

Fossil Algae and Biostratigraphy of the Middle Eocene Rock Succession at the Southeast of Minia, Nile Valley, Upper Egypt

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ABSTRACT. Twelve species of fossil algae recorded, here for the first time, from the Middle Eocene rocks of the area southeast of Minia, Nile Valley, Upper Egypt, are systematically studied. Five of these species belong to the red algae (Rhodophycophyta: families Corallinaceae and Solenoporaceae). Other six species belong to the green algae (Chlorophycophyta: families Codiaceae and Dasycladaceae) and one species of uncertain affinities.

The distribution of the microfossil content, namely larger foraminifera and algae, of the Middle Eocene (Lutetian) rock succession lead to the recognition of five biozones through this section, of which two zones are established on the basis of floods of algal species.

Paleontologic and biostratigraphic studies of the Middle Eocene rocks of the area lying to the southeast of Minia, Nile Valley, Upper Egypt, have been reported by many authors (*e.g.*, Cuvillier 1930, Bishay 1961, Krasheninnikov and Ponikarov 1964, Fahmy *et al.* 1969, Andrawis 1970 and El-Boukhary 1970, 1973). None of these references, however, includes detailed study of the fossil algal microflora of the area concerned. Here is the first attempt at a detailed paleontologic and biostratigraphic study of the microfloral content of the Middle Eocene succession exposed between long. 30°50' - 31°05' E and lat. 27°50' - 28°00' N on the eastern side of the Nile Valley southeast of Minia city. For this purpose, 160 rock samples were collected from four stratigraphic sections located along Wadi El-Meshag-gig (Fig. 1). The stratigraphic sequence of the Middle Eocene section at these localities could be differentiated into the following lithologic units, from oldest to youngest, following the classification introduced by Said (1962), Bishay (1966) and Keheila (1978).

- A) Minia Formation (hard clastic calcarenitic limestone with alveolines; Early Lutetian).
- B) Samalut Formation:
- 1- Meshag-gig Member (chalky, thinly-bedded nummulitic limestone; Early Lutetian).
 - 2- Beni Khaled Member (massive to bedded nummulitic limestone crowded with large *Nummulites gizehensis* and coralline algae; Late Lutetian).

The rock samples studied representing the different rock units of the four sections include a series of microfossil assemblages composed mainly of calcareous algae and larger foraminifera. The distribution of the microbiota (Fig. 2) allows the division of these well-defined lithologic units into five biozones. The biozones (Fig. 3) from base are: (1) The *Ovulites moreletti* Zone (oldest), (2) The *Alveolina frumentiformis* Zone, (3) The *Halimeda praemonilis* Zone, (4) The *Nummulites brongniarti* Zone and (5) The *Nummulites gizehensis*/*Archaeolithothamnium rude* Zone.

(1) *Ovulites moreletti* Zone

The *Ovulites moreletti* Zone is described here, for the first time, from the Middle Eocene of the study area. The base of the zone is defined by the first

