, and Algeria); Pliocene (Italy and Tunisia); Pleistocene (Italy); Recent (the Mediterranean Sea and the Atlantic Ocean).

Family Thalamoporellidae Levinsen, 1902
Thalamoporella zaltaniensis El Safori and Muftah, 2019, (*in Press*)

Description: Zoarium encrusts and membraniporiform. Zooecia distinct, arranged in alternating longitudinal rows and separated by thin furrows. Mural rim thin, convex, slightly salient, granulated, basal part pierced by two and rarely one small spine with a thick base and abraded shaft. Cryptocyst shallow, little convex to flat, finely granulated and perforated, grooved by two small symmetrical rounded opesiuels, placed just below the proximal border of the opesia. Opesia elliptical with rounded distal and concave to the little concave proximal border; peristome thin, salient. Ovicells are not observed.

Measurements:

Lz (2, 7) 0.391-0.492 (0.036) 0.449 mm
Iz (2, 7) 0.187-0.282 (0.042) 0.253 mm
Lo (2, 7) 0.043- 0.057 (0.013) 0.050 mm
Io (2, 7) 0.101- 0.108 (0.006) 0.104 mm
Lav (1, 2) 0.558- 0.565 (0.013) 0.561 mm
Iav (1, 2) 0.276- 0.284 (0.006) 0.280 mm

Occurrences: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample no. 7 (Fig. 4).

Family Cellaridae Fleming, 1828
Cellaria salicornioides Lamoroux, 1816

(Pl. 1, Fig. 4)

Cellaria salicornioides Lamouroux,1816: 127; Moissette, 1988: 104, pl. 17, figs. 1, 2; Hayward and McKinney, 2002: 36, Fig. 15F-K; Dulai *et al.*, 2010: 36, pl. 2, Fig. 7.

Description: Colonies erect and branching, with cylindrical internodes consisting of alternating 8-10 autozooidal rows. Autozooids oval to hexagonal, with a regular quincuncial arrangement. Opesia subterminal, semicircular, mural rim short, bluntly tapered. Cryptocyst concave, finely granulated. Avicularia not common, distinct as large autozooid, with large subcircular rostrum. Ovicell is a simple round opening distal to the opesia.

Measurements:

Zd (1, 3) 0.730-0.832 (0.024) 0.760 mm
Lz (1, 10) 0.288-0.400 (0.024) 0.311 mm
Iz (1, 10) 0.266-0.311 (0.015) 0.297 mm
Lo (1, 10) 0.044- 0.067 (0.010) 0.057 mm
Io (1, 10) 0.097- 0.124 (0.010) 0.120 mm

Occurrences: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample no. 3 (Fig. 4).

Distribution: Miocene (Portugal, Italy); Pliocene (Italy); Pleistocene (Italy); Recent (Mediterranean Sea, Atlantic Ocean, Red Sea) (Moissette, 1988).

Habitat: Shallow coastal sublittoral waters (50 m-80 m).

Family Quadricellariiidae Gordon, 1984

Nellia tenella (Lamarck, 1816)

(Pl. 1, Fig. 5)

Cellaria tenella Lamarck, 1816: 135.

Nellia tenella Cheetham,1963: 59, pl. 1, Fig. 14; Braga, 1963: 27; El Safori, 2002: 426, pl. 5, Fig. 7; Di Martino *et al.*, 2017: 109.

Description: Zoarium free, erect, straight, sometimes slightly curved, composed of four identical alternating autozooidal rows, open on four sides with square cross-section, cellariiform. Autozooids distinct, elongated, rectangular, separated by thin furrows. Mural rim convex, thin, salient. Gymnocyst smooth, slightly convex. Cryptocyst proximally placed, smooth, flat or slightly concave. Opeisa narrow elliptical to oval. Avicularia small paired, placed on gymnocyst at the proximelateral corners of autozooids, oval, pointing to the outside, with small central oval opesia. Ovicell endotoichal.

Measurements:

Lz (2, 10) 0.431-0.463 (0.007) 0.442 mm
Iz (2, 10) 0.243-0.274 (0.012) 0.261 mm
Lo (2, 10) 0.251- 0.267 (0.022) 0.264 mm
Io (2, 10) 0.112- 0.129 (0.013) 0.118 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos. 1-7 (Fig. 4). Also reported from the overlying members "U1 and UD" of Sahabi Formation in the locality P96c section.

