Mohamed Boukhary 1, Abbas Kenawy 2 and Rafaat Basta 3

ABSTRACT

Seven larger foraminiferal species: Nummulites aff. nemkovi SCHAUD, 1966, Nummulites partschi DE LA HARPE, 1880, Nummulites bassiounii BOUKHARY & BLONDEAU, 1991, Nummulites cf. campesinus SCHAUD, 1966, Assilina aff. major HEIM, 1908, Decrouezina aegyptiaca Boukhary, 1994 and Operculina sp. are described from the Early Eocene Gebel Umm Russeies, Northern Galala, Eastern Desert, Egypt. These taxa are biostratigraphically evaluated and according to the standard shallow benthic zones, the identified biozones span SBZ 10 to SBZ 12 in the shallow benthic zones (SBZ) of SERRA-KIEL et al. (1998) which are assigned to the Late Ypresian.

Keywords: Nummulites, Operculina, Gebel Umm Russeies, El Galala El Bahariya, Ypresian, Egypt

1. INTRODUCTION

El Galala El Bahariya is a high flat topped plateau located between latitudes 28°50’ N and 29°45’ N and longitudes 31°40’ E and 32°30’ E and is one of the most impressive topographical features in the northern part of the north Eastern Desert. The plateau overlooks the Gulf of Suez rising 977 m above sea level at Gebel Umm Russeies, and extends between 50 km south of Suez city in the north and Wadi Araba in the south, a distance of about 60 km. Inland, the plateau stretches westwards where it merges into the Mokatam plateau overlooking Cairo in the west. The El Galala El Bahariya plateau is cut by some wadis, but the main tributaries from west to east are: Wadi El Qena, Wadi El Ghul, Wadi El-Khafouri, Wadi Abu Diaba, Wadi Ogila, El Wadi El-Abyad, Wadi Naoz, Wadi Umm Russeies and Wadi Haroz (Fig. 1). The studied area lies at the far north and east sides of El Galala El Bahariya, between latitudes 29°30’ N and 29°40’ N and longitudes 32°07’ E and 32°25’ E.

Near the North Eastern part of the El Galala Plateau, At Khashm El-Galala, Wadi Haroz and Wadi Umm Russeies, the lower part of the scarp is composed of Lower Cretaceous variegated sandstone and marl (Malha Formation), overlain by a thick series of marly limestone, marl and a thick band of dolomite of Late Cretaceous age (Galala Formation).

The following Turonian fossiliferous dolomite and conglomeratic beds (Umm Russeies Formation) are exposed and, with thickness overlain by marly limestone and shale of Palaeocene age (Esna Shale). These rocks are capped by Eocene carbonates rocks which are completely dolomitic in the east and gradually change westward to dolomitic limestone. To the west of Wadi Naoz, Eocene limestones form the foot of the scarp, Palaeocene and Cretaceous strata never crop out again west of Wadi Naoz. The general dip of the strata is towards the west and varies from 8° to 10°.

El Galala El Bahariya was affected by tectonic movements which took place during the Late Cretaceous, the Early Eocene and the Neogene. The dominating faults trend East–West, especially in the northernmost part, but other trends NW–SE (Gulf of Suez) and NE–SW are not uncommon.

* In the memory of the late Professor Abbas Kenawy
Many faults along the northern face of North Galala are arranged en echelon (Fig. 1). El Galala El Bahariya, like other localities in the northern part of the Eastern Desert, is affected by volcanic intrusions. Sheet basalts can be seen at the top of the plateau, and also at the opening of Wadi Naoz, Wadi Umm Qena and Wadi Haroz (Fig. 1). As a consequence, the sediments are slightly metamorphosed at the contact and hence marblised limestone and calcite dykes are found at Wadi Haroz, Wadi Ghoul and Gebel Menedra.

