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## TERTIARY FORAMINIFERAL LIMESTONES FROM SINAI.

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(PLATES XIII AND XIV.)

THE following descriptions are based upon a collection of foraminiferal limestones, chiefly nummulitic, from Sinai, which were sent to the British Museum for description and determination by Captain H. G. Lyons, R.E., F.G.S., Director of the Geological Survey of Egypt.

Our previous knowledge of Sinaitic foraminifera has been somewhat scanty. It was pointed out, however, chiefly by Bauerman, that the Nummulitic Series is very well developed in this particular area, the country on the east side of the Gulf of Suez.

The occurrence of *Nummulites* and *Operculina* is recorded in Mr. Bauerman's paper<sup>1</sup> mainly from a locality south of Wadi Gharandel. Professor Rupert Jones supplied a note to that paper, and from the latter locality recorded *Nummulites Gizehensis* (large and small), *N. Ramondi*, *N. curvispira*, and *N. intermedia*; whilst from "the lowest rock seen just beyond Pharaoh's Fall" he records remains of *Nummulites Ramondi* and *Operculina canalifera* (?).

Foraminifera have been recorded from Sinai also by Ehrenberg.<sup>2</sup> These were principally obtained from washings of the rocks, and consequently are exceptionally minute forms.

Other occurrences of foraminifera from the adjacent country, chiefly Palestine, are noted by Fraas,<sup>3</sup> who described a form under the name of *Nummulites cretacea* from the Hippurite Limestone near Jerusalem, and which from the figure given is certainly not a nummulite, but bears some resemblance to a turgid *Orbitoides*, and is most probably of Tertiary age.<sup>4</sup> The same author mentions two other species, *Nummulites variolaria* and *N. Arabiensis*.

Lartet has figured and noted three species of *Nummulites* from Wadi Gharandel,<sup>5</sup> namely, *N. Lyelli*, *N. Guettardi*, and *N. Lucasana*.

<sup>1</sup> "Note on a Geological Reconnaissance made in Arabia Petraea in the Spring of 1868": Quart. Journ. Geol. Soc., vol. xxv (1868), p. 38.

<sup>2</sup> Mikrogeologie, vol. ii (1854), pl. xxv c. Also Parker & Jones: Ann. Mag. Nat. Hist., vol. ix (1872), p. 289.

<sup>3</sup> Aus dem Orient, 1867, pp. 82-4, pl. i, figs. 8a-c.

<sup>4</sup> See also Lartet: "Explor. géol. Mer Morte," 1877, pp. 157-9.

<sup>5</sup> Lartet, "Essai sur la Géol. Palestine," pt. ii, Paléontologie: Ann. Sci. géol., vol. iii (1872), p. 89, pl. ix, figs. 23, 25, 26.

Lastly, a series of specimens collected by the Palestine Exploring Expedition in 1865 from Gerizhem have been identified by Professor T. Rupert Jones,<sup>1</sup> who enumerates ten species, and some of these are comparable with our Sinaitic specimens.

The specimens dealt with in this paper were collected by Mr. Barron, of the Egyptian Geological Survey, between January and June, 1899.

The following is an epitomized account of the rock-specimens, with their contents:—

**No. 4,111, 1l.**—“Foraminiferal limestone; top of Jebel Abyad, south of Wadi Gharandel, Sinai.” Mokattam Series (Middle Eocene).

A dense cream-coloured limestone, largely composed of *Nummulites subdiscorbina* and *N. curvispira*, associated with a fair number of *N. Gizehensis*, var. *Pachoi*. The nummulites in these rock-specimens lie massed together, forming a kind of bank, which is in turn covered with fine detrital mud containing smaller foraminifera, such as *Bolivina*, *Globigerina*, *Discorbina*, and *Rotalia*. One of the nummulites in this rock has been partially transformed into beekite.

