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PLIOCENE CORALLINE ALGAE, SOUTH OF SAFAGA (RED SEA, EGYPT)

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ABSTRACT

Coralline algae are highly abundant in the Pliocene succession of the area south of Safaga (Red Sea, Egypt). The articulated corallines (Corallinoideae) are represented here by a single genus, *Amphiroa*. The crustose coralline group (Melobesioideae) are relatively common in the studied sections. They are represented only by two genera, *Lithophyllum* and *Lithoporella*.

Thirteen species of coralline algae are here recorded and described, for the first time, from the Pliocene rocks of the concerned area. Among these, the following four species are new: *Amphiroa bassiounii* n.sp., *Amphiroa cameroni* n.sp., *Amphiroa siyatinensis* n.sp. and *Lithoporella berggreni* n.sp.

INTRODUCTION

Little has been published about the Miocene and younger rocks of the area south of Safaga (Red Sea, Egypt). The regional stratigraphic setting of that area was treated by Hume (1916), Beadnell (1924), Waring & Jones (1940) and Stainforth (1949). Souaya (1963b), on the other hand, described the microfossils of four sections measured south of Quseir. He subdivided that Zug El-Bohar section (60 km to the south of the studied area), which proved to be the richest in the microfossils, into four biozones. These are, from top to bottom, as follows:

4. *Borelis schlumbergeri* Zone
3. *Borelis* cf *B. pygmaeus* Zone
2. *Archaias aduncus* Zone
1. *Neoalveolina melo* Zone

These biozones range in age from Miocene to Pleistocene. The lithostratigraphy of the sedimentary sequence of the region and the adjacent areas was treated by Waring & Jones (1940), Said (1962) and Akkad & Dardir (1966). The sequence has been subdivided by El-Haddad (1979) into five lithostratigraphic units, arranged from top to bottom:

5. Terraces and raised beaches.
4. Shagra Formation
3. Gasus Formation.
2. Abu Dabbab Evaporites.
1. Gabal El-Rusas Formation.

This classification is followed here.

In the present study the fossil algae are treated for the first time. For this purpose, three

sections located at Wadi El-Siyatin, Wadi Abu Hamra El-Bahari and Wadi Abu Shiqeili El-Bahari (Fig. 1) are sampled and examined for their microfossil content.

Micropaleontological investigation of the three studied sections revealed that the whole sequence of the Gabal El-Rusas Formation, the interbedded shales of the Abu-Dabbab Evaporites are almost barren of microfossils. Only a few reworked, badly preserved foraminiferal tests are encountered. The overlying succession (the upper part of the Gasus Formation and the whole Shagra Formation), on the other hand, comprises abundant species of Pliocene fossil algae (coralline algae). Besides, larger foraminifera (particularly *Borelis schlumbergeri* (Reichel), *Borelis* cf *B. pygmaeus* Hanzawa and other microfossils are also present. The distribution of the microfossils in the studied sections is shown in fig. 2.

The Gasus Formation (Waring & Jones, 1940), which conformably overlies the Abu Dabbab Evaporites, consists mainly of shales, siltstones, sandstones, conglomeratic sandstones and thin beds of conglomerates. It is about 41 m thick at Wadi Abu Shigeili El-Bahari.

The Shagra Formation (Akkad & Dardir, 1966) is composed mainly of clastic limestone with coral heads and fragmented fossils with rare sandstone and conglomerate intercalations.

The detailed study of the coralline algae shows that there are three main types of coralline algal forms included in the upper part of the Gasus Formation and the whole Shagra Formation of the study area. These are as follows:

1. **Crustose forms:**

Encrusting corallines occur as reefal limestone or "biocoenoses coralligenes" (Milliman, (1974).

Encrustose coralline algal sediments range in size from boulders (reef rock) to fine detritus. The crustose forms comprise mainly encrusting genera of varying shapes and sizes such as *Mesophyllum, Lithothamnium,* and *Lithoporella.*

2. **Branching forms:**

These constitute morphologically homogeneous groups of coralline algae having similar shapes and sizes, such as *Amphiroa* and *Jania* (Wray, 1977).

3. **Algal nodules (rhodoliths):**

The term "rhodoliths" was defined by Bosellini & Ginsburg (1971) as algal nodules, principally composed of red algae (Corallinaceae). Adey & Macintyre, on the other hand, emphasized that "rhodoliths" include algal balls in which the algal debris has grown around nuclei. According to Adey & Macintyre, the species of *Lithothamnium, Lithophyllum, Archaeolithothamnium,* and *Neogoniolithon* (as shown on pl. 4, figs. 1-6) are the main contributors responsible for the construction of these types of algal structures. A more detailed study of the encountered rhodoliths and their environmental significance will be attempted in a later publication.

BIOSTRATIGRAPHY

The vertical variation of the described microfossils through the succession overlying the evaporites, allows the subdivision of the sequence into two florizones, namely a lower *Amphiroa prefragilissima* Zone and an upper zone rich in rhodoliths.