Distribution: Eocene (France); Eocene-Oligocene (USA); Miocene (Egypt, Jamaica, Austria); Pliocene-Pleistocene (USA).

Family Scrupocellariidae Levinsen, 1909
Scrupocellaria elleptica (Reuss, 1848)

(Pl. 1, Fig. 6)

Bactridium elleptica Reuss,1848: 148, pl. 11, Fig. 1-9.

Scrupocellaria elleptica Neviani,1900: 149, pl. 16, Figs. 2, 3; Vavra, 1979: 598, pl. 1, Fig. 1; Pouyet and Moissette, 1992: 47, pl. 6, Fig. 1, 2; Haddadi-Hamdane, 1996: 73, pl. 5, Fig. 5.

Description: Zoarium free, erect, subcylindrical stems, oval cross-section, tapering basal part, cellariform. Autozooids distinct rhomboidal cylindrical, more narrow at the proximal part, arranged biserrially in alternating rows on the zoarial front, separated by thin furrows. Mural rim convex, thick, provided by a triangular tubercles distally and laterally directed, granulated. Opesia distal, elongate elliptical. Avicularia lateral, salient, triangular. vibracula dorsal, sub-triangular, inconstant. Dorsal convex, finely granulated. Ovicell not observed.

Measurements:

Lz (2, 5) 0.368-0.437 (0.035), 0.410 mm
Iz (2, 5) 0.138-0.184 (0.016) 0.176 mm
Lo (2, 5) 0.189-0.253 (0.028), 0.228 mm
Io (2, 5) 0.069-0.119 (0.030) 0.103 mm

Occurrence: Sirt Basin, As Sahabi, locality P53 formation "M", Sample nos. 1, 3, 5, 7 (Fig. 4). Also reported from the overlying member "U1" of Sahabi Formation in the locality P96c section.

Distribution: Eocene (France, Italy, Hungary, and France); Oligocene (Italy and France); Miocene (Egypt, Libya, France, Iran, Portugal, Austria, and Belgium); Pliocene (Portugal, Spain, Italy, and Tunisia); Pleistocene (Egypt, Algeria, and Italy).

Suborder Ascophora Levinsen, 1909
Family: Margarettidae Harmer, 1956
Margaretta cereoides (Ellis and Solander, 1786)

(Pl. 1, Fig. 7)

Cellaria cereoides Ellis and Solander, 1786: 26, pl. 5, Figs. B-E.

Margaretta cereoides Buge and Debourle, 1977: 344, pl. 8, Fig. 3; Vavra, 1979: p. 603, pl. 1, Fig. f ; Ziko and Hamza, 1987: p. 305, Fig. 77; Schmid, 1989: p. 52, pl. 15, Figs. 4, 5, 7, 8; Ziko, 1996: p. 136, Figs. 4-5; El Safori, 2002: 450, pl. 7, Fig. 6; Dulai *et al.*, 2010: 37, pl.4, Fig. 3

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

Measurements:

Lz (2, 10) 1.230-1.432 (0.095) 1.389 mm
Iz (2, 10) 0.464-0.497 (0.012) 0.477 mm
Lo (2, 10) 0.122- 0.142 (0.024) 0.132 mm
Io (2, 10) 0.164- 0.178 (0.017) 0.171 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos. 5, 7 (Fig. 4).

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 (Schmid, 1989).

Family: Celleporidae Busk, 1852
Celleporaria desioi (Cipolla, 1929)

(Fig. 6)

Holoporella desioi Cipolla, 1929: 379, pl. 43, Figs. 4-8, pl. 44, Figs. 2, 6; Annoscia, 1969: 88, pl. 1, Figs. 16-18.

Celleporaria desioi El Safori, 2002: 453, pl. 7, fig. 8.

Description: Zoarium cap-shaped, large-sized, multiserial, multilayered with a pimply surface, sometimes ovoid (Fig. 6). Autozooids ovoid, distinct, irregularly arranged in rows, separated by thin furrows. Frontal thin, convex, finely granulated. Aperture subcircular, umbonate with a slightly concave narrow poster. Adventitious

avicularia suboral on the top of the apertures mucrons. Vicarious avicularia absent. Ovicells not observed.

