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New Species of Fossil Algae from the Lower-Middle Eocene Rocks West and Northwest of Assiut, Nile Valley, Upper Egypt

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ABSTRACT. Six species belonging to four genera of fossil calcareous algae are here recorded, for the first time, from the Lower and Middle Eocene rocks west and northwest of Assiut, Nile Valley, Upper Egypt. Among these, the following three species are new: *Neomeris mirensis* n. sp., *Neomeris johnsoni* n. sp. and *Girvanella aegyptiaca* n. sp.

Three biozones, based on their microfossil content, are recognized through the Lower-Middle Eocene succession of the area.

Comprehensive studies, stratigraphic and paleontologic, of the Eocene rock succession exposed along both sides of the Nile Valley near Assiut have been provided by many workers (*e.g.* Zittel 1883, Blanckenhorn 1921, Cuvillier 1930, Nakkady 1958, Bishay 1961, 1966, El-Naggar 1970 and Omara *et al.* 1970, 1973). These works do not, however, include detailed studies on the fossil algal microflora of the Eocene succession. The aim of the present work is to provide the first study of fossil algae from the Eocene rocks exposed at the western scarp of the Nile Valley, near Assiut. Seven stratigraphic sections were measured and sampled in the area extending to the west and the northwest of Assiut and located between the latitudes 27°00′ and 27°30′ North, and the longitudes 30°40′ and 31°15′ East (Fig. 1).

The Lower and Middle Eocene rock succession in this area is mainly composed of limestones, chalky limestones and lime-mudstones. According to the recent studies of Lotfy (1980) the Eocene stratigraphic sequence in this area can be divided, from top to bottom, into the following lithologic units:

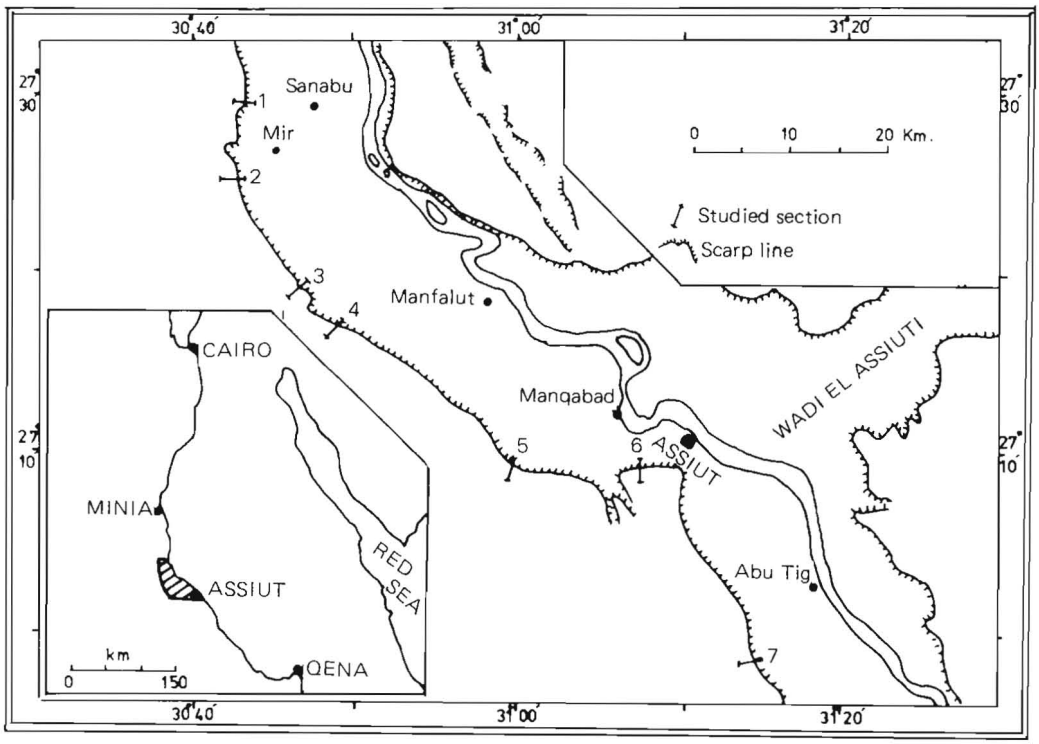

Fig. 1. Location map for the studied sections.