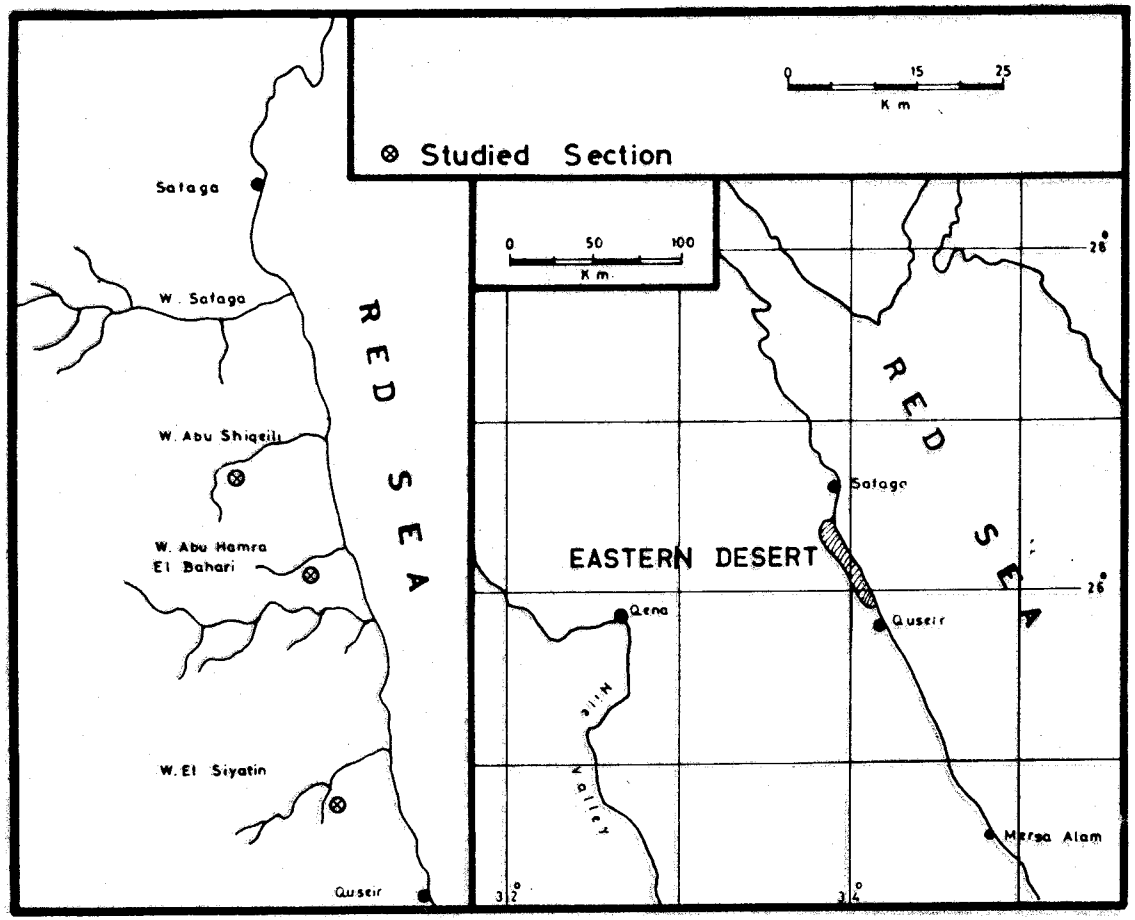

Fig. (1) Location map for the studied section

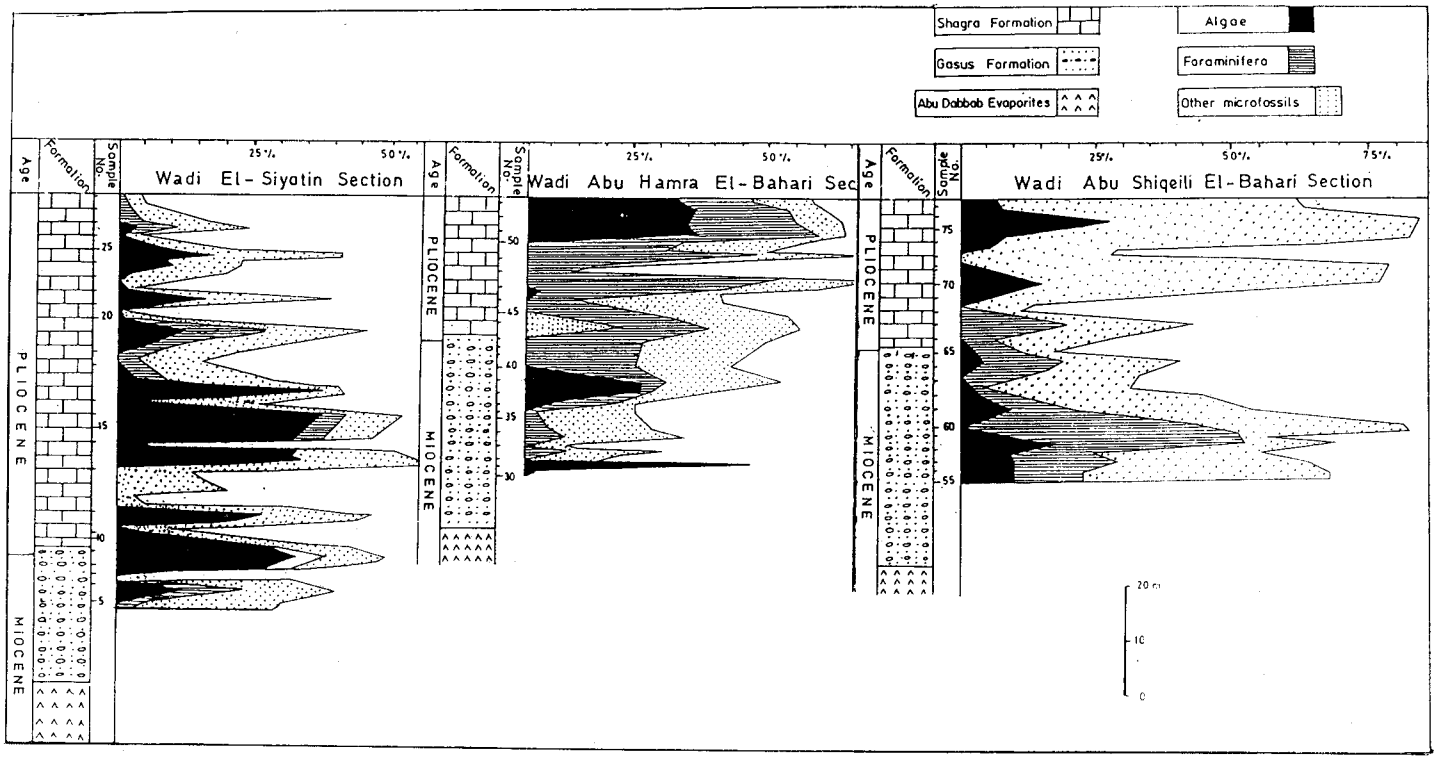

Fig. (2) DISTRIBUTION CHART OF THE MICROFOSSILS IN THE AREA SOUTH OF SAFAGA, RED SEA, EGYPT

The *Amphiroa prefragilissima* Zone comprises the upper part of the Gasus Formation and the lower part of the Shagra Formation. It varies in thickness from a few metres up to 50 m at its type section, Wadi El-Siyatin. This zone is characterised by abundant specimens of *Amphiroa fragilissima* Lamouroux, *Amphiroa todea* Souaya, *Amphiroa knolli* Khalifa & Boukhary, *Amphiroa bassiounii* n.sp., *Amphiroa cameroni* n.sp., *Amphiroa* sp., *Lithoporella berggreni* n.sp., *Lithophyllum dubium* Lemoine, *Lithophyllum prelichenoides* Lemoine, *Borelis schlumbergeri* (Reichel) and *Borelis* cf *B. pygmaeus* Hanzawa.

The upper zone, rich in rhodoliths, includes algal nodules principally composed of red algae. It coincides with the upper part of the Shagra Formation. Most of the described rhodoliths are spherical in shape and show burrows and borings such as *Lithophyllum, Lithothamnium,* and *Archaeolithothamnium.*

The identified coralline algal and foraminiferal species indicate a Pliocene age to the studied sequence. This age assignment is in accordance with previous age determination (Johnson, 1961, 1962, 1965; Souaya, 1963 a, b; Akkad and Dardir, 1966 and Orszag-Sperber (in Flugel, 1977) of similar fossil elements from different parts of the world.