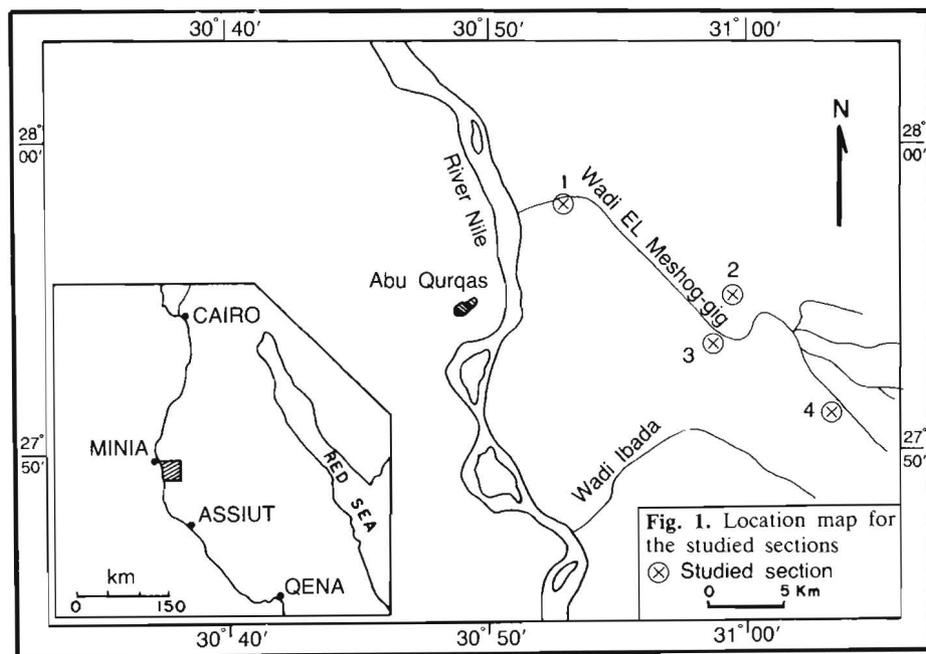


Fig. 1. Location map for the studied sections
 ⊗ Studied section
 0 5 Km

appearance and abundance of the species *Ovulites morelleti* Elliott. The frequency of this taxon ranges from 32.5 to 36% of the bulk of the rock samples, whereas the other taxa, including *Carpathoporella occidentalis* Dragastan, *Neomeris johnsoni* Khalifa, *Neomeris* sp. and *Alveolina frumentiformis* Schwager, are less frequent (3.5 - 10%). This zone occupies the lower part of the Minia Formation and is conformably overlain by the *Alveolina frumentiformis* Zone, as recorded from only one of the four sections, namely no. 1, in the northwestern part of the area (Figs. 1 & 2).

The age of *Ovulites morelleti* Zone is determined here as Early Lutetian on the basis of its stratigraphic position in relation to the conformably overlying *Alveolina frumentiformis* Zone which is allocated to the Early Lutetian in the area studied as well as many other areas in Egypt (Said 1962, 1963, Bishay 1966 and Kenawy *et al.* 1977). Furthermore, the zone-marker namely, *Ovulites morelleti* Elliott, is known from the Early Lutetian rocks of the Middle East, Iraq (Elliott 1955, 1957). Moreover, *Carpathoporella occidentalis* Dragastan is recorded from Lutetian rocks of Nevada (Johnson 1954, Dragastan 1967).

(2) *Alveolina frumentiformis* Zone

The *Alveolina frumentiformis* Zone has been previously described by Bishay (1961, 1966). It is here defined by the occurrence of floods of the index taxon, *Alveolina frumentiformis* Schwager (which first appears in the *morelleti* Zone) and the disappearance of the calcareous algal species which characterize the conformably underlying zone. The faunal assemblage of the *Alveolina frumentiformis* Zone comprises abundant specimens of *Nummulites lucasi* d'Archiac & Haime *N. variolarius* (Lamarck), *N. irregularis* Deshayes, and *Alveolina* sp. Its thickness varies from 1.5 m (section 3) to 29 meters (Fig. 3).