Measurements:

Lz (1, 10) 0.238-0.362 (0.074) 0.310 mm
Iz (1, 10) 0.187-0.243 (0.120) 0.238 mm
Lo (1, 10) 0.066- 0.075 (0.093) 0.064 mm
Io (1, 10) 0.065- 0.093 (0.040) 0.082 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos. 5 (Fig. 4).

Distribution: Miocene (Egypt, and Libya).

Fig. 6. *Celleporaria desioi,* formation "M", P53 As Sahabi area (scale bar=2 cm).

Celleporaria polythele (Reuss, 1848)

Cellepora polythele Reuss, 1848: 77, pl. 9, Fig. 18.

Holoporella polythele Canu, 1912: 217, pl. 12, Figs. 1-5, pl. 13, Figs. 6, 7; Souaya, 1965: 1141, pl. 139, Figs. 1, 2.

Celleporaria polythele David *et al*., 1970: 45; El Safori, 2000: 405, fig. 5: 7; El Safori, 2002: 451.

Description: Zoarium free, massive, thick, globular, multilamellar, celleporiform. Autozooids crowded, distinct, salient, disoriented represented by variable sizes. Frontal oloyest, very convex, bordered by areolar pores, which are more definite in large Autozooids. Orifice subcircular; proximal border convex, obliques. Avicularia rest on mucron, small, triangular, median, inconstant. Vicarious avicularia, rare or absent. Ovicell hyperstomial, commonly broken.

Measurements:

Lz (2, 10) 0.334-0.350 (0.032) 0.345 mm
Iz (2, 10) 0.376-0.395 (0.028) 0.387 mm
Lo (2, 10) 0.105- 0.123 (0.026) 0.110 mm
Io (2, 10) 0.110- 0.132 (0.017) 0.119 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample no. 5 (Fig. 4).

Family Phidoloporidae Gabb and Horn, 1862
Schedocleidochasma incisa (Reuss, 1874)

(Pl. 1, Fig. 8)

Lepralia incisa Reuss, 1847: 168, pl. 3, Fig. 4.

Buffonellodes incisa David and Pouyet, 1974: p. 170, pl. 9, Fig. 7; Pouyet and Moissette, 1992: 61, pl. 9, Fig. 3; Pouyet, 1997, p. 62, pl. 6, Fig. 5.

Schedocleidochasma incisa Berning, 2005: 120, pl. 12, Figs. 8, 9, 12.

Description: Colony encrusting unilaminar, multiserial. Autozooids elliptical to hexagonal, separated by either distinct grooves or indistinct sutures on marked ridges; frontal wall convex, smooth, with two large elongated pores in marginal corners at mid-distance. Orifice large, comprising more than one-third of zooid length, cleithridiate, anter large, round, set off from the smaller, round or semielliptical poster by a pair of pointed condyles directing downwards and proximally; three distal oral spines (up to five in astogenetically young zooids). Ovicell globular, recumbent on distal zooid, slightly longer than wide, surface imperforate, smooth and flattened frontally, with a pair of narrow proximolateral fissures delimiting a simple labellum with a straight or slightly concave proximal edge. Interzooidal avicularium common, single, originating from a marginal corner at mid-distance from an areolar pore, situated lateral or proximolateral to poster; cystid slightly was swollen; rostrum elongated triangular, directing laterally or distolaterally; crossbar complete without columella.

Measurements:

Lz (1, 10) 0.268-0.320 (0.074) 0.289 mm
Iz (1, 10) 0.219-0.289 (0.030) 0.244 mm
Lo (1, 10) 0.097- 0.121 (0.023) 0.109 mm
Io (1, 10) 0.060- 0.116 (0.018) 0.075 mm
Lov (1, 10) 0.152-0.180 (0.013) 0.164 mm
Iov (1, 10) 0.182-0.195 (0.010) 0.189 mm
Lav (1, 10) 0.112-0.125 (0.023) 0.120 mm
Iav (1, 10) 0.050-0.065 (0.020) 0.061 mm

Occurrence: Sirt Basin, As Sahabi area, locality P53 formation "M", Sample nos. 1, 7 (Fig. 4).