SYSTEMATIC PALEONTOLOGY OF ALGAE

The classification used to identify and classify fossil coralline algae proposed by Papenfuss (1955), and later modified by Johnson (1961, 1969), Ginsburg *et al.* (1971), Adey & Johansen (1972), Adey & Macintyre (1973) and Wray (1977) is here adopted. This classification is based on the study of the following features in thin sections: size, shape, and arrangement of cells. These elements play a major part in the identification and classification of fossil algae in general.

Among the Family Corallinaceae (coralline algae) the preserved tissue is commonly differentiated into a hypothallium and perithallium. The perithallium is above the basal hypothallium in the crustose forms and is outside the medullary hypothallium in the branching forms.

The various genera within this family are identified on the basis of characteristic development in the type and structure of the hypothallium and perithallium, and on the basis of the structure, size, and arrangement of the conceptacles. Species are usually differentiated on the basis of differences in the size of the cells, the size and shape of the conceptacles, and the type of the texture and structure of the tissue.

Among the crustose coralline algae, the basal hypothallium develops into any one of three different types. The first type, or simply hypothallium, has a bottom layer which consists of a number of arched layers of large cells.

The second type, or co-axial hypothallium, consists of curved layers of cells which in vertical section appear to form semicircles or arcs.

The third type, or plumose hypothallium, consists of a long thick tissue in which the layers of cells appear to start at the centre and then curve more or less evenly both upward and downward, forming a feathery or plumy structure in vertical section.

Usually, the cells of the hypothallium are larger than those of the perithallium. There is a number of exceptions to this statement, particularly in the genus *Lithophyllum.* Otherwise, in the monostromatic algae, such as *Lithoporella,* the tissue consists entirely of a single layer of

large hypothallic cells, except around the conceptacles where several layers of small cells are present. However, in most of the cases, the hypothallium is well developed, and in a few species, it appears to be thicker than the perithallium.

In many branching forms of coralline algae, there is a distinct differentiation of the tissue into a thick central medullary hypothallium and a thin outer marginal perithallium. In *Lithophyllum, Archaeolithothamnium* and all the articulated coralline algae (such as *Amphiroa*), the medullary hypothallium is coaxial.

The diagnostic features of the common genera of crustose coralline algae (after Johnson, 1961, p.47) are used in the identification of the Egyptian flora. These are shown in (Table 1).

Thirteen species of the Family Corallinaceae (red algae) are herein recorded and described. Of these, six species are already known in the literature, four taxa are described as new and three species are given open nomenclature. These latter are either micritized or abraded and therefore, the erection of new species was delayed until more abundant, better preserved material become available. Abundant and well preserved coralline algae are herein described from the Wadi El-Siyatin section. This type of section is, therefore, chosen to investigate the abundance of the described species. Their distribution is shown in fig. (3).

Table (1)

Genus	Structural Features							
	Hypothallium Type 1	Hypothallium Type 2	Hypothallium Type 3	Perithallium, Type 1	Perithallium, Type 2	Sporangia not in conceptacles	Conceptacles with numerous apertures	Conceptacles with single aperture
Archaeolithothamnium	X			X		X		
Lithothamnium	X			X			X	
Mesophyllum		X			X		X	
Lithophyllum		X			X			X
Lithoporella			X					X
Goniolithon		X			X			X
Melobesia			X		X		X	
Tenera	X			X				X
Dermatolithon			X		X		X	

X = present

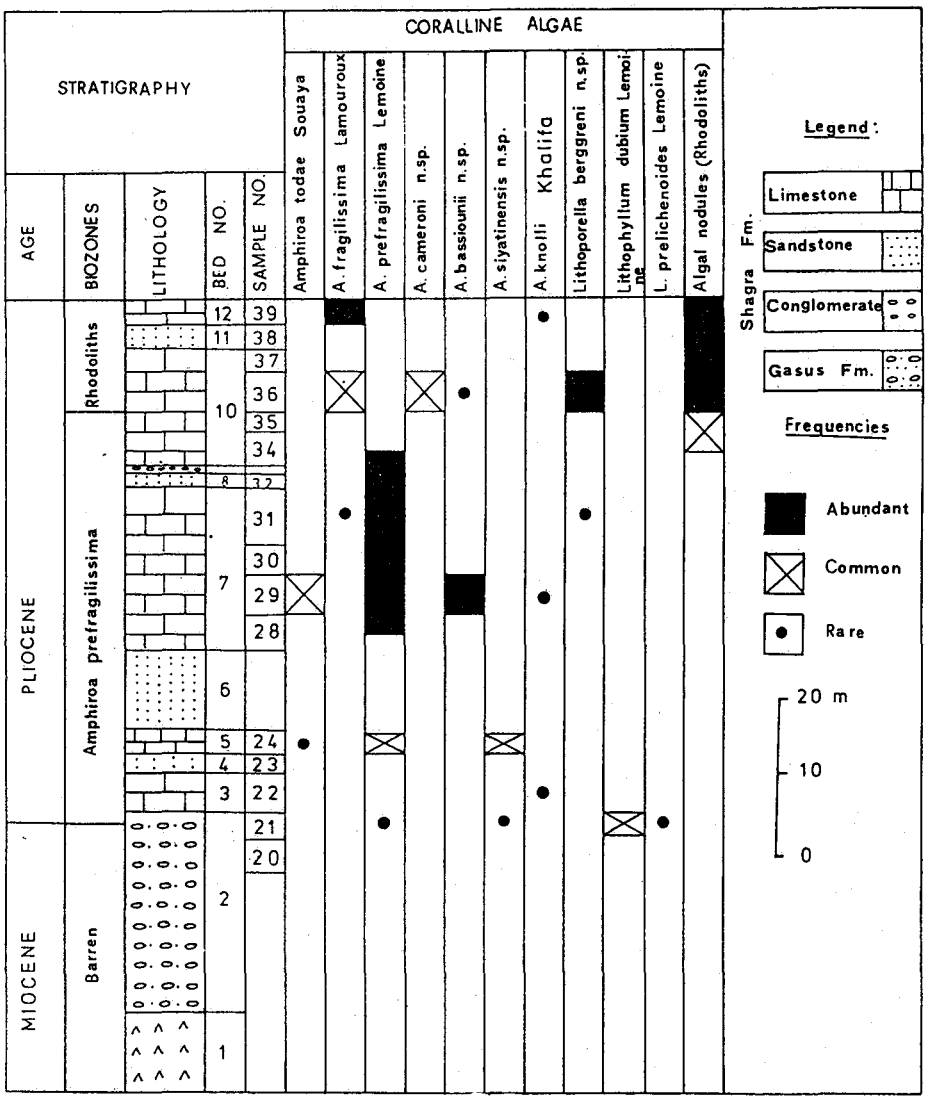

Fig. (3) Distribution chart of algae in Wadi El-Siyatin section

Phylum RHODOPHYCOPHYTA (Red Algae)
Class RHODOPHYCEAE
Order CRYPTONEMAILES
Family CORALLINACEAE (Coralline Algae)
Subfamily MELOBESIODEAE (Crustose Corraline Algae)
Genus LITHOPHYLLUM Philippi, 1837

Lithophyllum dubium Lemoine
(Pl. 3, fig. 3)

Lithophyllum dubium Lemoine, 1934, p. 282, fig. 13, Johnson & Kaska, 1965, p. 37-38, pl. 23, figs. 2,4.