**Figure 1:** Geologic map of the study area and location of studied sections.

**Figure 2:** Stratigraphic section measured at Gebel Umm Russeies (section no. 1).

| Formation    | Bed No. | Sample no. | Lithology                                                                 | Description                                                                 | Age      |
|--------------|---------|------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|----------|
| Thebes Fm.   | 19      | 63         | Chalky limestone, hard to moderately hard, highly fossiliferous with N. cf. campanius, Orbiculoideae sp., Bryozoa and echinoids sp. |                                                                                   |          |
|              | 18      | 60         | Limestone, hard massive fossiliferous, with N. cf. campanius                |                                                                                   |          |
|              | 17      | 55-56      | Bryozoan limestone, hard, chalky, with Orbiculoideae sp.                     |                                                                                   |          |
|              | 16      | 52-53-54   | Chalky limestone hard, contains chert nodules                              |                                                                                   |          |
|              | 15      | 49-50-51   | Dolomitic limestone, grey to greenish grey hard and compact                 |                                                                                   |          |
|              | 14      | 47-48      | Orbiculoideae sp., pale white, fine to medium grained                       |                                                                                   |          |
|              | 13      | 46         | Marly limestone, moderately hard, bedded, intercalated with chert bands, fossiliferous with Orbiculoideae sp. |                                                                                   |          |
|              | 12      | 35-36-37   | Nodular limestone, white to yellowish white and hard                        |                                                                                   |          |
|              | 11      | 33-34      | Marly limestone, pale white with N. campanius and N. pachyglottis           |                                                                                   |          |
|              | 10      | 32         | Limestone, white to snow-white, moderately hard to hard                      |                                                                                   |          |
|              | 9       | 24-27      | Marly limestone, grey to yellowish grey with N. aff. nemicola               |                                                                                   |          |
|              | 8       | 21-22-23   | Limestone grey to whitish grey with N. pachyglottis                         |                                                                                   |          |
|              | 7       | 18-19-20   | Marly limestone, yellowish grey moderately hard                             |                                                                                   |          |
|              | 6       | 15-16-17   | Nodular limestone pale white to grey                                         |                                                                                   |          |
|              | 5       | 14         | Alveolitid limestone white to snow-white moderately hard chalky              |                                                                                   |          |
|              |         | 9          | Highly fossiliferous mainly with spherical Alveolitida fsp.                 |                                                                                   |          |
|              | 4       | 7-8        | Marly limestone, yellowish grey moderately hard                             |                                                                                   |          |
|              | 3       | 6-6        | Marly grey slightly to moderately hard                                       |                                                                                   |          |
|              | 2       | 3-4        | Marly limestone, yellowish grey white Operculina sp.                        |                                                                                   |          |
|              | 1       | 2-3        | Thirty bedded marly limestone with ammonium                                |                                                                                   |          |

Late Cretaceous

Unconformity
This study is based on four measured stratigraphic sections (Figs. 2–5) representing the exposed Eocene succession. A brief description and discussion of the rock units from base to top is as follows: Esna Shale Formation, Thebes Formation, Minia Formation.

2. STRATIGRAPHICAL SETTING

The Eocene rocks are widely distributed in Egypt, well exposed along the Nile Valley, Sinai Peninsula, Western Desert, and the Eastern Desert including Northern and Southern Galala. There is great lateral variation in both lithofacies and biofacies.

2.1. The Esna Shale Formation

In the study area, the Esna Shale is composed of thinly bedded marl, marly chalk, grey-greenish to grey shale that unconformably overlies the Umm Russeies Formation (SWE-DAN et al., 1991). The base of the Esna Shale is characterized by the presence of Operculina sp. and Discocyclina sp. while...
the *Morozovella velascoensis* and *Morozovella edgari* zones are recorded higher in the sequence. The Esna Shale disappears in the western part of the study area, east of Wadi Naoz due to the regional dip. In the eastern part (W. Haroz), it consists of thinly bedded marly chalk and has a thickness of 35 m. The Esna Shale attains a thickness that ranges from 60 m at section 1 to 80 m at section 4. The microfaunal assemblages recorded in this study from the Esna Shale indicate an Ypresian age for this Unit.

2.2. The Thebes Formation

The Thebes Formation was introduced by SAID (1960) for a massive unit of limestone with flint bands of Ypresian age. The type locality is at Gebel Gurnah, west of Luxor, near the site of the ancient Thebes Capital of Egypt, where it is about 300 m in thickness. The basal beds of this unit are rich in *Operculina libyca* Schwager (*Operculina* limestone), while the lower part is poor in megafossils, and is massive—thickly bedded with tabular and concretionary flint bands. The upper part includes several marl beds alternating with nummulitic limestone bands rich in *Nummulites* and megafossils. The micro fossils include *Nummulites praecursor* and *N. subrandoni*, *Lucina thebaica*, *Conoclypeus delanouei*, indicating an Early Eocene age for this assemblage and formation.

SNAVELY et al. (1979) divided the Thebes Formation in the Nile Valley into three informal members: lower, middle and upper. The first member (lower member) is a transitional contact with the laminated shales and marls of the Esna
Shale Formation. It consists of laminated to thinly bedded fine grained limestone and chalk with scattered chert nodules. The middle member is 100–125 m thick, thinly bedded chalk with nodular limestone interbeds, rich with large benthonic foraminifera. The upper member reaches a maximum thickness of 50 m at Gebel Shaghab. It consists of interbeds of oyster limestone and oyster shell-debris with Alveolina limestone.

In the study area, SADEK (1926) mentioned that the Lower Eocene in El Galala El Bahariya composed of clastic sediments in the lower part, whereas its upper part is a carbonate, which is quite different from the Nile Valley sequence. SAID (1962, 1990) later stated that the Farafra Formation in the north and south Galala is rich in Alveolinid fauna of Early Eocene age. ABDALLAH et al. (1971) recorded 48 m of sandy dolomite bands rich in alveolinids, operculines and nummulitids overlying the chalky limestone of the Sudr Formation at Gebel Thelmet in the northeastern part of Southern Galala Plateau and named it the Southern Galala Formation SCHEIBNER et al. (2002).