The genera and species found in these rock-specimens are:—*Bolivina punctata*?, d'Orbigny; *Globigerina bulloides*, d'Orb.; *G. conglobata*, Brady; *G. cretacea*?, d'Orb.; *Discorbina rugosa* (d'Orb.); *D. globularis* (d'Orb.); *Rotalia calcariformis* (Schwager); *Nummulites subdiscorbina*, De la Harpe; *N. curvispira*, Meneghini; *N. Gizehensis*, Ehr., var. *Pachoi*, De la Harpe; *Orbitoides dispansa* (Sow.); *O. ephippium* (Schlotheim); and *O. papyracea* (Boubée).

**No. 4,112, 2l.**—“Foraminiferal limestone, beach deposit (later);<sup>2</sup> Jebel Abyad, Sinai.” ? Bartonian (Upper Eocene) or ? top of Mokattam Series (Middle Eocene).

A soft-textured, pale cream-coloured rock. Thin sections of this specimen when viewed under the microscope show the rock to be finely granular to crystalline, and to contain a fair number of foraminifera, some of which are broken and worn (? derived).

The foraminifera in this rock are:—*Globigerina bulloides*, d'Orb.; *Operculina complanata* (Defr.), var. *discoidea*, Schwager; *Nummulites planulata* (Lamarck); *N. variolaria* (Lam.); and *Orbitoides dispansa* (Sowerby).

**Nos. 4,135, 3l, and 4,113, 4l.**—“Foraminiferal limestone; junction of Wadi Baba and Wadi Shellál.” Libyan Series (Lower Eocene).

This rock has a whitish chalky appearance, and is seen under the microscope to be almost completely recrystallized as dolomite, the rhomb-sections of that mineral being very perfect. The foraminifera have retained generally their shape and structure, but in many instances their tests are bitten up by dolomite rhombs. The chambers of the foraminifera are also often filled up by the crystals. Besides foraminifera numerous fragments of polyzoa (unaltered) are scattered throughout the rock.

<sup>1</sup> Catal. Foss. Foram. Brit. Mus., 1882, p. 49.

<sup>2</sup> Mr. Barron writes (March, 1900) with regard to this deposit: “It has the characters of a beach deposit in that it is gritty and contains well-marked conglomerate beds. There is no doubt, however, that it is part of the Eocene series.”

The foraminifera seen in these specimens are:—*Textularia agglutinans*, d'Orb.; *Operculina complanata* (Defr.), var. *canalifera*, d'Archiac; and *Nummulites Ramondi*, Defr.

No. 4,163, 5l.—“Nummulites near top of Jebel Safariat, Sinai.” Mokattam Series (Middle Eocene).

A collection of nummulites of the type *N. complanata*, comprising *N. Gizehensis* (Forskål), var. *Ehrenbergi*, De la Harpe; *N. Gizehensis*, var. *Lyelli*, d'Archiac & Haime; and *N. Gizehensis*, var. *Pachoi*, De la Harpe.

No. 3,598, 13l.—“Nummulitic bed, Wadi Khadâhid, Sinai.” Mokattam Series (Middle Eocene).

An ochreous-coloured, incoherent limestone, consisting almost entirely of nummulites (chiefly *N. curvispira*).

The following foraminifera were found:—*Truncatulina umbonifera* (Schwager); *Nummulites Gizehensis*, var. *Pachoi*, De la Harpe; *N. curvispira*, Meneghini; *N. Barroni*, sp. nov.; and *N. Ramondi*?, DeFrance.

No. 3,902, 15l.—“Foraminiferal limestone, Jebel Krer (same range as Jebel Abyad), Sinai.” Libyan Series (Lower Eocene).