Description: This form is represented by a single specimen consisting of regular crusts. The crusts are up to 2 mm thick and superimposed upon each other. They seem to be composed entirely of perithallium. Hypothallium is not distinct. The perithallium is characterised by long cells layers and short cells layers arranged according to the formula 1L - 1S. The perithallium is 1.9 mm thick and with pronounced horizontal partitions. The perithallium cells are rectangular, measuring 10μ-20$\mu$by 7μ-12μ. Conceptacles are not found.

Remarks: The Egyptian specimen shows close affinities to Lemonine's species which was described from the Carpathian and Greece.

Lithophyllum dubium Lemoine was previously recorded from the Upper Paleocene to Lower Eocene (Johnson & Kaska, 1965). In the present work, this taxon is described from the Pliocene succession, South of Safaga, Red Sea, Egypt.

Occurrence: Wadi El-Siyatin Section, Gasus Formation, Bed No. 2, Sample No. 21.

Lithophyllum cf. *L. prelichenoides* Lemoine
(Pl. 1, fig. 7)

Lithophyllum prelichenoides Lemoine, 1917, p. 262, text - figs. Lemoine, 1924, p. 280. - Lemoine, 1939, p. 99, text-figs. 65-66. - Johnson, 1957, p. 229, pl. 49, figs. 1-2. - Souaya, 1963a, p. 1212, pl. 161, figs. 2,6: pl. 162, fig. 2. - Johnson, 1964, p. 19.

Occurrence: Wadi El-Siyatin Section, Gasus Formation, Sample No. 21.

Lithophyllum sp.
(Pl. 3, fig. 4)

Description: A single specimen of a strongly branching form, 1.8 mm thick, is found. A branch consists of a thick medullary hypothallium surrounded by a well-developed marginal perithallium. Hypothallium is coaxial, varying between 0.8 mm and 1.0 mm in diameter. It is composed of arched layers of the regular type. The perithallium reaches up to 0.3 mm in diameter, with a layered or grid appearance. Rounded to elliptical cavities, probably conceptacles, are embedded in the marginal perithallic tissue.

Remarks: In general tissue structure, this form resembles *Lithophyllum* sp. Johnson & Kaska. However, the hypothallium of the latter species is composed of alternating layers of long and short cells. Despite the distinctive characteristics of our specimen, more complete specimens are needed for specific determination.

Occurrence: Wadi El-Siyatin Section, Gasus Formation, Bed No. 2, Sample No. 21.

Genus LITHOPORELLA Foslie, 1909

Lithoporella berggreni n.sp.
(Pl. 3, fig. 2)

Etymology: Named in honour of Dr. William Berggren, Woods Hole Oceanographic Institute, U.S.A.

Type locality: Wadi El-Siyatin, South of Safaga, Red Sea, Egypt (Fig. 1).

Occurrence: Shagra Formation, Bed Nos. 7, 10. Sample Nos. 31, 36.

Holotype: Pl. 3, Fig. 2; Sample No. 36.

Description: Our specimen consists of single-layered crusts representing basal hypothallium with no additional perithallium tissue. The crusts are superimposed one on top of the other. The hypothallium is composed of large (up to 65μ), vertically elongated cells. The perithallium is absent except around conceptacles where the thallus appears to be thicker and composed of several layers of small cells. The cells dimension of the hypothallic tissue range from 40μ to 100μ in length and 20μ to 45μ in width. The conceptacles are single-pored with tetraspores. They show great variation in their dimensions, 800μ-1200μ in diameter and 250μ-350μ in height.

Remarks: Most of the *Lithoporella* species which have been described from the Eocene to the Recent have been designated as *Lithoporella melobesioides*. Our specimens show more variation in cell and conceptacles size than the latter species and other *Lithoporella* species described in the literature.

Table (2) shows the measurements (in microns) of some species of *Lithoporella* as compared to our studied specimens.

Table (2)

Species	Sample No.	Cell dimensions		Conceptacles	
		Length	Width	Diameter	Height
Lithoporella berggreni	31	40-55	20-25	800-900	250-300
(n.sp.)	36	75-100	35-45	1050-1200	320-350
**L. melobesioides* Foslie	25-85	15-30		600-1000	—
**L. atlantica* Foslie	32-60	18-40		500-800	—
**L. conjuncta* Foslie	36-55	14-30		400-800	

*Measurements after Johnson (1961, p. 51).

Subfamily CORALLINOIDEAE (articulated Coralline Algae)
Genus AMPHIROA Lamouroux 1812
Amphiroa fragilissima Lamouroux
(Pl. 1, fig. 5; pl. 3, fig. 1)

Amphiroa fragilissima Lamouroux. — Johnson, 1961, p. 70, pl. 14, fig. 5.

Description: Segments are elongate, flattened, tapering and are of nearly uniform width. The specimens are composed of tiers of hypothallium cells, surrounded by a very thin distinct layer of marginal perithallium. The coaxial hypothallium (medulla) is built of layers of long and short cells arranged according to the formula 5 long — 1 short. Long cells in the centre of the tiers commonly 30μ-50μ long and 8μ-10μ wide; short cells 10μ-15μ long and 5μ-10μ wide.

Remarks: The identified specimen compares well with the *Amphiroa fragilissima,* described by Johnson (1961) from the Pleistocene of Saipan. Johnson's specimen is composed mostly of thick perithallium, while our specimen includes branches of thin perithallium.

Occurrence: Wadi El-Siyatin Section, Shagra Formation, Bed Nos. 7, 10, 12, Sample Nos. 31, 36, 39.

Amphiroa prefragilissima Lemoine
(Pl. 1, figs. 1,2)

Amphiroa prefragilissima Lemoine, 1917, pp. 275-277, text — fig. 23 — Souaya, 1963 b, p. 256, pl. 3, figs. 5, 6.

Description: The specimens include fragments varying in length and reach up to 1.8 mm. The diameter of the branches range between 0.50 mm and 0.95 mm. The tissue is composed entirely of medullary coaxial hypothallium and outer marginal perithallium. The hypothallium cells form concentric arched layers of long and short cells. The cells layers are arranged according to the formula 5L or 4L - 1S. The long cells are rectangular, erect and straight in the central part and inclined or curved towards the periphery. They are higher in the centre and wider at the periphery.

Remarks: In most aspects this form fits the characteristics of the species described by Souaya (1963 b) from the Zug El-Bohar area in Egypt.

Occurrence: Wadi El-Siyatin, Gasus Formation, Bed No. 2, Sample No. 21; Shagra Formation, Bed Nos. 5, 7, Sample Nos. 24, 28-34.