Here, the Thebes Formation is classified lithological into lower, middle and upper members based on lithological and biological characters, that are as follows:
The Lower Member: This member is composed of white to pale white limestone and marl to marly limestone of yellowish white color, slightly hard, with rare chert nodules in the upper part. There are many horizons crammed with *Nummulites partschi*, *Nummulites aff. nemkovi*, small and medium sized *Orbitolites* and small specimens of *Lucina*. The thickness of this horizon ranges from 25 to 40 m and increases towards the western side of the study area. At the base of the Thebes Formation, *Alveolines* have been found southwest of Wadi Naoz (sections 3 and 4 respectively).

The Middle Member: This member is composed of a sequence of well bedded, white or cream limestone, with poorly lithified bands of chalky to marly limestone, rich with chert bands and nodules. It is also characterized by the cyclic presence of hard bands of limestone about 30–50 cm thick, and is overlain by thinner (10–15 cm) soft bands of a chalky to marly limestone. The top part is made of chert band; each band attains a thickness of a 5 to 8 cm including *Nummulites partschi* and rare medium to large sized *Nautilus* sp. The thickness of this member ranges from 50–90 m, increasing towards the west. The maximum thickness occurs at Wadi Ogila (90 m).

The Upper member: This is represented by massive white to snow white chalky limestone, and massive, hard to moderately hard limestone. Near the top of the formation, the member contains many bands full of *Nummulites cf. campesinus* SCHAUB, *Orbitolites* sp., *Bryozoa*, *Pelecypods* (*Lucina* sp., *Vulsella* sp. and *Ostrea* sp.), *Gastropods* (*Natica* sp., *Trochus* sp., *Turritella* sp.), and *Echinoids*.

The nummulitic limestone member measures about 100, 147, 115 and 132 m at sections 1, 2, 3 and 4 respectively. In the west at Wadi Ogila the member reaches its maximum thickness 160 m, whereas the thickness of this member is reduced to the East, measuring 80 m at Wadi Haroz.

2.3. The Minia Formation

In the studied area, the Minia Formation conformably overlies the Thebes Formation. It occupies the topmost part of the scarp face of El Galala El Bahariya as well as outcropping over the surface of the plateau. The formation is well exposed at Gebel Umm Russies and extends beyond the study area. It also crops out on the western side of Wadi Naoz. The formation is composed of white to snow white limestone at the base, intercalated with dolomitic limestone in the middle which increases in thickness upwards where it is interbedded with thin beds of limestone and chalky limestone. This part of the section is very rich in larger foraminifera (*Nummulites*), algae and macrofossils. The following species were identified from this part of the formation: *Nummulites bassiounii* BOUKHARY & BLONDEAU, *Decrouezina aegyptiaca* (CUVILLIER), *Assilina aff. major* HEIM, *Orbitolites* sp., *Carolina fischeri* STROUGO, *Vulsella crispata* FISCHER, large size *Turritella* sp., *Natica* sp., *Trochus* sp. and *Pterolucina monosulcata* (STROUGO) and long *Alveolina cf. frumentiformis*.

The Minia Formation yields *N. bassiounii*, *D. aegyptiaca*, and *A. aff. major*.

The total thickness of this part of the sequence reaches 150 m in section 2, 90 m in section 3 and 170 m in section 4.

3. BIOSTRATIGRAPHY

The distribution of the different species of the larger foraminifera mainly (*Nummulites* and *Operculina*) in the studied succession of the studied area had enabled the identification of 4 biostratigraphic zones. These matched well with SBZ 10 to SBZ 12 of the Standard Shallow Benthic Zones of SERRA-KIEL et al. (1998). Figure 6 shows the distribution of the larger foraminifera in the studied area and the identified biostratigraphic zones, from top to base, as follows:

4. *Nummulites bassiounii*/*Decrouezina aegyptiaca/Assilina aff. major* Zone
3. *Nummulites partschi/Nummulites cf. campesinus/N. aff. nemkovi* Zone
2. *Nummulites partschi* Zone
1. *Operculina sp. Zone*
Plate 1
1–19 Nummulites partschi DE LA HARPE
1–12 Sample 22, Bed 8, Gebel Umm Russeies (section no. 1); Depository 22822–22833.
13–19 Sample 30, Bed 10, Gebel Umm Russeies (section no. 1); Depository 301034–301045.
These bio zones are assigned to the Late Ypresian following the scheme of Schaub (1981) and Serra-Kiel et al. (1998).

Depository: The material is deposited in the collection of Boukhouary, Department of Geology, Faculty of Science, Ain Shams University, Egypt.

3.1. The Morphological Characteristics of Nummulitids Taxonomy

Superfamily Nummulitacea DE BLAINVILLE, 1827
Family Nummulitidae DE BLAINVILLE, 1825
Genus Nummulites LAMARCK, 1801
Type species: Nummulites laevigatus (BRUGUIERE) [Camerina laevigata, BRUGUIERE, 1792]

Nummulites partschi Group
Nummulites partschi DE LA HARPE, 1880 (Pl. 1, Figs. 1–19)

1880 Nummulites partschi DE LA HARPE, p. 33, pl. III/1, figs. 1–7(B)
1880 Nummulites oosteri DE LA HARPE, pl. 38, pl. X/II, fig. 1–6(A)
1951 Nummulites partschi DE LA HARPE – SCHAUß, p. 140, fig. 12, 159–183; pl. 3, fig. 16–18; pl. 4, fig. 1–9, 13–15
1981 Nummulites partschi DE LA HARPE – SCHAUß, p. 108, fgs. 80, 87; pl. 28, fgs. 1–20; pl. 29, fgs. 1–14, tab. 5/c

Microspheric Form (B-Form): Form lenticular or flat, slightly irregular rounded or truncated periphery, granulation visible on the surface especially near the periphery sometimes granules arranged on or between the septal filaments, surface with radial septal filament or curved diameter 6.5–13.2 mm, thickness 2.8–3.3 mm.