II. Middle Eocene Rocks

C) Minia Formation (Early Lutetian)

2) Beet Ankh Member.

1) Maabda Member.

I. Lower Eocene Rocks

B) Ibrahimi Formation (Late Ypresian)

A) Drunka Formation (Late Ypresian)

The distribution of the fossil algal microflora and larger foraminifera (Fig. 2) through the Eocene succession exposed in the study area leads to the recognition of three successive zones of which the lower zone is introduced here for the first time, and defined on the basis of the flood of characteristic algal species. These biozones (Fig. 3) are from top to bottom, as follows:

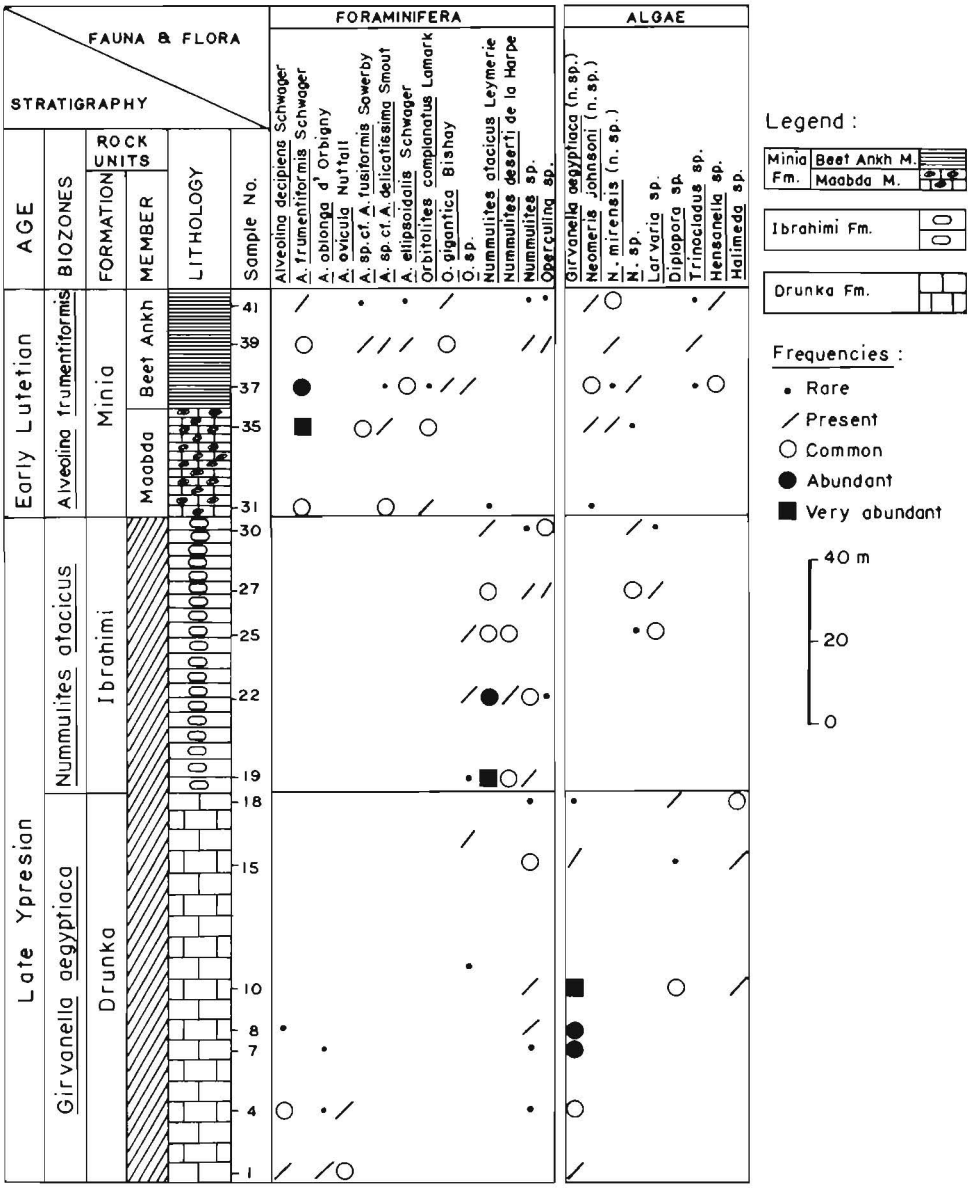

Fig. 2. Composite distribution chart of the algal microflora and larger foraminifera of the eocene rocks at the western environs of Assiut, Nile Valley, Egypt.