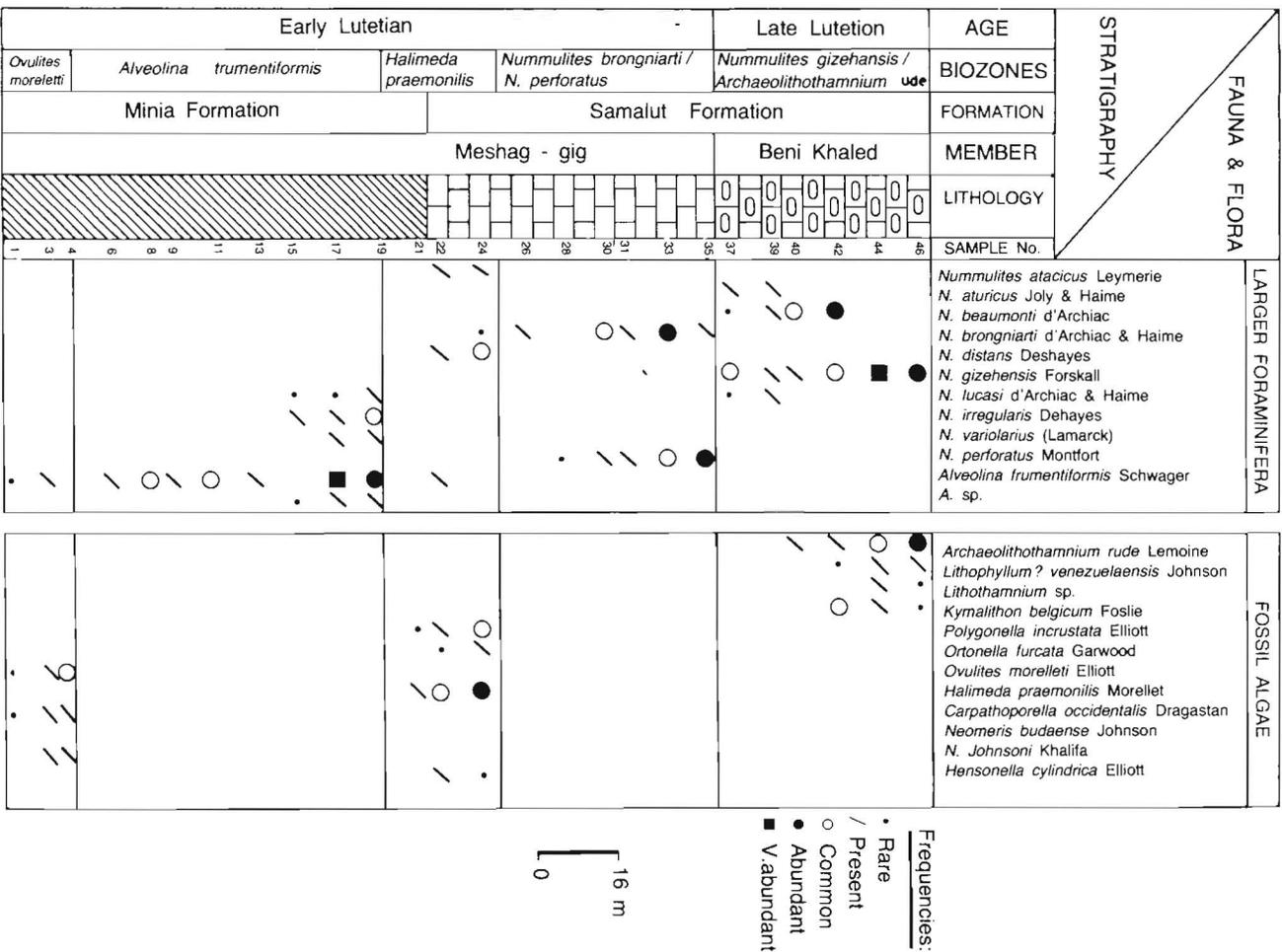
The age of the marker species of this zone, *Alveolina frumentiformis* Schwager has been recorded as Early Lutetian by many authors in different parts of Egypt including the area of the present study (Said 1962, Bishay 1966 and Kenawy *et al.* 1977). Moreover, *Nummulites lucasi* d'Archiac & Haime and *N. irregularis* Deshayes were determined as Early Lutetian by Blondeau (1972).

The *Alveolina frumentiformis* Zone, as defined in the present study is, therefore, allocated to the Early Lutetian.

(3) *Halimeda praemonilis* Zone

The *Halimeda praemonilis* Zone is introduced here for the first time in the biostratigraphy of the Middle Eocene of the Nile Valley, Egypt. The base of this zone is marked by the first appearance of the index species *Halimeda praemonilis* Morellet which occurs in floods just above its first appearance, and the disappearance or rarity of the marker species of the underlying *Alveolina frumentiformis* Zone. The characteristic algal assemblage of this zone is dominated by the following species: *Ortonella furcata* Garwood, *Polygonella incrustata*

Fig. 2. Distribution Chart of the Algal Microflora and Larger Foraminifera of the Eocene Rocks, Southeast of Minia, Nile Valley.