An impure chalky limestone, with many included fragments of an older rock, possibly Cretaceous in age, which includes *Globigerina cretacea*?, d'Orb. When viewed microscopically, this limestone appears to have originally been a fine-grained calcareous mud, with numerous specimens of foraminifera. We find here *Miliolina circularis* (Born.); *Alveolina Boscii* (Defr.); *A. decipiens*, Schwager; *Bigennerina? nodosaria*, d'Orb.; *Globigerina cretacea*?, d'Orb.; *Operculina complanata* (Defr.), var. *canaliculata*, d'Archiac; *Nummulites Guettardi*, d'Arch. & Haime, var. *antiqua*, De la Harpe; *Orbitoides dispansa* (Sow.); and *O. papyracea* (Boubée).

In the following descriptions, especially with regard to the nummulites, I have had the advantage of consulting Professor T. Rupert Jones, F.R.S., to whom I am much indebted.

## FORAMINIFERA.

### Family MILIOLIDÆ.

#### Subfamily MILIOLININÆ.

#### MILIOLINA, Williamson [1858].

#### *Miliolina circularis* (Bornemann). (Pl. XIV, Fig. 1.)

*Triloculina circularis*, Bornemann, 1855: Zeitsch. deutsch. Geol. Gesell., vol. vii, p. 349, pl. xix, fig. 4.

*Miliolina circularis* (Born.), Sherborn & Chapman, 1886: Journ. Roy. Micro. Soc., ser. II, vol. vi, p. 742, pl. xiv, figs. 2a, b.

A *Miliolina* occurs in a section of one of the Sinai limestones. It perfectly agrees in outline and the disposition of the inner chambers with the above species, especially those found in Tertiary clays elsewhere, as the London Clay and the Septarian Clay of Hermsdorf.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15l. Libyan Series (Lower Eocene) : Jebel Krer, Sinai.

Subfamily ALVEOLININÆ.

ALVEOLINA, d'Orbigny [1826].

*Alveolina Boscii* (DeFrance). (Pl. XIII, Fig. 6a.)

*Oryzaria Boscii*, DeFrance, 1820 : Dict. Sci. Nat., vol. xvi, p. 106 ; Atlas Zooph., pl. xlviii, fig. 4.

*Alveolina Boscii* (Defr.), d'Orb., 1826 : Ann. Sci. Nat., vol. vii, p. 306, No. 5 ; Modèles, No. 50. Brady, 1884 : Rep. Chall., vol. ix, p. 222, pl. xvii, figs. 7-12.

The elongate and more or less fusiform specimens of *Alveolina* in the oldest Tertiary limestones of Sinai may be referred to the above species. Schwager figures an allied form, *A. frumentiformis*,<sup>1</sup> which is more slender than *A. Boscii*, from the Egyptian limestone of the Libyan Series.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15l. Libyan Series (Lower Eocene) : Jebel Krer, Sinai. Rare.

*Alveolina (Flosulina) decipiens*, Schwager. (Pl. XIV, Fig. 2.)

*Alveolina (Flosulina) decipiens*, Schwager, 1883 : Palæontographica, vol. xxx, Pal. Theil, p. 103, pl. xxvi (iii), figs. 1a-k.

This interesting species appears to be similar to some *Alveolina* from India, associated in like manner with *Nummulites* and *Orbitoides*. It was found by Schwager in the Libyan Series of Nekeb-el-Farudj and El-Guss-Abu-Said.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15l. Libyan Series (Lower Eocene) : Jebel Krer, Sinai. Frequent.

Family TEXTULARIIDÆ.

Subfamily TEXTULARIINÆ.

TEXTULARIA, DeFrance [1824].

*Textularia agglutinans*, d'Orbigny. (Pl. XIV, Fig. 3.)

*Textularia agglutinans*, d'Orb., 1839 : Foram. Cuba, p. 144, pl. i, figs. 17, 18, 32-34.

A specimen of the above was met with in one of the sections, which has the aboral end somewhat more attenuate than is usual in the typical form. The texture of the shell-wall is coarsely arenaceous, and the limestone in which it occurs was probably deposited in quite shallow water.

Coll. Geol. Surv. Egypt, No. 4,113, Box No. 4l. Libyan Series (Lower Eocene) : junction of Wadi Baba and Wadi Shellál.