Amphiroa toddae Souaya
(Pl. 1, figs. 3, 6)

Amphiroa toddae Souaya, 1963 b, p. 256, 258, pl. 3, figs. 1-3, 8.

Description: The specimens include fragments of branches which reach a length of 2.2 mm. Their thickness is usually small, varying between 0.18 mm and 0.50 mm. The thallus is composed mainly of regular hypothallic tissue. The medullary hypothallium consists of two types of cell layers, long cells alternate with short cells, arranged according to the formula 4L-1S. The rows of long cells are straight and their walls on the sides appear to be inclined or curved inward. The rows of the short cells are usually gently to well arched. In most of the specimens, which have no perithallium there is a very thin dermal layer of minimal unmeasurable cells. Conceptacles are not found.

Remarks: Our specimens fit Souaya's original description. Souaya (1963 b) documented this taxon from the Pliocene of the Zug El-Bohar area (Red Sea, Egypt).

Occurrence: Wadi El-Siyatin Section, Shagra Formation, Bed Nos. 5, 7, Sample Nos. 24, 29.

Amphiroa cameroni n.sp.
(Pl. 2, figs. 2,5,6)

Etymology: This species is named in honour of Dr. Barry W. Cameron, Professor of Geology, Boston University, U.S.A.

Type locality: Wadi El-Siyatin, see figure 1.

Occurrence: Shagra Formation, Bed No. 10, Sample No. 36.

Holotype: Pl. 2, Fig. 5, Sample No. 36.

Paratype: Pl. 2, Figs. 2,6, Sample No. 36.

Description: The examined samples include fragments of branches which vary in their length between 0.70 mm and 0.95 mm. Their diameter ranges between 250μ and 390μ. The tissue is composed entirely of medullary coaxial hypothallium and marginal perithallium. The hypothallium cells form an arched layer and it consists of long cells and short cells. They are arranged in rows following the formula 3L-1S. The cells of maximum length are found at the middle of each arch and decrease in length toward the peripheries. The long cells of the hypothallic tissue are rectangular, straight in the central part and inclined or curved inward on the sides. The short cells are also rectangular and more arched than the hypothallic cells. The perithallium varies in thickness between 0.05 mm and 0.08 mm, depending on the preserved part. It is layered with marginal conceptacles. The conceptacles are singlepored and elliptical in shape. The conceptacles dimensions are 200μ-250μ in diameter and 110μ-160μ in height. Detailed dimensional data are given in table (3).

Remarks: The type specimen has a very distinctive and characteristic structure of thallus and conceptacles. Among the many *Amphiroa* species described in the literature there is none which resembles it.

Table (3)

Measurements (in microns) and distribution of *Amphiroa cameroni* n.sp.

Sample No.	Maximum thickness of branch	Formula	Maximum hypothallium thickness	Maximum perithallium thickness	Hypothallium cells		Perithallium cells		Conceptacles	
					Length	Width	Length	Width	Diameter	Height
	250		200	50	20	10	8	6	200	110
35	270		210	60	18	8	6	5	210	130
		3L-1S								
	300		220	80	15	6	5	4	220	150
36	390		300	90	12	6	4	3	250	160

Amphiroa bassiounii n.sp.
(Pl. 1, figs. 4, 8)

Etymology: Named to honour Dr. M.A. Bassiouni, Professor of Geology, Ain Shams University, Cairo, Egypt.

Type locality: Wadi El-Siyatin section, see figure 1.

Occurrence: Shagra Formation, Bed Nos. 7, 10, Samples Nos. 29,36.

Holotype: Pl. 1, fig. 4; Sample No. 29.

Paratype: Pl. 1, fig. 8, Sample No. 36.

Description: This species includes fragments of branches which may reach 1.9 mm in length. Their diameter (width) is usually small, ranging from 0.25 mm to 0.35 mm. The crust consists of tiers of hypothallic cells, surrounded by a very thin layer of marginal perithallic cells. The perithallium, when present, is characterised by cells which are often neither clear in shape nor in arrangement. The axial meduallary hypothallium consists of two types of cells arranged according to the formula 2 long - 1 short (2L-1S), or 3 long - 1 short (3L-1S). The rows of long cells are either gently arched or straight or nearly so, whereas the tiers of the short cells are well arched or curved.

The long cells are usually rectangular, straight in the central part, and inclined or curved inward on the sides. Detailed dimensional data is given in table (4).

Table (4)

Measurements (in microns) and distribution of *Amphiroa bassiounii* n.sp.

Sample No.	Maximum thickness of branch	Formula	Maximum hypothallium thickness	Maximum perithallium thickness	Hypothallium cells		Perithallium cells	
					Length	Width	Length	Width
	250		200	50	15	10	12	8
29	275	2L-1S	250	25	18	8	10	6
		or						
	300	3L-1S	280	20	16	6	8	5
36	350		340	10	14	5	6	4

Remarks: Wedge-shaped small diameter, thin perithallium, limited variation in the alternation formula (long cells and short cells), little variation in the size of the long cells in the same row and in the same specimen, are the characteristic features of this species.

Amphiroa siyatinensis n.sp.
(Pl. 2, figs. 1,7-9)

Etymology: Name derived from Wadi El-Siyatin, South of Safaga, Red Sea, Egypt.

Type locality: Wadi El-Siyatin section, see figure 1.

Occurrence: Gasus Formation, Bed No. 2, Sample No. 21; Shagra Formation, Bed No. 5, Sample No. 24.

Holotype: Pl. 2, Fig. 1; Sample No. 24.

Paratype: Pl. 2, Figs. 7-9; Sample No. 24.

Description: This species is represented by a number of branches which vary in their diameter

between 1.8 mm and 2.5 mm. The tissue is composed of well-developed hypothallium, perithallium and marginal conceptacles. The hypothallium is 800μ-1500μ thick and has a regular concentric coaxial structure. The coaxial hypothallium consists of two types of cells layers arranged in rows forming three rows of long cells layers alternating with one row of short cells. The rows of the short cells are more arched or curved than the rows of the long cells. The long cells are rectangular and their height may be relatively small on the sides, whereas their width may sometimes be larger than the height. These cells are straight in the central part and inclined or curved towards the interior on the sides.

Perithallium is usually thicker than hypothallium, with strong growth zones. It is layered and with marginal or lateral conceptacles in position. The conceptacle chamber (single-pored conceptacles) is oval to semirounded in shape and measures about 150μ-250μ in diameter and 100μ-150μ (height). Detailed dimensional data are given in table (5).

Remarks: The peculiar structure of the hypothallium with its long cells, and the very thick perithallic tissue with its marginal conceptacle are the characteristic features of the species. The appearance is different from any other Tertiary species known to the writer.

Table (5)
Measurements (in microns) and distribution of *Amphiroa siyatinensis* n. sp.