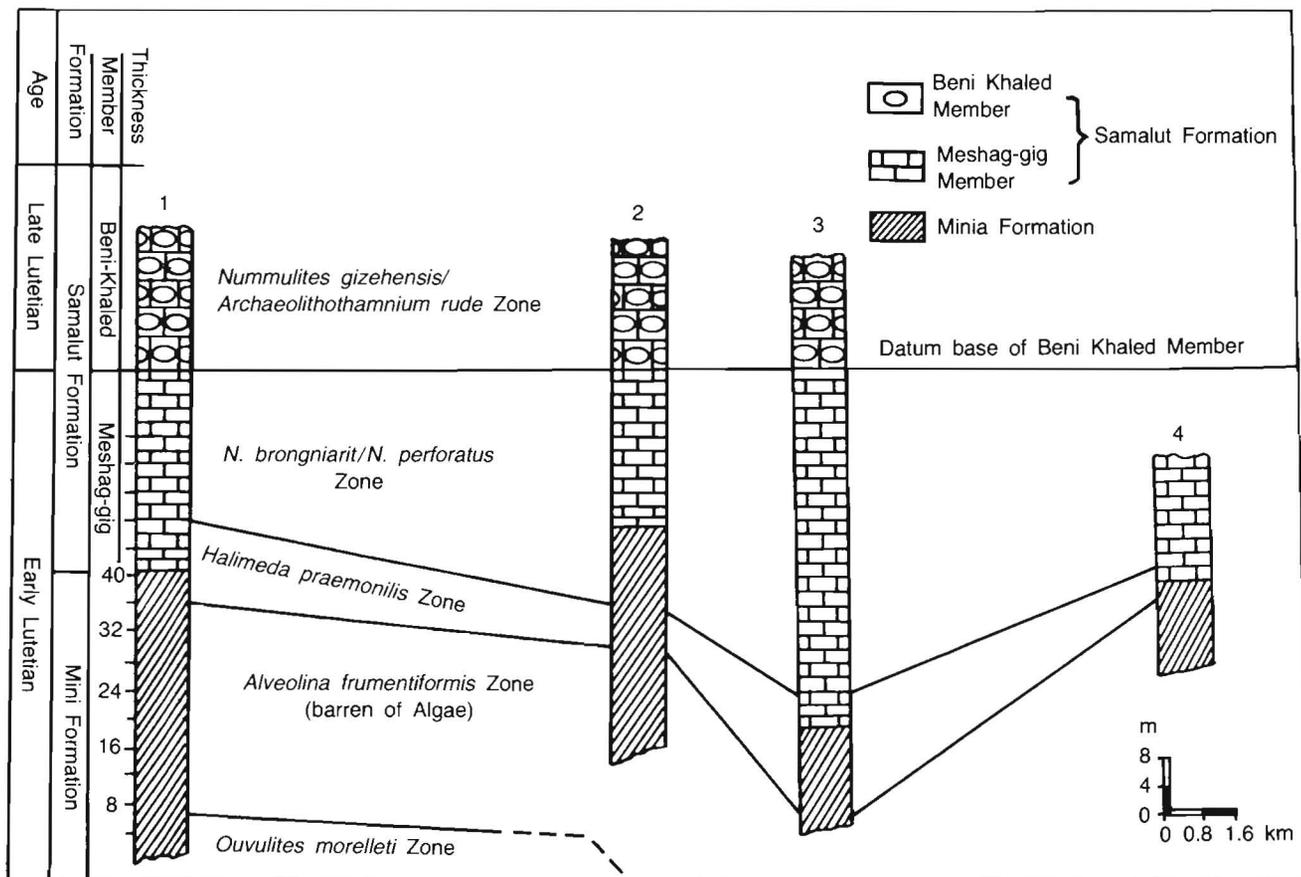


Fig. 3. The Florizones and the Faunizones in the Area
 Southeast of Minia

Elliott, *Hensonella cylindrica* Dragastan, together with algal plates (phylloid algae), micrite envelops and algal oncolites. Besides, larger foraminifera such as *Nummulites ataticus* Leymerie, *N. lucasi* d'Archiac & Haime, *N. globulus* Leymerie, *N. distans* Deshayes and very rare specimens of *Alveolina frumentiformis* Schwager are also present.

The *Halimeda praemonilis* Zone is confined to the upper part of the Minia Formation and the basal part of the Samalut Formation (Meshag-gig Member). It shows lateral variation in thickness from 16 meters to one meter (Fig. 3). This zone conformably underlies the *Nummulites brongniarti/Nummulites perforatus* Zone.

Halimeda praemonilis Morelet has been described from the Middle Eocene (Early Lutetian) sections of the Middle East (Elliott 1955, Johnson 1961). Moreover, *Nummulites lucasi* d'Archiac & Haime, *N. distans* Deshayes and *Alveolina frumentiformis* Schwager have been reported from the Middle Eocene (Early Lutetian) rocks of Egypt and elsewhere (Said 1962, 1963, Bishay 1966, Blondeau 1972 and Kenawy *et al.* 1977).

Accordingly, the *Halimeda praemonilis* Zone, as defined in the present study is assigned to the Early Lutetian.

(4) *Nummulites brongniarti/Nummulites perforatus* Zone

This zone has been previously discussed by Kenawy *et al.* (1977) from the Middle Eocene succession located north of the area studied. It is characterized by the abundance of *Nummulites brongniarti* d'Archiac & Haime and *N. perforatus* Montfort. In this zone *Nummulites irregularis* Deshayes, *N. ataticus* Leymerie and *N. aturicus* Joly & Leymerie are also encountered. It is here recognized in the lower part of Samalut Formation (Meshag-gig Member) with lateral thickness variation from 22 meters to 46 meters.