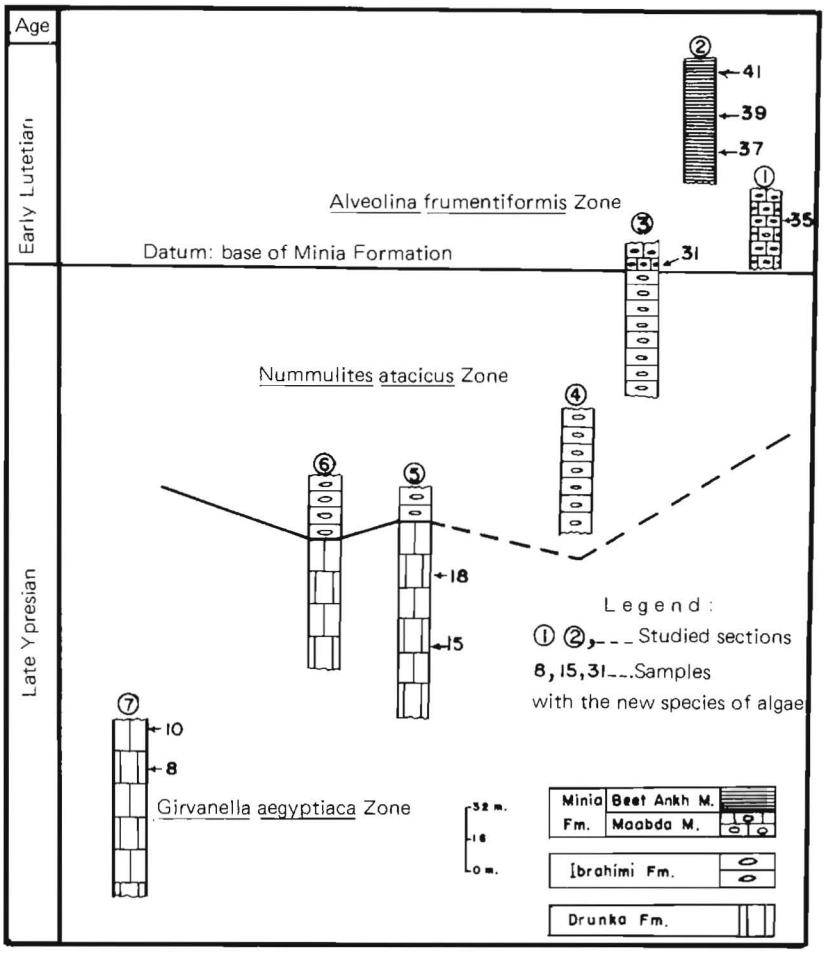

Fig. 3. Correlation of the eocene flori- and the faunizones at the western environs of Assiut.

3) *Alveolina frumentiformis* Zone (Early Lutetian interval of the Minia Formation).

2) *Nummulites atacicus* Zone (Late Ypresian interval of the Ibrahimi Formation).

1) *Girvanella aegyptiaca* Zone (Late Ypresian interval of the Drunka Formation).

1. Girvanella aegyptiaca Zone

The *Girvanella aegyptiaca* Zone is here introduced for the first time in the biostratigraphy of the Lower Eocene rocks of the Nile Valley. It is characterised by the appearance of floods of the index species (up to 62% of bulk rock sample) just above its first appearance, together with an associated abundant algal assemblage. The upper limit of this zone is marked by the first occurrence of *Nummulites atacicus* Leymerie, which distinguishes the overlying zone. The *Girvanella aegyptiaca* Zone occupies the upper interval of the Drunka Formation and has an average thickness of about 69 m, as shown in sections 5, 6 and 7 (Fig. 2).

Besides the index species, *Girvanella aegyptiaca* n.sp., the algae *Halimeda* sp. and *Diplopora* sp. are common. Larger foraminifera includes common *Alveolina ovicula* Nuttall, *A. decipiens* Schwager, *A. oblonga* d'Orbigny, *Orbitolites* sp. and *Nummulites* sp.