BIGENERINA, d'Orbigny [1826].

*Bigenerina nodosaria* ?, d'Orbigny. (Pl. XIII, Fig. 7b.)

*Bigenerina nodosaria*, d'Orb., 1826 : Ann. Sci. Nat., vol. vii, p. 261, No. 1, pl. xi, figs. 9-11 ; Modèles, No. 57.

*Dimorphina nodosaria*, d'Orb., 1846 : Foram. Foss. Vienne, p. 221, pl. xii, figs. 21, 22. *Bigenerina nodosaria*, d'Orb., Brady, 1884 : Rep. Chall., vol. ix, p. 369, pl. xlv, figs. 14-18.

<sup>1</sup> Palæontographica, vol. xxx (1883), Pal. Theil, p. 100, pl. xxv (ii), figs. 4a-i.

A vertical section of a stout bigenerine form occurs in one of the sections, and is most probably referable to the above species. *B. nodosaria* has been recorded from various deposits dating from Middle Tertiary times.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15*l*. Libyan Series (Lower Eocene) : Jebel Krer, Sinai.

Subfamily BULIMININÆ.

BOLIVINA, d'Orbigny [1839].

*Bolivina punctata*?, d'Orbigny. (Pl. XIV, Fig. 4.)

*Bolivina punctata*, d'Orb., 1839 : Voyage Amér. Mérid., vol. v, Foraminifères, p. 63, pl. viii, figs. 10-12.

*B. phylloides* (Ehrenberg), Schwager, 1883 : Palæontographica, vol. xxx, Pal. Theil, p. 113, pl. xxix (vi), fig. 10.

The specimen under notice is a vertical section of a narrow form cut at such an angle as to give a chevroned aspect to the chambers. It is possibly referable to the well-known Tertiary species *Bolivina punctata*, and similar specimens have occurred in both the Libyan and Mokattam Series of Egypt.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1*l*. Mokattam Series (Middle Eocene) : top of Jebel Abyad, south of Wadi Gharandel, Sinai.

Family GLOBIGERINIDÆ.

GLOBIGERINA, d'Orbigny [1826].

*Globigerina bulloides*, d'Orbigny. (Pl. XIV, Fig. 5.)

*Globigerina bulloides*, d'Orb., 1826 : Ann. Sci. Nat., vol. vii, p. 277, No. 1 ; Modèles, No. 76. Schwager, 1883 : Palæontographica, vol. xxx, Pal. Theil, p. 118, pl. xxvii (iv), figs. 5*a-c*.

Several undoubted specimens of this form were detected in the fine material of the sections made from rock-specimen No. 4,112. Schwager found *G. bulloides* in both the Libyan and the Mokattam Series in Egypt.

Coll. Geol. Surv. Egypt, No. 4,112, Box No. 2*l*. Bartonian Series (Upper Eocene) or top of Mokattam Series (Middle Eocene) : Jebel Abyad, Sinai.

*Globigerina conglobata*, Brady. (Pl. XIV, Fig. 6.)

*Globigerina conglobata*, Brady, 1879 : Quart. Journ. Micro. Sci., vol. xix, p. 72. Id., 1884 : Rep. Chall., vol. ix, p. 603, pl. lxxx, figs. 1-5 ; pl. lxxxii, fig. 5.

This species is occasionally seen in the sections of No. 4,111, but the specimens are somewhat fragmentary. It has previously occurred in beds as old as the Oligocene or Miocene, notably in the limestones of Christmas Island. It is distinguished by the fewness of the chambers and the comparative thickness of the shell-walls.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1*l*. Mokattam Series (Middle Eocene) : top of Jebel Abyad, south of Wadi Gharandel, Sinai.

*Globigerina cretacea*?, d'Orbigny. (Pl. XIV, Fig. 7.)

*Globigerina cretacea*, d'Orb., 1840: Mém. Soc. géol. France, ser. I, vol. iv, p. 34, pl. iii, figs. 12-14.