Distribution: Miocene (Egypt, Portugal, France, Italy, Austria, Poland, Guadalquivir, Spain, Algeria, Morocco); Pliocene (Spain, Italy).

4. Results and discussions

The Miocene bryozoans of North Africa and South Europe are represented in stratigraphic levels without specific new occurrences (Moissette, 1988; El Hajjaji, 1992). However, evidences for a bryozoan event during Badenian (a central Paratethys stage) of Middle Miocene time were recognized in several sections in North-South transect through the Paratethys (Zagoršek, 2015). As indicated by Holcová and Zágoršek (2008), the main factor for bryozoan accumulation is probably changes in trophic condition, together with high variability of temperature. Evidences from Paratethys Middle Miocene bryozoans without major occurrences in the bryozoan species but rather they show changes in growth from North (erect) to South (encrusting) along the Paratethys. The slight changes in bryozoan event can be recognized from their stratigraphic distributions and the domain of some species on certain horizons. El Safori (2002) recognized two bryozoan assemblage zones from Siwa Oasis accompanied by the water transgression of middle Serravallian (Siwa sequence). These assemblages are close to equivalent assemblages from the Ar Rahla Member of the Maradah Formation (El Safori and Muftah, in press). The Pre-Sahabi succession of formation "M" is dated Tortonian based on the presence of foraminifers and calcareous nannofossils (Muftah *et al*., 2013) as well as Strontium isotopic dating (El-Shawaihdi *et al*., 2014) which representing the Late Serravallian 2nd bryozoan assemblage defined from Siwa. In addition, it is the equivalent to Serravallian-Tortonian bryozoan Member that defined from the Cairo-Suez Road section (Cherif and Yahia, 1977) on a stratigraphical basis.

A shallow neritic depositional environment for formation "M" has been interpreted by De Heinzelin and El-Arnauti (1982, 1983 and 1987) according to the lithological nature and faunal contents. The macro/microfossil contents suggest a depositional setting under transgressive inner neritic marine environment. The presence of low diversity bryozoans (*Nellia tenella, Crisia* spp., *Celleporaria desioi, Calapensia* sp., *Cellaria* sp., *Scrupocellaria elleptica* and *Steginoporella iberica reussi*) at some levels is clearly indicative of shallow water with low rate of sedimentation (Lagaaij and Gautier, 1965; El Safori, 2000). The presence of the membranous type *Cel-*

leporaria desioi is very characteristic in this formation (Fig. 6), altogether with the associated species that listed in Fig. 5 are indicating the shallow marine environment of low energy conditions (Lagaaij and Gautier, 1965; El Safori, 2000). On the other hand, only three species of the above-mentioned list (*Nellia tenella, Scrupocellaria elleptica* and *Crisia* sp) are reported from the locality P96c Profile of Sahabi Formation in members "U1" and "UD" (Muftah, 2013). The presence of these three species alone indicates low energy shallow marine environment of less than 50 m.

5. Conclusions

The shallow marine carbonates of formation "M", the Late Miocene (Tortonian) pre-Sahabi Formation at P53 in the As Sahabi area, Sirt Basin contained low diverse and bryozoan remains. A descriptive taxonomy has been performed for fourteen species from this measured Tortonian formation "M". The reported assemblage is closely similar to that described by Cherif and Yahia, (1977) in Cairo-Suez roadcut section and partly to which represents the 2nd bryozoan assemblage defined from Siwa (El-Safori, 2002) and from the Ar Rahlah Member of Maradah Formation El-Safori and Muftah, 2019 (*in press*). Most of the bryozoan taxa described herein are indicative to shallow marine warm water with low sedimentation energy. The concerned taxa more or less inhabit wide geographical distribution with shallow marine environment.