Sample No.	Maximum thickness of branch	Formula	Maximum hypothallium thickness	Maximum perithallium thickness	Hypothallium cells		Perithallium cells		Conceptacles	
					Length	Width	Length	Width	Diameter	Height
19	1800	3L-1S	800	1000	18	10	12	10	150	100
	1900		1000	900	16	8	10	8	180	120
21	2000		1200	800	12	6	8	7	200	129
	2500		1500	1000	10	6	6	5	250	150

Amphiroa knolli Khalifa & Boukhary
(Pl. 1, fig. 9)

Amphiroa knolli Khalifa & Boukhary, 1982, p. 218, pl. 1, figs. 3-5.

Description: The examined material includes fragments of branches which reach up to 1.5 mm length. Their width varies between 0.3mm and 0.7 mm. Branching is typically pinnate (dichotomous to trichotomous). The cellular tissue is composed of tiers of medullary hypothallium surrounded by a thin marginal perithallium. The meduallary hypothallium is coaxial and consists of layers of long and short cells following the formula 2L-1S or 1L-1S. The long cells are rectangular in shape and their height appears to be smaller on the sides. The walls of the cell layers appear to be gently arched in the central part and more curved on the peripheries. The characteristic feature of which is the presence of lateral branches originating from the main one. The lateral branches show regular rows of cell layers following the formula 1L-1S.

Remarks: This species was previously described by Khalifa and Boukhary (1982) from the Pliocene succession of Mersa Alam (Red Sea, Egypt). Our specimen is here reported from the Pliocene succession of the area south of Safaga (Red Sea, Egypt).

Occurrence: Shagra Formation, Bed Nos. 3, 7, Sample Nos. 22, 29.

Amphiroa sp. A
(Pl. 2, figs. 3, 4)

Description: Segments up to 1.5 mm long and 0.8 mm wide. Each segment consists of a well-developed medullary hypothallium surrounded by a thick marginal perithallium. The hypothallium is coaxial, composed of regularly alternating rows of long cells and short cells. Long cells are 50μ-75μ long by 15μ-25μ wide. Short cells range between 20μ and 30μ in length and 10μ to 15μ in width. Conceptacles were not observed.

Remarks: Specific determination was not attempted because of the poor preservation of the specimens.

Occurrence: Wadi Abu Hamra El-Bahari Section, Shagra Formation, Sample No. 47.

Amphiroa sp. B
(Pl. 3, fig. 5)

Description: A single specimen composed of a wedge-shaped branch, 2 mm in length and 0.6 mm in width. The thallus is composed of well-developed hypothallium and perithallium. The hypothallium is coaxial, composed of cell layers arranged according to the formula 2L-1S. There are no conceptacles.

Remarks: Although there is some resemblance to *Amphiroa* species A, the tissue of the latter species is different in shape and cell size.

Occurrence: Wadi Abu Shiqeili El-Bahari Section, Shagra Formation, Sample No. 70.

REFERENCES

ADEY, W.H. and **H.W. JOHANSEN.** 1972. Morphology and Taxonomy of Corallinaceae with special reference to Clathromorphum, *Mesophyllum,* and *Neopolyporolithon* gen. nov. (Rhodophyceae, Cryptonemiales). Phycologia, 11(2): 159-180.

ADEY, W.H. and **I.G. MACINTYRE.** 1973. Crustose coralline algae: a revaluation in the geological sciences. Geol. Soc. Am. Bull., 84(3): 883-904.

AKKAD, S. and **A.A. DARDIR.** 1966. Geology of the Red Sea Coast between Ras Shagra and Mersa Alam, Egypt, Geol. Surv., Paper 35: 67 pp.

BEADNELL, H.J.L. 1924. Report on the geology of the Red Sea Coast between Quseir and Wadi Ranga, Egypt. Min. Fin., Cairo, (Petrol. Research Ser.), Bull., 13: 37 pp.

BOSSELINI, A. and **R. GINSBURG.** 1971. Form and internal structures of Recent algal nodules (rhodolites) from Bermuda, J. Geol., 79(6): 669-682.

COX, L.R. 1929. Notes on the Miocene Ostreadae and Pectinidae of the Red Sea region, with remarks on the geological significance of their distribution. Malac. Soc., 18: 165-209.

EL-HADDAD, A. 1979. Geological studies on the Miocene and Younger sediments south of Safaga, Red Sea, Egypt. M.Sc. thesis, Assiut University, Faculty of Science, Egypt, 169 pp.

FLUGEL, E. 1977. Fossil Algae. Springer-Verlag, Berlin, New York, 375 pp.

GINSBURG, R., R. REZAK and **J.L. WRAY.** 1971. Geology of calcareous algae (notes for short courses). Comparative Sediment. Lab., Univ. Miami, 64 pp.

HUME, W.F. 1916. Report on oilfields regions of Egypt. Egypt, Surv. Dept., Cairo, 103 pp.

JOHNSON, J.H. 1957. Bibliography of fossil algae: 1942-1955. Colorado School Mines Quart., 52(2): 92 pp.

JOHNSON, J.H. 1961. Limestone — building algae and algal limestones. Colorado School Mines, 297 pp.

JOHNSON, J.H. 1962. The algal genus *Lithothamnium* and its fossil representatives. Colorado School Mines Quart., 57(1): 111 pp.

JOHNSON, J.H. 1964. Paleocene calcereous red algae from northern Iraq. Micropaleontology, 10(4): 477-485.

JOHNSON, J.H. 1965. Three Lower Cretaceous algae new to the Americas: Jour. Paleontology, 39: 719-720.

JOHNSON, J.H. 1969. A review of the Lower Cretaceous algae. Colorado School Mines Prof. Contrib., 4: 71 pp.

JOHNSON, J.H. and **H.V. KASKA.** 1965. Fossil algae from Guatemala. Colorado School Mines Prof. Contrib. 1: 152 pp.

KHALIFA, H. and **M. BOUKHARY.** 1982. Coralline Algae from the Neogene and Pleistocene of Mersa-Alam, Red Sea, Egypt. Qatar Univ. Sci. Bull. 2(1): 209-223.

LEMOINE, MME. PAUL. 1917. Contribution a L'etude des Corallinacae fossiles. I. Generalites sur la structure de corallinacees. Soc. Geol. France Bull., 4^{e}ser'., 17. 223-240.

LEMOINE, MME. PAUL. 1924. Melobesiees miocenes recueillies par M. Bourcat en Albanie: Soc. Geol. France Bull., ser. 4, 23(5-6): 275-283.

LEMOINE, MME. PAUL. 1934. Algues calcaires de la famile des Corallinacees recueillies dans les Carpathes occidentales par M.D. Andrusov: Czechoslovakia, Statni Geol. Ustav. Vestnik, 9(5): 269-289.

LEMOINE, MME. PAUL. 1939. Les algues calcaires fossiles de L'Algerie. Materiaux pour la Carte geol. de L'Algerie, ser. 1, Paleontologie, 9: 128.