*G. cf. cretacea*, d'Orb., Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 119, pl. xxix, figs. 13a-d.

Numerous small specimens of a small-chambered, neatly coiled *Globigerina*, very closely resembling *G. cretacea*, occur in the presumably oldest nummulitic beds of Sinai. This species has also been doubtfully referred to as occurring in the argillaceous beds (Libyan Series) of El-Guss-Abu-Said by Schwager.

It is of great interest to note this occurrence here, since if the species be proved by specimens isolated from the rock, they will either have been derived from neighbouring Cretaceous beds or otherwise show an upward range for the species, typical examples of which are not known out of the Cretaceous formations.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Also No. 3,902, Box No. 151. Libyan Series (Lower Eocene: Jebel Krer (same range as Jebel Abyad), Sinai.

## Family ROTALIIDÆ.

## Subfamily ROTALIINÆ.

## DISCORBINA, Parker &amp; Jones [1862].

*Discorbina rugosa* (d'Orbigny). (Pl. XIV, Fig. 9.)

*Rosalina rugosa*, d'Orb., 1839: Voyage Amér. Mérid., vol. v, pt. 5, Foraminifères, p. 42, pl. ii, figs. 12-14.

*Discorbina rugosa* (d'Orb.), Brady, 1884: Rep. Chall., vol. ix, p. 652, pl. lxxxvii, figs. 1, 4. Sherborn & Chapman, 1889: Journ. Roy. Micro. Sci., p. 487, pl. xi, fig. 33.

This neat little shallow-water organism is fairly well known in Eocene strata, and is a characteristic form in the London Clay.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai.

*Discorbina globularis* (d'Orbigny). (Pl. XIV, Fig. 8.)

*Rosalina globularis*, d'Orb., 1826: Ann. Sci. Nat., vol. vii, p. 271, No. 1, pl. xiii, figs. 1-4; Modèles, 1826, No. 69.

*Discorbina globularis* (d'Orb.), 1897, Jones & Chapman, in Professor Judd's Second Report on specimens of the deposits of the Nile Delta: Proc. Roy. Soc., vol. lxi, p. 38.

The specimen seen in section is that of a simple, strongly inflated *Discorbina*, similar to the above-named species. It has already been recorded from slices of Eocene pebbles from the Nile Delta, and it is also known from the Eocene of Grignon. It occurs in nearly all fossiliferous strata dating from Tertiary times to the present. In recent deposits *D. globularis* is most abundant in shallow water, averaging about 50 fathoms.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai.

TRUNCATULINA, d'Orbigny [1826].

*Truncatulina umbonifera* (Schwager). (Pl. XIV, Figs. 10a, b.)

*Discorbina umbonifera*, Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 126, pl. xxvii (iv), figs. 14a-d.

The specimen obtained from the limestone of Sinai is apparently a depauperated or irregularly grown individual of the above species. The affinities of the original specimens and also of the present appear to be nearer *Truncatulina* than *Discorbina*. Schwager's specimens came from the Libyan Series of El-Guss-Abu-Said, Egypt.

Coll. Geol. Surv. Egypt, No. 3,598, Box No. 13l. Mokattam Series (Middle Eocene): Wadi Khadâhid, Sinai.

ROTALIA, Lamarck [1804].

*Rotalia calcariformis* (Schwager). (Pl. XIV, Fig. 11.)

*Discorbina calcariformis*, Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 120, pl. xxvii, figs. 9a-d.

The specimens seen in these sections show a true rotaliform structure in the shell-wall, with an interseptal canal system. Schwager's figures also show secondary shell-thickening, and we therefore refer them to the genus *Rotalia*. *R. calcariformis* is not far removed in outline from *R. calcar* of the present day, but since the latter species shows a marked tendency to vary in the direction of the elongation of the cuspid processes on the outer segments, and *R. calcariformis* has a somewhat blunt cusp, the two series of specimens may reasonably be kept distinct.