The assemblage of *Alveolina* spp. has been regarded both in Egypt and elsewhere as an indicator of the upper Lower Eocene (late Ypresian) (Nuttall 1925, Said & Kerdany 1961, Bishay 1966). Furthermore, the disappearance of the characteristic algal assemblage of this zone coincides with the first appearance of the index species of the succeeding *N. atacicus* Zone (late Ypresian, Bishay 1966) suggests a late Ypresian age for the *Girvanella aegyptiaca* Zone.

2. *Nummulites atacicus* Zone

The *Nummulites atacicus* Zone was first introduced by Bishay (1966) in his work on the biostratigraphy of the Early Eocene rocks of the Nile Valley. In the present study area, it conformably overlies the *Girvanella aegyptiaca* Zone and is in turn conformably overlain by the *Alveolina frumentiformis* Zone. It coincides with the Ibrahimi Formation and measures about 72 m in thickness. The highest percentage of fauna of *Nummulites atacicus* Leymerie is 75% and is seen in section 4 (Ibrahimi Formation).

Besides the index species *Nummulites deserti* de la Harpe, *N.* sp., *Operculina* sp., *Alveolina* sp., *Oribitolites* sp. bryozoa, *Larvaria* sp., *Neomeris* sp. and other fossil fragments are also present in this zone.

In Egypt and elsewhere, *Nummulites atacicus* Leymerie is an index fossil of the late Ypresian (Cuvillier 1930, Schaub 1951, Sabry 1963, Bishay 1961, 1966).

3) *Alveolina frumentiformis* Zone

This biozone is defined by the first appearance of *Alveolina frumentiformis* Schwager and the disappearance of *Nummulites atacicus* Leymerie.

The percentage of fauna of *Alveolina frumentiformis* in this biozone reaches approximately 25%. It essentially coincides with the Minia Formation of the sections studies and is more than 57 m thick.

Besides the abundance of *Alveolina frumentiformis* Schwager other fossils are *Neomeris mirensis* n.sp. *Neomeris johnsoni* n.sp. *Neomeris* sp., *Trinocladus* sp., *Hensonella* sp., *Nummulites* sp., *Operculina* sp., *Alveolina* sp. cf. *A. fusiformis* Sowerby, *A.* sp. cf. *A. delicatissima* Smout, *A. ellipsoidalis* Schwager, *A.* sp., *Orbitolites complanatus* Lamarck, *O. gigantica* Bishay and *O.* sp.

This biozone has been previously described from the early Middle Eocene (Minia Formation) of the Nile Valley (Cuvillier 1930, Said 1962, 1963, Krasheninnikov and Ponikarov 1964, Bishay 1966 and Soliman *et al.*, 1976).

Thus, the age of *Alveolina frumentiformis* Zone in the study area is lower Middle Eocene (early Lutetian).

Systematic Paleontology

Two main types of fossil calcareous algae are here recorded and described for the first time in the Lower and Middle Eocene rocks of the study area: calcareous green algae (Phylum Chlorophyta) Family Dasycladaceae and calcareous blue-green algae (Phylum Cyanophyta).

The classification of Family Dasycladaceae is based on the scheme proposed by Pia (1920) and applied by Rezak (1959). It is based on the following characteristic features:

1. General shape of the ttallus (cylindrical, club-shaped, ...etc.).

2. Type of thallus (segmented, unsegmented, branched, ...etc.).

3. Form of primary branches (rays) (simple, branched, cylindrical, tapering, ...etc.).

4. Shape of central stem (stipe).

5. Sporangia (position and shape).

6. Dimensional data (measurement ratios).

The phylum Cyanophyta was previously studied by Pia (1927) who introduced an artificial group 'Porostromata'. The term Porostromata includes all fossil algae of unknown systematic position which have a microstructure consisting of masses or bundles of well-defined tubes of blue-green algal origin. Later, Pia (1937) restricted the Family Porostromata to the common genera *Girvanella* Nicholson & Etheridge and *Rothpletzella* Wood. Species of *Girvanella* have been differentiated on the basis of the diameter of the tubes, thickness of cell walls and the character of branching (when present).