MILLIMAN, J.D. 1974. Marine carbonates. Springer — Verlag, Berlin, 375 pp.

PAPENFUSS, G.F. 1955. Classification of the algae: a century of progress in the natural science 1853-1953. Calif. Acad. Sci., San Francisco, 115-224.

SAID, R. 1962. The geology of Egypt. Elsevier Pub. Co., Amsterdam, New York, 377 pp.

SOUAYA, F.J. 1963a. On the calcareous algae (Melobesioideae) of Gebel Gharra (Cairo — Suez road) with a local zonation and some possible correlations. Jour. Paleont . 37(6): 1204-1216.

SOUAYA, F.J. 1963b. Micropaleontology of four sections south of Quseir, Egypt. Micropaleontology, 9(3): 233-266.

STAINFORTH, R.M. 1949. Foraminifera in the Upper Tertiary of Egypt. Jour. Paleont., 23: 419-422.

WARING, G.A. and **T. JONES.** Geology of the Red Sea Coast of Egypt, between north lat. 25°40 and 23°30. Unpublished report Socony Vacuum Oil Co. Inc.

WRAY, J.L. 1977. Calcareous algae. Elsevier Publ. Co., Amsterdam, New York, 185 pp.

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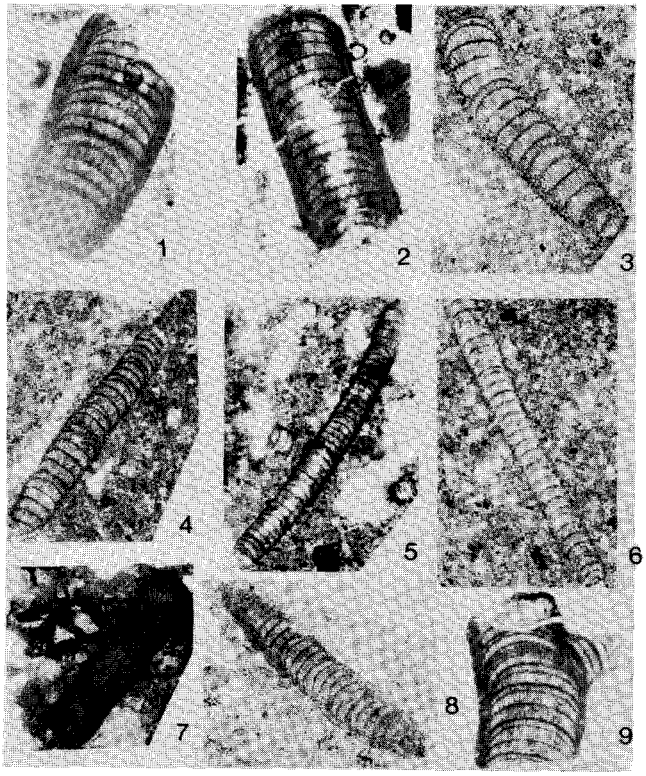


Explanation of plate 1

Figures:

1, 2. *Amphiroa prefragilissima* Lemoine.
Vertical section of a branch showing coaxial hypothallium and perithallium, X 50, 2, holotype.

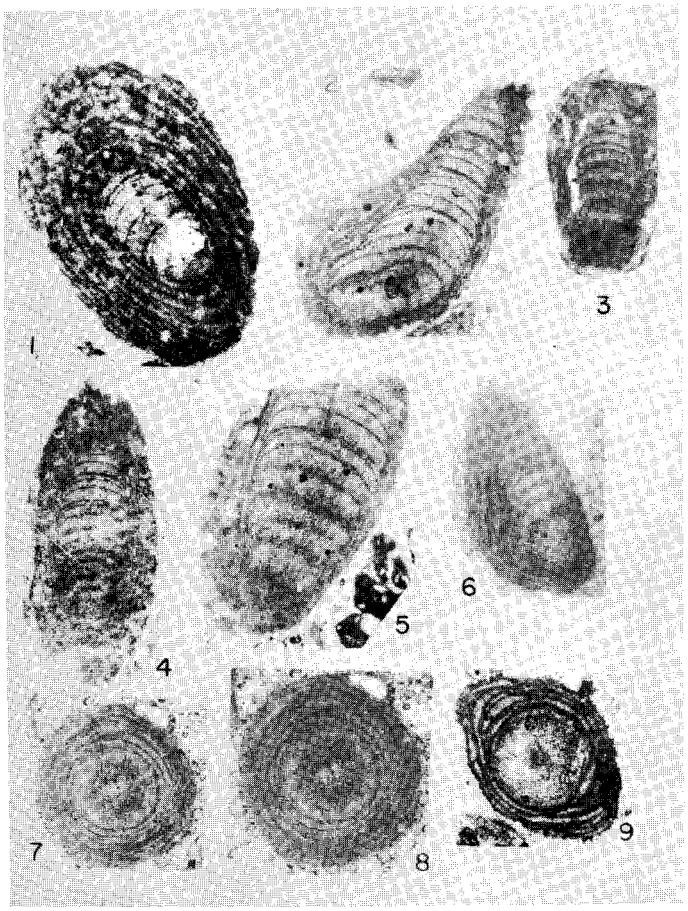
3, 6. *Amphiroa toddae* Souaya
Vertical section showing well-developed coaxial hypothallium with alternating layers of long and short cells, X 40.

4, 8. *Amphiroa bassiounii* n.sp.
Sect on through branch showing well-developed medullarly hypothallium with layers of long and short cells, X 50, 4, holotype.

5. *Amphiroa fragilissima* Lamouroux.
Section showing medullarly hypothallium with layers of long and short cells, X 50, holotype.

7. *Lithophyllum* of. *L. prechenoides* Lemoine
Section through branch, X 40.

9. *Amphiroa knolli* Khalifa & Boukhary.
Vertical section of branch composed of hypothallium and perithallium, X 50.