Equatorial Section: With the characteristics of the Nummulites partschi group, the septa are inclined, particularly near the outer marginal cord, spire more or less regular and loosely coiled laxer toward the periphery, marginal cord relatively thick and regular, approximately, 1/5 of the height of the whorls, septa straight and slightly curved or inclined, chamber quadrangular in the centre, while isometric in the centre becoming elongated (length greater than height) near the periphery.

Number of whorls in relation to the radius is as follows: 8 whorls in a radius of 3.5 mm, 9 whorls in a radius of 3.99 mm and 10 to 12 whorls in a radius of 5.6 to 6.72 mm.

Megalospheric Form (A-Form): Form lenticular more or less inflated, truncated or rounded pillars arranged around the centre. Diameter: 2.5–4.5 mm, thickness: 1.5–2.6 mm, number of whorls v. radius; 3 whorls in a radius of 1.26–1.54 mm and 4 whorls in a radius of 1.75–1.89 mm. Protoconch size ranges from 0.35 mm to 0.49 mm.

Remarks: Our species compares well with Nummulites partschi. It differs from N. burdigalensis cantabricus Schaub as being much larger and loosely coiled coiling (Table 1).

Nummulites partschi as mentioned in Schaub (1981) has a wide distribution in the Tethyan Province and is a guide species for the Ypresian. According to Schaub (1981), Nummulites partschi lays in the phylogenetic series between Nummulites ornatus “Upper Ilerdian” and Nummulites tau ricus DE LA HARPE (Middle to Upper Cuisian).

Stratigraphic distribution: This species is recorded from the Thebes Formation of all the studied sections. In the stratigraphic section no. 1, it is recorded from Beds 8, 10 and 11. In the stratigraphic section 2, the species is recorded from Beds 3 and 8. In the stratigraphic section no. 3, the species is recorded from Beds 4, 8 and 9 and in the stratigraphic section no. 4 the species occurs in from Bed 12.

Age: Late Ypresian.

Table 1: Measurements of Nummulites partschi (this study) in comparison with Nummulites partschi described by Schauch (1981).

| Character                      | Nummulites partschi (after Schauch, 1981) | Nummulites partschi (this study) |
|-------------------------------|------------------------------------------|----------------------------------|
| Diameter A-Form               | 2.2–4.7 mm                               | 2.5–4.5 mm                       |
| Thickness                     | 1.1–2.5 mm                               | 1.5–2.6 mm                       |
| Granulation                   | granules condensed coarse and spirally arranged | granules concentrated in the polar region |
| Number of whorls and radius   | 3–4 whorls in a radius of 0.9–1.4 mm     | 3 whorls in a radius of 1.26–1.54 mm and 4 whorls in a radius of 1.75–1.89 mm |
| Protoconch size               | 0.3–0.6 mm                               | 0.35–0.49 mm                     |

| Character                      | Nummulites partschi (this study)         |
|-------------------------------|------------------------------------------|
| Diameter B-Form               | 5–13 mm                                  |
| Thickness                     | 1.8–4.5 mm                               |
| Granulation                   | granules on the whole surface of the test | granules concentrate only on the polar region |
| Number of whorls and radius   | 11 whorls in a radius of 5–5.3 mm and 13 whorls in a radius of 6 mm | 8 whorls in a radius of 3.5 mm, 9 whorls in a radius of 3.99 mm to 10–12 whorls in 5.06–6.72 mm |
Plate 2
1–8 Nummulites aff. nemkovi SCHAUÉ, sample 24, Bed 9, Gebel Umm Russeies (section no. 1); Depository 2491–24914.
Nummulites distans Group
Nummulites aff. nemkovi SCHAU 1966
(Pl. 2, Figs. 1–9)
1961 Nummulites nemkovi minor D’ARCHIAC, NEMKOV & BAR-KHATOVA, p. 63, pl. IV, figs. 5–11
1966 Nummulites nemkovi SCHAU sp. nov. – SCHAU, p. 297, fig. 2
1981 Nummulites nemkovi SCHAU, 1966, p. 183, fig. 108; pl. 66, figs. 6, 7, 20–31, 36, tab. 12/e

Microspheric Form: (B-Form): Form lenticular, flat with polar thickening, or somewhat planar with an undulating periphery, surface more or less smooth. Pillar can be seen only within the internal whorls when the external whorls are exfoliated, septal filaments curved or S-shaped and irregular, marginal cord rather thick. Diameter ranges from 17.3 to 18.5 mm and thickness from 2.1 to 2.5 mm.