The lower limit of this zone is marked by the complete disappearance of the fossil algae represented in the underlying *Halimeda praemonilis* Zone, whereas its upper boundary is defined by the first occurrence of the coralline algae in the overlying zone (Figs. 2 & 3).

The *Nummulites brongniarti/Nummulites perforatus* Zone and its foraminiferal assemblages have been cited from the Middle Eocene sections of the Nile Valley (Bishay 1961, 1966 and Kenawy *et al.* 1977).

(5) *Nummulites gizehensis/Archaeolithothamnium rude* Zone

Nummulites gizehensis/Archaeolithothamnium rude Zone is recorded here for the first time in the biostratigraphy of the Middle Eocene succession of Egypt. This zone is characterized by floods of *Nummulites gizehensis* (Forskal), whose tests build up about 44% of the rock samples and the coralline algae assemblage, among which *Archaeolithothamnium rude* Lemoine is the most abundant, constituting about 34% of the bulk of rock sample. A fauni - flori - zone is, therefore, here

erected. It is characterized by the following assemblages, besides the zone - markers: *Nummulites lucasi* d'Archiac & Haime, *N. beaumonti* d'Archiac, *N. aturicus* Joly & Leymerie, *Lithophyllum? venezuelaensis* Johnson, *Lithophyllum cf L. pfenderae* Lemoine, *Lithothamnium* sp. and *Kymalithon belgicum* Foslie.

The *Nummulites gizehensis/Archaeolithothamnium rude* Zone coincides with the upper part of the Samalut Formation (Beni Khaled Member). It measures more than 32 meters in thickness.

Archaeolithothamnium rude has been reported from the Late Lutetian sections of Venezuela and North America (Johnson 1969).

Nummulites gizehensis has been previously described as an index taxon of the Late Lutetian in sections in the Nile Valley and elsewhere (Bishay 1961, 1966, Said 1963, El-Boukhary 1970, 1973 and Kenawy *et al.* 1977). Thus, the age of the *Nummulites gizehensis/Archaeolithothamnium rude* Zone is Late Lutetian.

Systematic study of fossil algae

The following fossil calcareous algae are recorded here for the first time from the Middle Eocene (Lutetian) rocks, namely, the Minia and Samalut Formations.

The classification scheme followed is that proposed by Papenfuss (1955), later modified by Johnson (1961).

Table 1:

Phylum	Family	Genera & Species
Rhodophycophyta (Red algae)	Corallinaceae	<i>Archaeolithothamnium rude</i> Lemoine <i>Lithophyllum? venezuelaensis</i> Johnson <i>Lithothamnium</i> sp. <i>Kymalithon belgicum</i> Foslie
	Solenoporaceae	<i>Polygonella incrustata</i> Elliott
Chloro- phycophyta (Green algae)	Codiaceae	<i>Ortonella furcata</i> Garwood <i>Ovulites morelleti</i> Elliott <i>Halimeda praemonilis</i> Morellet
	Dasycladaceae	<i>Carpathoporella occidentalis</i> Dragastan <i>Neomeris budaense</i> Johnson <i>Neomeris johnsoni</i> Khalifa
Fossils of uncertain affinities		<i>Hensonella cylindrica</i> Elliott

Family Corallinaceae (Coralline Algae)
Genus *Archaeolithothamnium* Rothpletz, 1891
Archaeolithothamnium rude Lemoine
(Plate 2, Figure 2,4)

1969 *Archaeolithothamnium rude* Lemoine; Johnson, pp. 8 & 114, Figs. 1-3).

Description:

Thallus compact, formed of rows of rectangular cells. The cross-partitions, which separate the cells in a vertical row, are usually thinner and less conspicuous than the vertical cell walls. The tissue is differentiated into a hypothallus and a perithallus. The hypothallus is composed of curved rows of cells and is commonly relatively thin and sometimes represented by only a few layer of cells. However, many strongly branching forms have a well developed medullary hypothallus of strongly arched layers of cells. The most distinctive feature of the species is the fact that the sporangia are not collected into conceptacles but are isolated in the tissue as individuals, in rows, or layers.