Table (1)

Phylum	Family	Genera & Species
CHLOROPHYCOPHYTA (Green algae)	Dasycladaceae	*Neomeris mirensis* n.sp. *Neomeris johnsoni* n.sp. *Neomeris* sp. *Trinocladus* sp.
CYANOPHYTA (Blue-green algae)	Section 'Porostromata'	*Girvanella aegyptiaca* n.sp.
FOSSILS OF UNCERTAIN AFFINITIES		*Hensonella* sp.

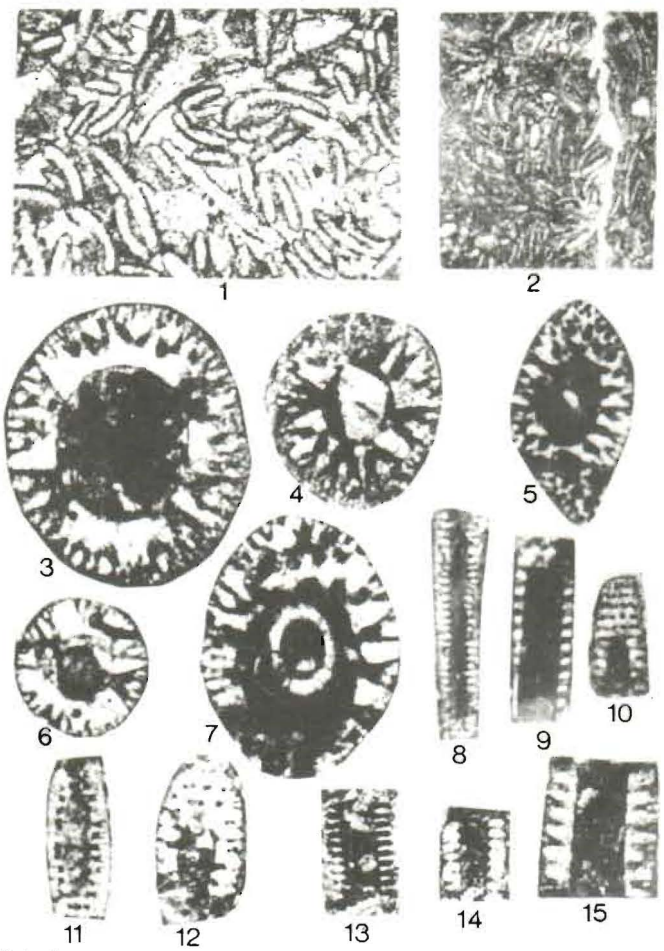

Plate 1.

The above mentioned classification schemes are followed in the present work; the species reported are shown in the following table; the described and figured specimens are deposited in the Museum of the Geology Department, Assiut University, Egypt.

Phylum CHLOROPHYCOPHYTA
(Green Algae)
Family DASYCLADACEAE
Genus *Neomeris* Lamouroux, 1816
Neomeris mirensis n. sp.
(Pl. 1, Fig. 3, 6, 14 & 15)

Etymology

Name derived from the type locality (section 1), west of Mir town (Fig. 1).

Type Locality

Western scarp of the Nile Valley, at about 14 km from the river bank, southwest of Mir town.

Type Section

Section (1), Maabda Member of the Minia Formation (Early Lutetian), *Alveolina frumentiformis* Zone.

Holotype

Pl. 1, Fig. 3, section (1), sample no. 35.

Paratype

Pl. 1, Fig. 6, section (1), sample no. 35; Pl. 1, Fig. 14 & 15, section (3), sample no. 31.

Description

The thallus of the figured specimens consists of unsegmented spherical bodies. They vary in diameter from 1.5 mm to 4.0 mm with large central stem from which arise regular whorls of primary branches. Each primary ends in a tuft of secondary branches. The secondary branches, in turn, end in a terminal hair. Sporangia have a spherical to ovoid shape and develop at the ends of the pronounced secondary branches. Calcification is almost absent around the central stem.

Dimensions (in mm)

1. Length: 2.0-5.0.
2. Outer diameter: 2.0-4.5.

3. Inner diameter: 1.0-2.5.
4. Diameter of central stem: 1.0-2.0.
5. Diameter of secondary branches: 0.06-0.08.
6. Sporangia:
   a) Diameter: 0.1-0.15.
   b) Height: 0.15-0.25.