Equatorial Section: Spire and septa are of the same character as the Nummulites archiaci-pratti group, the curved and broadly arched number of whorls v. radius is as follows: 13 whorls in a radius of 8.68 mm, 9 and 10 mm and 14 whorls in a radius of 9.60 mm.

Megalospheric Form (A-Form): Form lenticular, flat, septal filaments radial to undulate. A few granules occur around in a radius of 9.60 mm.

No. of whorls v. radius is as follows: 3 whorls in a radius of 1.8 mm, protoconch size ranges from 0.25 to 0.35 mm.

Remarks and differences: Nummulites aff. nemkovi is compares and matches well with the description and figures given in SCHAU (1981) except for a small difference in thickness, which seems to be lower in the present material. It is larger than N. haymanensis and smaller than N. kaufmanni and N. distans.

Stratigraphic distribution: This species is recorded from stratigraphic section no. 1, Bed 9 and 4 and in stratigraphic section no. 2, Bed 4.

Age: Late Ypresian.

Nummulites burdigalensis Group
Nummulites cf. campesinus SCHAU, 1966
(Pl. 3, Figs. 1–14)
1966 Nummulites campesinus sp. – SCHAU (1966a), p. 361, figs. 3k–n; figs. 4, 5; pl. 1, figs. 22–27; pl. II, figs. 1–15
1973 Nummulites campesinus SCHAU – KAPELLOS, p. 77, figs. 162–170; pl. 47, figs. 1–9; pl. 48, figs. 1–4
1974 Nummulites campesinus SCHAU – PAVLOVEC in CIMERMAN et al., p. 66 to 70, pl. 17, 18
1976 Nummulites campesinus SCHAU – RAHAGHI & SCHAU, p. 773, pl. III, figs. 1–6
1981 Nummulites campesinus SCHAU, p. 83, figs. 72, 74, 81; pl. 7:23–44; pl. 8:1–22; pl. 9:1–20; tab. 2:g,h

Microspheric Form (B-Form): Test lenticular to flat, septal radial or S-shape and wrinkled in a few specimens, granulated with granules covering the whole surface of the test. Diameter ranges from 5.8 to 9.8 mm, thickness is 1.8–3.1 mm.

Equatorial Section: Spire regular, as in the Nummulites burdigalensis group, test lenticular with a more or less rounded periphery, marginal cord rather thick, number of whorls v. radius is as follows: 12 whorls in a radius of 4.3 mm and 13 whorls in a radius of radius 4.6 mm.

Megalospheric Form (A-Form): Form biconical lenticular thick in the middle of the test; surface with radial septal filaments or curved with developing granules in the pole. Diameter ranges from 2.5–3.6 mm, thickness is 1.0–1.9 mm.

Equatorial Section: Spire as in form B is regular with the character of Nummulites burdigalensis group. Number of whorls v. radius is as follows: 5 whorls in a radius of 1.4–1.8 mm, protoconch size ranges from 0.25 to 0.35 mm.

Remarks: Nummulites cf. campesinus is a primitive stage of N. campesinus SCHAU; it falls into the lower part of the dimensional range of this species.

Stratigraphic distribution: Several occurrences of this species are recorded from the Thebes Formation, stratigraphic section no. 1, Beds 18 and 19; stratigraphic section no. 2, Beds 8, 9 and 10, stratigraphic section no. 3, Bed 10, and stratigraphic section no. 4, Beds 13 and 14.

Age: Late Ypresian.

Table 2: Comparison between Nummulites cf. campesinus and Nummulites campesinus (measurements from SCHAU, 1981).

| Character          | Nummulites cf. campesinus SCHAU (this study) | Nummulites campesinus SCHAU (from SCHAU, 1981) |
|--------------------|---------------------------------------------|-----------------------------------------------|
|                    | **B-Form**                                  | **A-Form**                                    |
| Diameter           | 5.8–9.8 mm                                  | 2.5–3.6 mm                                   |
| Thickness          | 1.8–3.1 mm                                  | 1.0–1.9 mm                                   |
| No. or whorls v. radius | 12–13 per radius 4.4–4.6 mm | 4–5 mm                                        |
| Granulation        | granulated                                  | 5 whorls in a radius 1.4–1.8 mm              |

|                     | Nummulites cf. campesinus SCHAU (this study) | Nummulites campesinus SCHAU (from SCHAU, 1981) |
|                     | **B-Form**                                  | **A-Form**                                    |
| Diameter           | 5–12 mm                                     | 4–5 mm                                        |
| Thickness          | 3–5 mm                                      | 2.5 mm                                        |
| No. of whorls v. radius | 11 whorls in 2.5–4.2 mm and 15 whorls in 2.4 to 4.6 mm | 4–5 whorls in a radius 1.7–2.0 mm             |
| Protoconch size    | 0.25–0.35 mm                                | 0.35–0.45 mm                                  |
Plate 3
1–14 Nummulites cf. campesinus SCHaub, sample 65, Bed 14, south of Wadi Naoz (section no. 4); Depository 65141–651414.
**Nummulites subramondi Group**