Occurrence:

Beni Khaled Member of the Samalut Formation (Fig. 2), upper Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Lithophyllum* Philippi, 1837
Lithophyllum? venezuelaensis Johnson
(Plate 2, Figure 5)

1969 *Lithophyllum? venezuelaensis* Johnson, p. 111, Pl. 5, Figs. 1-3.

Description:

The tissue is clearly divided into a basal hypothallus and an upper perithallus. The hypothallus characteristically is coaxial, that is, formed of regularly curved or arched layers of cells. It also consists of cell threads with prominent cross partitions occurring at the same level, producing a fairly regular tissue. The sporangia are collected into conceptacles.

Occurrence:

Beni Khaled Member of the Samalut Formation (Fig. 2), upper Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

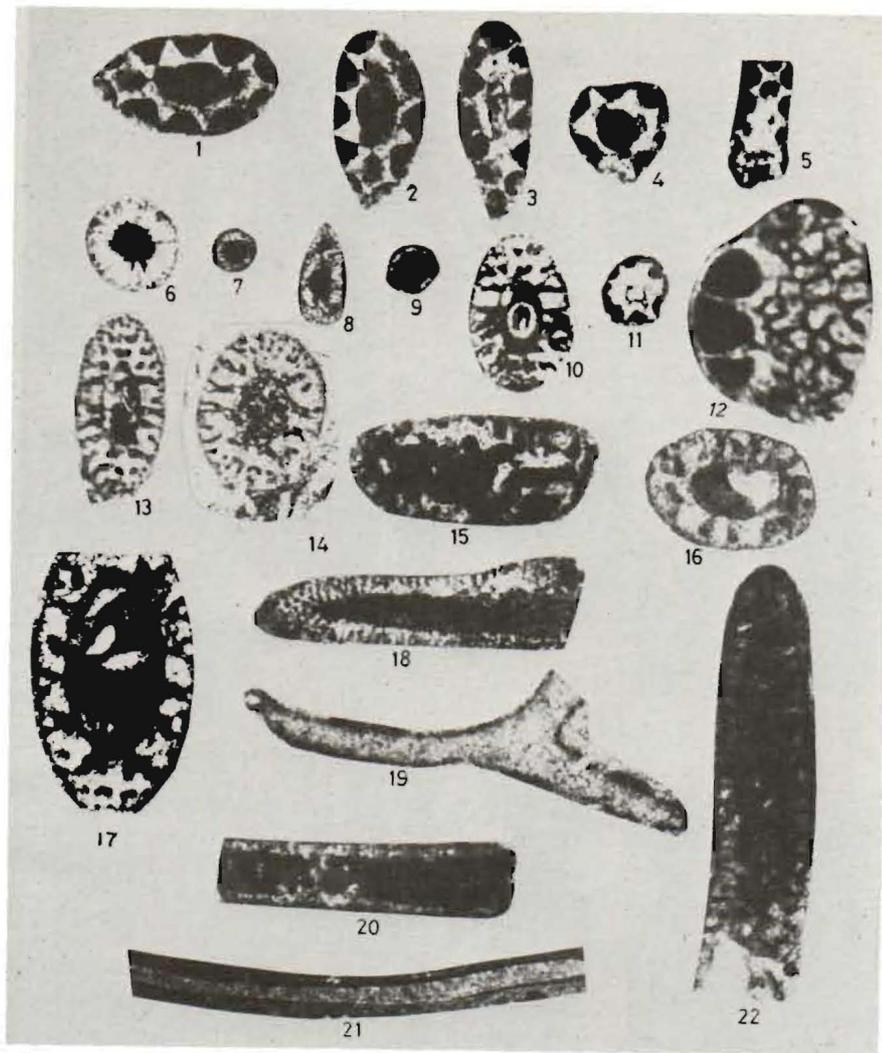


Plate 1.

- (1-5, 11) *Carpathoporella occidentalis* Dragastan, 1,2,3,5 oblique transverse sections; 4,11, cross sections. All $\times 50$.
 (6-9) *Ovulites moreletii* Elliott. Transverse section ($\times 50$).
 (10) *Neomeris johnsoni* Khalifa. Transverse section ($\times 20$).
 (12) *Polygonella incrustata* Elliott. Transverse section ($\times 60$).
 (13,14) Transverse sections, probably *Belzungia* ($\times 30$).
 (16,17) *Neomeris budaense* Johnson, 16, 17. Transverse sections ($\times 30$).
 (15,20,22) *Halimeda praemonilis* Morellet. Longitudinal section ($\times 25$).
 (18) *Hensonella cylindrica* Elliott. Oblique section ($\times 30$).
 (19) *Ortonella furcata* Garwood. Section of large growth showing the character of branching ($\times 50$).
 (21) Algal plate (*Phylloid alga*), $\times 50$.