Remarks

The specimens of *Neomeris mirensis* n.sp. show some similarities (in general shape and central stem) to *Neogyroporella elegans* Yabe & Toyama (Johnson 1969, P. 163, Pl. 51. Fig. 1-5), but the former is distinguished by having secondary branches with terminal hair and in having sporangia growing at the ends of the well developed secondary branches.

It also differs from the Cretaceous *Neomeris budaense* Johnson (Johnson 1969, P. 155, Pl. 43, Fig. 4 & 5) from Texas in being larger in size, in having a wider central stem-cavity and more calcification on the primary branches. In vertical sections, our species may be distinguished from *Neomeris budaense* by having large sporangia.

Neomeris johnsoni n.sp.
(Pl. 1, Fig. 4, 7 & 9)

Etymology

This species is named in the honour of Dr. J. Harlan Johnson, Emeritus Professor of Geology, Colorado School of Mines, for his scientific contribution in the field of fossil algae.

Type Locality

Western scarp of the Nile Valley, at about 15 km from the river bank, northwest of Manfalut town.

Type Section

Section (2), Beet Ankh Member of the Minia Formation (Early Lutetian), *Alveolina frumentiformis* Zone.

Holotype

Pl. 1, Fig. 7; section (2), sample no. 37.

Paratype

Pl. 1, Fig. 4; section (2), sample no. 39; Pl. 1, Fig. 9; section (2), sample no. 41.

Description

Thallus has elliptical shape with small and spherical central stem from which arise regular whorls of primary branches. The central stem is mainly characterised by its rounded edge with moderately thick walls. Calcification is strong around the sporangia and almost absent around the central stem. Sporangia are more or less globular, isolated and surrounded by second order branches.

Dimensions (in mm):

1. Length: 5.0.
2. Outer diameter: 3.0-3.5.
3. Inner diameter: 2.5-3.0.
4. Diameter of central stem: 0.5.
5. Diameter of secondary branches: 0.05-0.06.
6. Sporangia:
   a) Diameter: 0.1-0.12.
   b) Height: 0.1-0.2.

Remarks

This species differs from the well known *Neomeris* spp. in the literature (see Johnson, 1961a, 1969) by having a small and spherical central stem. The latter is also characterised by a rounded edge with thick walls.

Neomeris sp.
(Pl. 1, Fig. 5 & 10)

Occurrence

Maabda Member of the Minia Formation (Early Lutetian) *Alveolina frumentiformis* Zone; section 1, samples no. 35 & 37.

Description

Thallus with more or less ovoid to elliptical shape. Sporangia spherical, growing at the ends of specially developed secondary branches. Central stem has oval shape without calcification. Calcification is only strong around the sporangia and envelops the secondary branches.

Remarks

This third species of *Neomeris* is left in open nomenclature until more and better material is available for study.

Genus *Trinocladus* Raineri, 1922
Trinocladus sp.
(Pl. 1, Fig. 8)

Trinocladus sp. Johnson. Johnson, 1969, p. 152 Pl. 40, Fig. 8.

Occurrence

Maabda Member of the Minia Formation (Early Lutetian); *Alveolina frumentiformis* Zone; section 2 samples no. 37, 39 & 8 c41.

Description

The cylindrical thallus of *Trinocladus* has a moderately large central stem. Primary branches, occurring in regular whorls, give rise to secondary branches, and these in turn to clusters of tertiary branches. Lower whorls may show only primaries as shown in Pl. 1, Fig. 8, whereas the upper parts of the plant preserve the full range of branch forms.

Phylum CYANOPHYTA (Blue-green algae)
Section POROSTROMATA Pia, 1927
Genus *Girvanella* Nicholson and Etheridge, 1880.
Girvanella aegyptiaca n.sp.
(Pl. 1, Fig. 1,2)

Etymology

From its first occurrence in the Early Eocene rocks of the Nile Valley, Egypt.

Type Locality

Western scarp of the Nile Valley, at about 12 km from the river bank, west of Mangabad.

Type Section

Section 5, Drunka Formation (Late Ypresian); *Girvanella aegyptiaca* Zone.

Holotype

Pl. 1, Fig. 1, section (5), sample no. 15.

Paratype

Pl. 1, Fig. 2, section (7), sample no. 10.

Description

Thallus consists mainly of an aggregation of calcareous tubes. The majority of the tubes are nearly straight; others are twisted. Filaments occur in groups. The tubes have relatively thick calcareous walls, are unsegmented and unbranched. They are simple in form without partitions or any perforations in the side walls. Sporangia are unknown.