**Lineage of Nummulites perplexus** SCHAUB, 1981

**Nummulites bassiounii** BOUKHARY & BLONDEAU, 1991

(Pl. 4, Figs.1–14)

1883 *Nummulites lincana* obsolete – DE LA HARPE, p. 208, pl. 4, figs. 11–14, Form-A (non *N. obsolete* DE LA HARPE, 1877), p. 824, pl. XL, figs. 8a, b)

1991 *Nummulites bassiounii* – BOUKHARY & BLONDEAU, p. 23, fig. 5 (1–9), (with the listed synonymy)

**Microspheric Form (B-Form):** Test of medium size, lenticular with truncated subangular margin, granulated in juveniles and non granular in adults as in this generation the granulation is a regressive feature. Septal filaments radial, S-shaped to broadly meandering or wrinkled. Diameter ranges from 8.5 mm to 16.2 mm and thickness ranges from 3 to 6 mm.

**Equatorial section:** Spire regular and the septa are typical of the *Nummulites subramondi* group, curved at the base while perpendicular at the top. Number of whorls against the radius: 10–14 whorls in a radius of 5.5–6.25 mm and 15–17 whorls in a radius of 6.30–7.7 mm.

**Megalospheric Form (A-Form):** Test small, lenticular to biconical with radial septal filaments slightly twisted at the pole. A few small granules on the pole are observed. Diameter ranges from 3.0 to 4.0 mm, thickness ranges from 1 to 2 mm. Number of whorls v. radius: 4 whorls in a radius of 1.7 to 1.89 mm. Protoconch diameter ranges from 0.49 to 0.6 mm.

**Remarks:** *Nummulites bassiounii* BOUKHARY & BLONDEAU (1991) was believed to be the ancestral form of *Nummulites perplexus* SCHAUB (1981). Both of these are related to the *Nummulites subramondi* group.

**Stratigraphic distribution:** It occurs in the Minia Formation stratigraphic section no. 2, from Bed 15 and section no. 3 from Bed 13.

**Age:** Late Ypresian.

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**Genus: Assilina** D’ORBIGNY, 1839

**Type Species:** *Assilina spira* DE ROISSY, 1805 designated by D’ARCHIAC & HAIME, 1853

**Assilina aff. major** HEIM, 1908

(Pl. 1, Figs. 1–10)

aff. 1908: *Assilina granulose var. major* HEIM, p. 247, fig. 24e; pl. 6, fig. 26
aff. 1963: *Assilina major* HEIM – SCHAUB, p. 294, fig. 5
aff. 1963: *Assilina major* SCHAUB – PAVLOVEC, p. 474, fig. 35
aff. 1966b: *Assilina major* HEIM – SCHAUB, p. 294, fig. 1
aff. 1974: *Assilina major* SCHAUB – PAVLOVEC in CIMERMAN et al., p. 56; pl. 10–12; pl. 13, fig. 1
aff. 1976: *Assilina major* HEIM – RAHAGI & SCHAUB, p. 799; pl. 7, figs. 8–10

**Microspheric Form (B-Form):** Discoidal, slightly undulated and highly granulated near the centre. Diameter ranges from 13 to 17 mm, thickness is 1.2–2.2 mm.

**Equatorial Section:** In keeping with the characteristics of the *Assilina spira* group, the number of whorls for given radius is as follows: 8 whorls in a radius of 7.35 mm, 6.51 mm, and 6.86 mm and 9 whorls in a radius of 7.1 mm and 7.91 mm.

**Megalospheric Form (A-Form):** Diameter ranges from 3.5–6.2 mm, thickness is 0.6–1.2 mm. Number of whorls per radius is as follows: 3 whorls in a radius between 1.47–2.83 and 5 whorls in a radius of 2.975 mm, 3.08 mm, 2.94 mm, 3.01 mm and 2.94 mm. Diameter of protoconch ranges from 0.28 mm to 0.42 mm (Table 3).

**Stratigraphic distribution:** This species is only recorded only from stratigraphic section no. 2, Bed 16.

**Remarks:** Our species compares well with *Assilina major* of SCHAUB (1981).

**Age:** Late Ypresian.

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**Table 3: Comparison between Assilina major (this study) and Assilina major HEIM, of SCHAUB (1981).**

| Character          | Assilina major HEIM (this study) | Assilina major HEIM in SCHAUB, 1981 |
|--------------------|----------------------------------|-------------------------------------|
| **B-Form**         |                                  |                                     |
| Diameter           | 13–17 mm                         | 17–26 mm                            |
| Thickness          | 1.2–2.2 mm                       | 1.2–2.5 mm                          |
| No. or whorls v. radius | 8 whorls in a radius of 6.5–7.0 mm | 10 whorls in a radius of 8.5–11.5 mm |
| No. of whorls      | 8–9 whorls                       | 10–12 whorls                        |
| Diameter           | Present                          | Present                             |

| **A-Form**         |                                  |                                     |
| Diameter           | 3.5–6.2 mm                       | 6–10 mm                             |
| Thickness          | 0.60–1.2 mm                      | 0.8–1.5 mm                          |
| No. of whorls v. radius | 3 whorls in a radius of 1.5–2.5 mm | 5 whorls in a radius of 3.5–5.0 mm   |
| Protoconch size    | 0.28–0.42 mm                     | 0.5–0.9 mm                          |
Plate 4
1–14 Nummulites bassiounii BOUKHARY & BLONDEAU, sample 47, Bed 13, Gebel Umm Russeies; Depository 741–7414.
Plate 5
1–10 Assilina aff. major HEIM, sample 98, Bed. 16 (section no. 2); Depository 98161–981610.
Plate 6

1–15 *Operculina* sp., sample 2, Bed 1, Esna Shale, Gebel Umm Russeies (section no. 3); Depository 211–2115.