Plate 2. 7

- (1,8) *Lithothamnium* sp. Vertical sections showing conceptacles, hypothallus and perithallus ($\times 15$).
- (2,4) *Archaeolithothamnium rude* Lemoine. Nearly vertical sections showing tissue of well-developed hypothallus, perithallus and sporangia ($\times 25$).
- (3,6) *Carpathaporella occidentalis* Dragastan. Nearly oblique transverse sections ($\times 50$).
- (5) *Lithophyllum? venezuelaensis* Johnson. Nearly vertical sections ($\times 50$).
- (7,9) *Kymalithon belgicum* Foslie. Oblique longitudinal sections with hypothallus, perithallus, and sporangia developed in perithallic tissue ($\times 25$).

Genus *Lithothamnium* Philippi, 1837*Lithothamnium* sp.

(Plate 2, Figures 1,8)

Description:

Thallus crustose with a relatively thick hypothallus and a much thinner perithallus. Hypothallus having a thick layer of curved cell threads. Cells show an unusual size variation: length 15-29 μ width 10-15 μ , Perithallus relatively thin with cells 8-10 μ long and 8-10 μ wide. Individual sporangia of different sizes and shapes also occur.

Occurrence:

Beni Khaled Member of the Samalut Formation (Fig. 2), upper Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Kymalithon* Lemoine, 1967*Kymalithon belgicum* Foslie

(Plate 2, Figures 7,9)

1969 *Kymalithon belgicum* Foslie, Johnson, pp. 10,11, pl. 6, Figs. 1,2,3, pl. 23, Figs. 1,2, pl. 24, Figs. 1,2.

Description:

The tissue is well differentiated into hypothallus and perithallus. The basal hypothallus is formed of narrow threads of cells, gradually curving upward into the perithallus. Sporangia develop in the outer part of the perithallic tissue in small groups, usually containing rounded spores.

Occurrence:

Beni Khaled Member of the Samalut Formation (Fig. 2), upper Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Polygonella* Elliott, 1957*Polygonella incrustata* Elliott

(Plate 1, Figure 12)

1956 *Lithoporella melobesiodes* (Foslie); Elliott, p. 327, pl. 2, Figs. 8,9.

1957 *Polygonella incrustata* Elliott, p. 230, pl. 1, Figs. 11, 12.

1968 *Thaumatoporella parvovesiculifera* (Raineri); Johnson, pp. 7, 8, pl. 1, Figs. 1,2.

Description:

Single-layer spreads of encrusting cells that are rectangular in vertical section and appear as a honeycomb pattern of polygonal cells in sections, of which the most common type is pentagonal; cells 0.07-0.1 mm. in height and 0.02-0.03 mm. in width.

Occurrence:

Middle part of the Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Family Codiaceae

Genus *Ortonella* Garwood, 1914

Ortonella furcata Garwood

(Plate 1, Figure 19)

1961 *Ortonella furcata* Garwood; Johnson, p. 99, pl. 36, Figs. 1-4.

Description:

Thallus forms small rounded nodules or nodular masses, each of which consists of a series of fine ramifying tubes which radiate from the center of the nodules. The tubes are straight or slightly undulating, completely and often widely separated, and circular in cross section. They vary slightly in size, but individual tubes show a nearly uniform diameter throughout. The tubes have a marked dichotomous branching with the angle of divergence of the branches usually about 35°. Sporangia unknown.

Occurrence:

Top part of the Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Ovulites* Lamarck, 1816

Ovulites morelleti Elliott

(Plate 1, Figures 6-9)

1955 *Ovulites morelleti* Elliott, pp. 126-127, pl. 1, Figs. 4-6.

Description:

Hollow elongate-tabular bodies, with slight terminal clubbing, an opening at both ends. Length ranges up to 1.5 mm. whereas diameter is normally up to 0.3 mm.. Wall finely perforate, pores are straight and radial, 0.01-0.02 mm. in diameter.

Occurrence:

Basal part of Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Halimeda* Lamouroux, 1812

Halimeda praemonilis Morellet

(Plate 1, Figures 15, 20,22)

1969 *Halimeda praemonilis* Morellet; Johnson, p. 43, pl. 30, Fig. 3.