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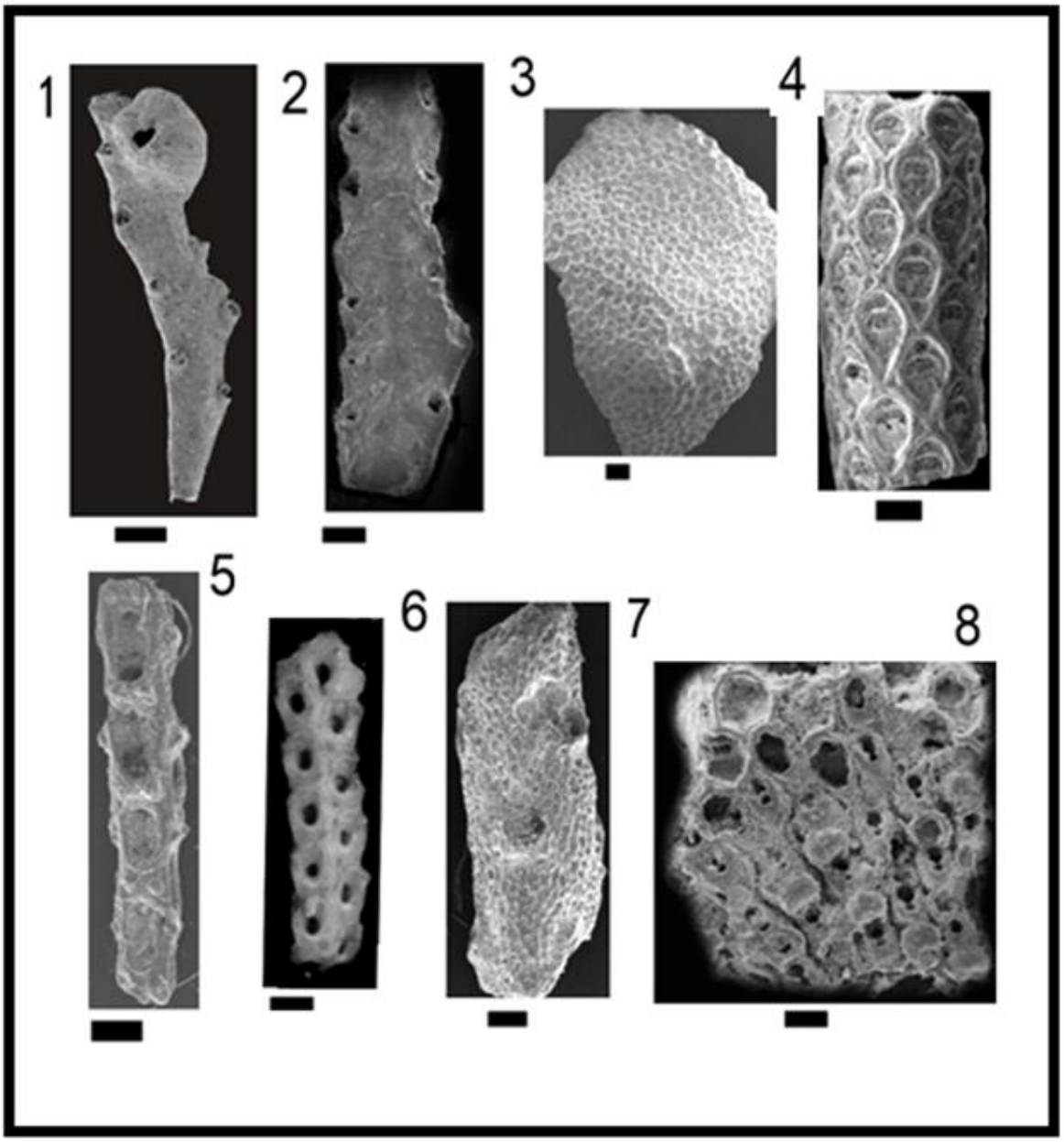
Plate 1



Explanation of Plate I (Scale bar =100 µm)

1. *Crisia elongata* (Linnaeus, 1758)
2. *Crisia hornesi* Reuss, 1847
3. *Tretocycloecia dichotoma* (Reuss, 1848)
4. *Cellaria salicornioides* Lamoroux, 1816
5. *Nellia tenella* (Lamarck, 1816)
6. *Scrupocellaria elleptica* (Reuss, 1848)
7. *Margaretta cereoides* (Ellis and Solander, 1786)
8. *Schedocleidochasma incisa* (Reuss, 1874)