16–21 *Decrouezina aegyptiaca* (CUVILLIER), sample 52, Bed 13, southwest of Wadi Naoz (section no. 3); Depository 521316–251321.
Table 4: Comparison between Nummulitic zonations in Paleogene of Crimea with those in Galala Plateau Egypt, (after KAPELLOS, 1973).

| Paleogene stratigraphic commission of Soviet Union after BERGGREN (1971) | WADE (1984) | XI European micropalaeontological Congress (1971) | KAPELLOS (1973) | This study (Northern Galala Plateau, Egypt) | SERRA-KIEL et al. (1998) scheme | Time Unit |
|-----------------------------|-----------------|---------------------------------|-----------------|---------------------------------|---------------------------------|---------|
| Crimea Bakchisaray         | Crimea          | Crimea                          | Crimea          |  |                                 |                                 |         |
| BIODRAKIAN                  |                  |                                 |                  |                  |                                  | Lutelian |         |
| Acarinina rotundis marginalis zone | A. rotondus  | Chokrinogalithus quadratus zone  | Lutetian         |                  |                                 | Lutetian |         |
| Nummulites marginata zone   |                 |                                 |                  |                  |                                  |         |         |
| Acarinina crassaformis zone  |                 |                                 |                  |                  |                                  |         |         |
| Nummulites polygonatus zone  |                 |                                 |                  |                  |                                  |         |         |
| Dicoaster iodoxalis zone    |                 |                                 |                  |                  |                                  |         |         |
| SIMFEROPOLIYAN             |                  |                                 |                  |                  |                                  |         |         |
| Globorotalia aragonensis caucasica zone |                 |                                 |                  |                  |                                  |         |         |
| Nummulites distans zone     |                 |                                 |                  |                  |                                  |         |         |
| Nummulites distans minor zone |                 |                                 |                  |                  |                                  |         |         |
| Dicoaster iodoxalis zone    |                 |                                 |                  |                  |                                  |         |         |
| BAKCHISRARIAN               |                  |                                 |                  |                  |                                  |         |         |
| Globorotalia magnicostata zone |                 |                                 |                  |                  |                                  |         |         |
| Nummulites crinulosa zone   |                 |                                 |                  |                  |                                  |         |         |
| Dicoaster iodoxalis zone    |                 |                                 |                  |                  |                                  |         |         |
| GATYATSIAN                  |                  |                                 |                  |                  |                                  |         |         |
| Operculina seminula zone    |                 |                                 |                  |                  |                                  |         |         |
| Marnhastites trilobatus zone |                 |                                 |                  |                  |                                  |         |         |
| Kossovo zone                |                 |                                 |                  |                  |                                  |         |         |
| KACHIAN                     |                  |                                 |                  |                  |                                  |         |         |
| Acarinina acarinata zone    |                 |                                 |                  |                  |                                  |         |         |
| Acarinina subglobosa zone    |                 |                                 |                  |                  |                                  |         |         |
| Acarinina tajikistanensis djahanis zone |           |                                 |                  |                  |                                  |         |         |

|                      |                  |                                 |                  | N. bassouieii / Decroueziana aegyptica / Assilina aff. major Biozone | SBZ 12 | Late    |
|                      |                  |                                 |                  | Nummulites partsi / N. aff. nemkovi / N. cf. campestris Biozone | SBZ 11 | Middle  |
|                      |                  |                                 |                  | Nummulites partsi Biozone | SBZ 10 | Early   |
|                      |                  |                                 |                  | D. birostratus zone | D. multitubulatus zone | Iliened |         |
|                      |                  |                                 |                  | Heliolithus riedeli zone |                  | Middle Palaeocene | Not exposed |
Genus *Decrouezina* BOUKHARY, 1994  
*Decrouezina aegyptiaca* (CUVILLIER, 1930)  
(Pl. 6, Figs. 1–15)

1883 *Operculina* cf. *canalifera* D’ARCHIAC – SCHWAGER, p. 144, pl. 19, fig. 3

1930 *Assilina praepirina* DOUVILLE var. *aegeytiaca* CUVILLIER, p. 139, pl. 13, fig. 4

1990 *Operculina praepirina* var. *aegeytiaca* CUVILLIER – STROUGO et al., p. 64

1994 *Decrouezina aegyptiaca* CUVILLIER – BOUKHARY, p. 97, pl. 1, figs. 1–7

Microspheric Form (B-Form): Test flat with central swelling. Test of medium size, assilinoid in shape with thick marginal cord. Test evolve except for the central part (about 3 whorls) which is involute. Diameter is up to 25 mm, 5–6 whorls in 12 mm.