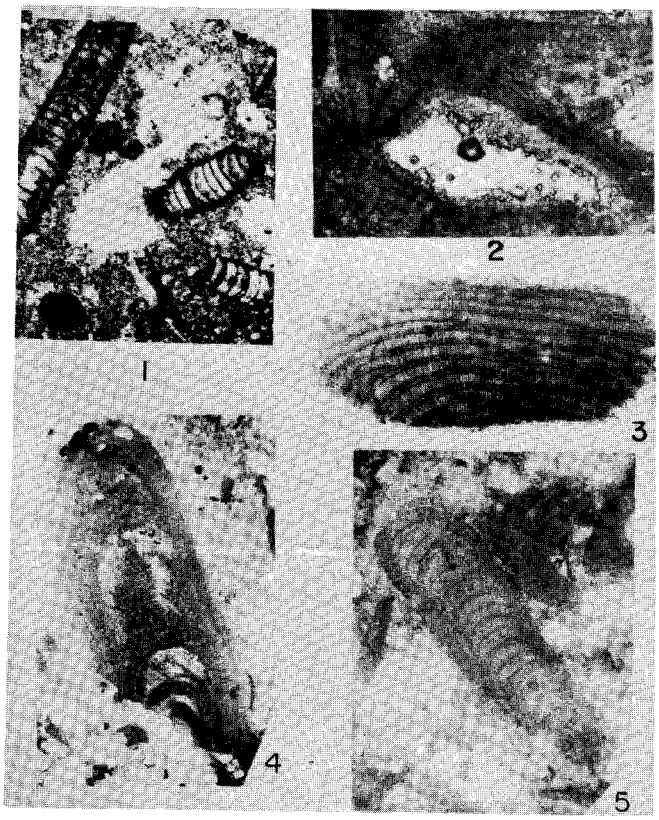
Explanation of plate 2

Figures:

1,7,8,9. *Amphiroa siyatinensis* n.sp.
Oblique vertical sections showing hypothallium and thick perithallium, X 50, 7,8,9, slightly oblique section showing thick marginal perithallium with marginal elliptical conceptacles, X 40, 1, holotype.

3,4. *Amphiroa* sp. A.
Vertical sections with hypothallium and outer marginal perithallium, X 50.

2,5,6. *Amphiroa cameroni* n.sp.
Slightly oblique vertical sections showing hypothallium and perithallium with marginal elliptical conceptacles, X 60, 5, Holotype.



Explanation of plate 3

Figures:

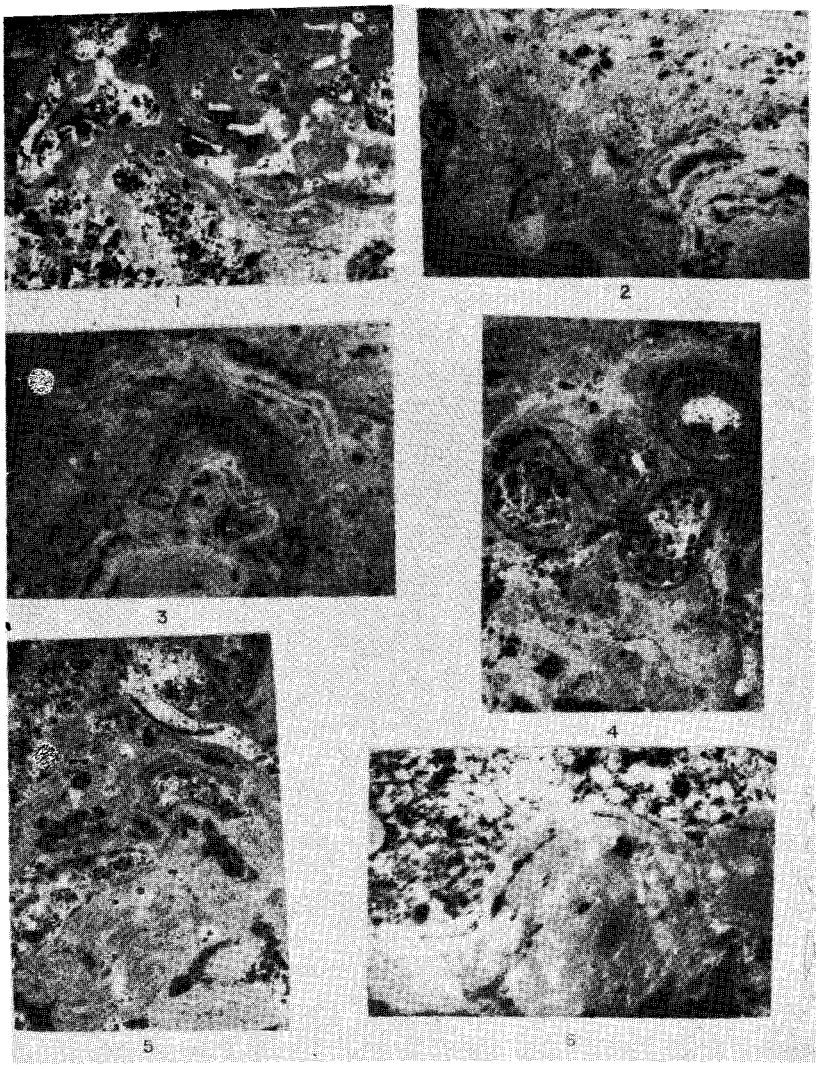
1. *Amphiroa fragilissima* Lamouroux
Photomicrograph of thin section showing zone rich in *Amphiroa fragilissima,* X 40.

2. *Lithoporella berggreni* n.sp.
Section of superimposed thalli with conceptacles, X 100.

3. *Lithophyllum dubium* Lemoine
Section showing perithallic tissue with regular horizontal layering and cross-partitions, X 40. Hypothallium was not observed.

4. *Lithophyllum* sp.
Vertical section with hypothallium and perithallium, X 50.

5. *Amphiroa* sp. B.
Section through branch showing layers of long and short cells in the hypothallic tissue and perithallium, X 50.



Explanation of plate 4

Figures:

1,2. Thin sections in algal nodule (rhodolith), probably showing *Lithothamnium,* X 10; Wadi E. Siyatin section, Shagra Formation, Bed No. 10, Sample No. 37.

3. Thin section in algal nodule (rhodolith) showing *Archaeolithothamnium,* X 10; Wadi El-Siyatin section, Shagra Formation, Bed No. 10, Sample No. 36.

4. Thin section in rhodolith showing *Lithophyllum,* X 10; Wadi El-Siyatin section, Shagra Formation, Bed No. 10, Sample No. 36.

5,6. Polished surface sections in rhodoliths made up of successive layers of corallines, X 4; Wadi El-Siyatin section, Shagra Formation, Bed No. 12, Sample No. 39.

طحالب البليوسين الكورالية ، جنوب سفاجة (البحر الأحمر ، مصر)

حامد خليفة محمد

أسفرت الدراسات المعملية والميكروسكوبية لقطاعات صخور البليوسين الواقعة جنوب سفاجة (البحر الأحمر) على تصنيف وتعريف ووصف ثلاثة عشر نوعاً تنتمى لشعبة الطحالب الحمراء المتحفرة . من هذه الأنواع وصفت أربعة أنواع جديدة هى :

Lithoporella berggreni (n . sp) , Amphiroa bassiounii (n . sp) , Amphiroa cameroni (n . sp) , Amphiroa siyatinensis (n . sp .)

وبناء على المحتوى الأحفورى (الطحالب الكلسية الحمراء) في التتابع الطبقي الممثل في المنطقة - أمكن التعرف على نطاقين حيويين - وباستخدام هذه الأنواع الموصوفة ومضاهاتها بمثيلاتها في أماكن أخرى من العالم أمكن تحديد عمر هذه الصخور الحاوية لها بأنها تتبع عصر البليوسين .