Description:

Bushy, composed of tufts of segmented branching stems or fronds. Segments may be broad and leaflike, flattened, subcylindrical, or even subconical. Calcification proceeds inward from the outer surface and is commonly incomplete. Segments are composed of tabular filaments. These are coarse in the center of the segment but branch into smaller and smaller tubes ending in clusters of fine, short tubes perpendicular to the surface.

Occurrence:

This species ranges throughout the Minia Formation and the Meshag-gig Member of the Samalut Formation (Fig. 2), southeast of Minia, Nile Valley, Upper Egypt.

Family Dasycladaceae

Genus *Carpathoporella* Dragastan, 1967

Carpathoporella occidentalis Dragastan

(Plate 1, Figures 1-5,11; plate 2, Figures 3,6)

1967 *Carpathoporella occidentalis* Dragastan, pp. 444-445, pl. 1, Figs. 7,9; pl. 2, Figs. 10-16.

Description:

Thallus cylindrical, not segmented. Central stem well developed. Primary branches are present in widely spaced whorls and are also strongly flattened in longitudinal sections. They probably widen at tips and support a cortical membrane. Sporangia not developed.

Occurrence:

Basal unit of the Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Genus *Neomeris* Lamouroux, 1816

Neomeris budaense Johnson

(Plate 1, Figures 16, 17)

1969 *Neomeris budaense* Johnson, p. 68, pl. 42, Figs. 1-4; pl. 43, Figs. 1,3,4,5.

Description:

Plant consists of a central stem from which arise very regular whorls of primary branches. Each primary branch ends in a tuft of secondary branches, each of which ends in a terminal hair. Sporangia are spherical, ovoid or pyriform, growing at the ends of the secondary branches. Calcification is almost absent around the central stem and most of the primary branches. The calcification normally envelops the secondary branches, and commonly extends beyond the outer ends of the primary branches. Thallus measures about 0.75 mm. in length.

Occurrence:

Middle part of the Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Neomeris johnsoni Khalifa

(Plate 1, Fig. 10)

1984 *Neomeris johnsoni* Khalifa, New species of fossil algae from the Lower - Middle Eocene rocks at the western environs of Assiut, Nile Valley, Upper Egypt. Bull. Fac. Sci. Assiut Univ., Egypt. (In press).

Occurrence:

Lower part of Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

Fossils of Uncertain Affinities

Genus *Hensonella* Elliott, 1960

Hensonella cylindrica Elliott

(Plate 1, Figure 18)

1968 *Hensonella cylindrica* Elliott; Johnson, pp. 39-41, pl. 7, Figs. 1-5.

Description:

Hollow cylindrical tubes of variable length up to 2.5 mm; always incomplete; observed diameters vary from 0.2 to 0.5 mm. The walls in longitudinal and

transverse sections show a very thin inner dark layer with definite structure, and a thick outer layer of aragonite. In thin section the outer layer shows numerous radial cracks which often occasion a regular "petalled" appearance in transverse section.

Occurrence:

Minia Formation (Fig. 2), Middle Eocene, southeast of Minia, Nile Valley, Upper Egypt.

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دراسة الطحالب الجيرية المتحجرة والنطاقات الحيوية في تتابع صخور الأيوسين الأوسط لمنطقة جنوب شرق المنيا وادي النيل - مصر

حامد خليفة محمد، حسن عبد الحميد سليمان
عصمت كحيله

قسم الجيولوجيا - جامعة أسيوط - مصر

من خلال الدراسات المخبرية والميكروبياليتولوجية لصخور
الايوسين الأوسط بمنطقة جنوب شرق المنيا - وادي النيل -
مصر أمكن التعرف، لأول مرة على اثنتي عشر نوعاً من
حفريات الطحالب الجيرية. من بين هذه الأنواع الموصوفة
ستة أنواع تنتمي للطحالب الحمراء، وخمسة أنواع من
الطحالب الخضراء. تم تصنيف ووصف هذه الأنواع وأهميتها
الطباقية في تاريخ القطاعات المدروسة والمثلة في منطقة
البحث.

بناء على المحتوى الأحفوري (الفورامينيفيرا الكبيره
والطحالب الجيرية) في تتابع صخور الأيوسين الأوسط
للقطاعات المدروسة أمكن تحديد خمسة قطاعات حيوية
ومحلية.