Megalospheric Form (A-Form): Test small and flat, diameter ranges from 3.7 to 5.5 mm; protoconch ranges from 0.35 to 0.42 mm.

Remarks: *Decrouezina* (type-species: *Assilina praepirina* var. *aegeytiaca* CUVILLIER, 1930) was believed by BOUKHARY (1994) as the descendant taxon of *Ranikothalia*, for the presence of common characters between both, such as the thick marginal cord, presence of plexus marginalis. The phylogeny of this group of taxa is from tight open.

Stratigraphic distribution: This species occurs in Gebel Umm Russeies in stratigraphic section no. 3, bed 13.

Age: Late Ypresian.

*Operculina* sp.  
(Pl. 6, Figs. 1–15)

Microspheric Form (B-Form): Test flat loose spire with a rather thick marginal cord. Test granulated and granulation concentrated in the central part of the test. Septa in the last whorl are upright, oblique in the first part. Chambers are high and narrow. Diameter 2.38 to 5.6 mm, thickness: 0.84 to 1.12 mm.

Megalospheric Form (A-Form): Test small, in axial section the first and second chambers are rounded, isolepide, the middle part is triangular. In equatorial section the septa are perpendicular at the base while arched at the top.

Diameter: 0.63 to 1.62 mm, thickness: 0.21 to 0.77 mm. Protoconch ranges from 0.12 to 0.17 mm.

Stratigraphic distribution: *Operculina* sp. is recorded from the Esna Shale, stratigraphic section no. 3, Bed 1.

Age: Late Ypresian.

Table 4 shows the comparison between the biozones recorded from Gebel Umm Russeies, and Northern Galala with those recorded from the Palaeogene of the Crimea after (KAPPELLOS, 1973), and the standard shallow benthic zones (SBZ) identified by SERRA-KIEL et al., 1998.

4. CONCLUSIONS

At Gebel Umm Russeies, the Ypresian sediments unconformably overlie Upper Cretaceous rock; the Palaeocene is completely missing. However, at Wadi Naot (Northern Ga-
lala) a nearby section to the Gebel Umm Russeies study area, the Palaeocene section is well represented between the Upper Cretaceous and the Ypresian units. Further north in the Gebel Ataqa area, the Palaeocene is also missing (OSMAN, 2003).

In the Southern Galala Plateau where the Lower Eocene rocks are exposed, the following foraminifera have been observed: *Nummulites praetecticus*, *N. saharaensis* and *Basionina sanctipauli* (BOUKHARY et al., 1998). At Gebel Umm Russeies this assemblage is missing, instead the microfauna here includes *Operculina* sp. The different faunas in the two locations belong to the same time (Early Ypre-
sian), yet the conditions of deposition varied greatly from a reefal shallow environment in the south hence the flourishing of *Nummulites* to an open platform in the north where these fossils are replaced by *Operculina*.

The Gebel Umm Russeies area seems to have been uplifted after the Upper Cretaceous sediments namely the Adhiba Formation were deposited (EL AKKAD & ABDAL-
LAH, 1971) for the whole of the Palaeocene. To the south, the blocks were submerged during this time span hence Pal-
aeocene sediments were deposited. Over many blocks in both the Northern and Southern Galala, the sedimentary basin be-
came more shallow because of infilling by these sediments, hence the environment of deposition of the next sediment (Early Ypresian, Esna Shale) includes shallow marine fauna i.e. *Nummulites* spp. In contrast, at the Gebel Umm Russeies section, the platform was relatively deeply drowned and a different fauna (*Operculina* sp.) flourished.

The Thebes Formation (Ypresian) covers a huge stretch of Egypt to the latitude of 22° 40' in the south. An extensive Tethyan transgression during the Ypresian was recorded over many parts of Egypt. Marine waters transgressed over the Gulf of Suez blocks regardless of their locations. All the blocks are capped by Lower Eocene rocks, representing different envi-
ronmental conditions, but all belonging to the Ypresian.

At Gebel Umm Russeies, the Thebes Formation is re-
presented by Carbonate beds, partly marly, chalky and dolo-
mite. Nodular limestones are common – whereas oolites are of limited occurrence.

ACKNOWLEDGEMENT

The authors deeply thank Prof. Bahay ISSAWI, Prof. of Stratigraphy (ex in the Geological Survey of Egypt) for his revision of the manu-
script. Acknowledgements are extended to Prof. Mohamed EL AMIN BASSIOUNI (Ain Shams University) for his valuable comments during the progress of the work. The authors are grateful to Prof. Jochen KUSS (Bremen University) for critically revising the manuscript. Deep gratitude goes to the two reviewers Prof. Cesare PAPAZZONI and Danielle DECREUZE for their review of the manuscript which improved it substantially. Many thanks to Prof. Amin STROUGO (Ain Shams University) for his help in the field work.

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Manuscript received January 2, 2008
Revised manuscript accepted May 5, 2008