Dimensions of Holotype (in microns):

1. Length of tubes: 550-900.
2. Diameter of tubes: 80-100.
3. Thickness of walls: 10-20.

Dimensions of Paratype (in microns):

1. Diameter of tubes: 50-55.
2. Thickness of walls: 8-10.
3. Length of tubes: 350-600.

Girvanella is a very common fossil with a world-wide distribution and wide stratigraphic range, being reported from the Cambrian to the Cretaceous (Wray 1977). *Girvanella aegyptiaca* n.sp. is here described for the first time from the Early Eocene rocks of Egypt. This species differs from *Girvanella problematica* Nicholson and Etheridge and *Girvanella grandis* Banks and Johnson (see Johnson 1960, 1961b) by having unbranching tubes of medium size and thick walls.

Fossil of Uncertain Affinities
Genus *Hensonella* Elliott, 1960
Hensonella sp.
(Pl. 1, Fig. 11 & 12)

Occurrence

Minia Formation (Early Lutetian), *Alveolina frumentiformis* Zone; section 2, sample no. 37 & 41.

Description

This species is mainly characterised, in both cross and vertical thin-sections, by its thin inner dark layer without definite structure and thick outer layer. The

latter apparently shows radial structure. Thallus consists of hollow cylindrical tubes of lengths, apparently incomplete up to 2.0 mm.

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Explanation of plate 1

Fig. (1, 2) *Girvanella aegyptiaca* n.sp. . 1, Thin-section consists of large and twisted tubes of uniform diameters (× 10). Early Eocene, Drunka Formation, section (5), sample no. 15.2. Thin-section showing dense ground-mass formed of large numbers of twisted filaments (× 10). Early Eocene, Drunka Formation, section (7) sample no. 10.

Fig. (3, 6, ,14, 15) *Neomeris mirensis* n.sp. 3, 6, Cross-sections showing the central stems, primary and secondary branches with sporangia (× 15). 14, 15, Vertical-sections showing only primary branches (× 15). Middle Eocene sample (Early Lutetian), Minia Formation (Maabda Member) section 1, sample no. 35, section 3, sample no. 31.

Fig. (7, 9) *Neomeris johnsoni* n.sp. 4, 7, Cross-sections showing the elliptical shape and sporangia (× 20). 9, Vertical section (× 15). Middle Eocene, Minia Formation (Beet Ankh Member), section 2, samples no. 37, 39, 41.

Fig. (5, 10) *Neomeris* sp. 5, An oblique cross-section showing central stem, primary and secondary branches with spherical sporangia (× 15). 10, An oblique vertical section showing sporangia (× 10). Middle Eocene, Minia Formation, section 1, sample no. 35; section 2, sample no. 57.

Fig. (8, 13) *Trinocladus* sp. Vertical-section showing primary branches (× 10). Middle Eocene, Minia Formation, section 2, sample no. 37.

Fig. (11, 12) *Hensonella* sp. Oblique section showing thin dar inner layer and thick outer layer of radiate structure (× 15). Middle Eocene, Minia Formation, section 2, samples no. 37, 41.

تسجيل أنواع جديدة من حفريات الطحالب الكلسيه فى تتابع صخور الإيوسين المبكر - الأوسط فى المناطق الغربية لمدينة أسيوط - وادي النيل (جنوب مصر)

حامد خليفة محمد

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من خلال الدراسة المعملية والمجهرية لبعض قطاعات من صخور الإيوسين المبكر والأ وسط فى المناطق الغربية لمدينة أسيوط وادى النيل - مصر، أمكن التعرف على ستة أنواع من الطحالب الجيرية المتحفرة والتى تنتمى إلى أربعة أجناس فقط.

تم تصنيف ووصف هذه الأنواع ومداها الزمنى فى تاريخ القطاعات الاستراتجرافية المدروسة. ومن بين هذه الانواع: *Girvanella aegyptiaca, Neomeris mirensis, Neomeris johnsoni* وصفت كأنواع جديدة.

أمكن تحديد ثلاثة نطاقات حيوية، بناء على المحتوى الأحفورى، فى تتابع صخور الإيوسين الممثلة فى منطقة البحث.