*R. calcariformis* was found in the argillaceous beds of El-Guss-Abu-Said (Libyan Series), Egypt.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1l. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Frequent.

Family NUMMULINIDÆ.

Subfamily NUMMULITINÆ.

OPERCULINA, d'Orbigny [1826].

*Operculina complanata* (Defrance), var. *canalifera*, d'Archiac.

(Pl. XIII, Figs. 3a, 4a; Pl. XIV, Fig. 12.)

*Operculina ammonæa*, Leymerie (pars), 1844: Mém. Soc. géol. France, ser. II, vol. i, p. 359, pl. xiii, fig. 11.

*O. canalifera*, d'Archiac, 1850: Hist. Prog. Géol., vol. iii, p. 245. D'Archiac & Haime, 1853: Deser. Anim. groupe nummulitique Inde, p. 182, pl. xii, figs. 1a-c; and vol. ii (1854), p. 346, pl. xxxv, fig. 5a; pl. xxxvi, figs. 15a, 16a.

*O. libyca*, Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 142, pl. xxix (vi), figs. 2a-g.

After a careful comparison of the various specimens of the large and compressed forms of *Operculina* which are often so abundant in the nummulitic series and subsequent formations of Asia, Africa, Europe, and the West Indies, we have arrived at the conclusion that the so-called species, so numerous described and figured, can only be regarded as varieties of the type form *O. complanata* (Defrance). These varieties, nevertheless, when confined within certain limits of

characters, determined probably by the influence of local conditions, will prove of value in determining facies and minor series of strata in given areas.

*O. complanata*, var. *canalifera* is characterized by the rapid increase in the width of the whorls in the last turn or so. The surface of the central area of each chamber is slightly excavate, and the sutural lines of the segments are often marked out by a thick secondary shell growth. Greatest length of test in the specimens from Sinai,  $\frac{2}{8}$  inch (10 mm.); diameter at oral extremity,  $\frac{7}{8}$  inch (7 mm.); thickness,  $\frac{5}{8}$  inch (.5 mm.).

The original specimens, described by d'Archiac, were from the yellow limestone, Hala range, province of Cutch, India, where it was associated with *Nummulites Ramondi*. *O. complanata*, var. *canalifera*, has also been recorded from the nummulitic beds of Beni Hassan and Cairo, Egypt, and from Palestine and Bulgaria. Described under the name of *O. libyca* by Schwager, and recorded by him from the Libyan Series of El-Guss-Abu-Said.

Coll. Geol. Surv. Egypt, Nos. 4,113 and 4,135, Box Nos. 4l and 3l respectively. Libyan Series (Lower Eocene): junction of Wadi Baba and Wadi Shellal, Sinai. Abundant and typical. Also No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer, Sinai. Frequent, but somewhat dwarfed specimens.

*Operculina complanata* (Defrance), var. *discoidea*, Schwager.

(Pl. XIV, Fig. 13.)

*Operculina discoidea*, Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 145, pl. xxix (vi), figs. 5a-d.

O. cf. *canalifera*, d'Arch., id., 1883: ibid., p. 144, pl. xxix (vi), figs. 3a, b.

This variety is distinguished from the foregoing by the even width of the whorls of the shell, which increase but slightly in each turn of the series.

Gümbel has figured a somewhat similar variety from the nummulitic series of Kressenberg, Bavaria, which he has referred to d'Archiac's *Operculina canalifera*.<sup>1</sup>

The specimens from Sinai measure  $\frac{7}{8}$  inch (7 mm.) in the diameter of the shell, and its thickness is  $\frac{5}{8}$  inch (.5 mm.).

Schwager's specimens were obtained from the white clay of Aradj (Mokattam Series), Egypt.

Coll. Geol. Surv. Egypt, No. 4,112, Box No. 2l. ? Bartonian Series (Upper Eocene) or ? top of Mokattam Series (Middle Eocene): beach deposit, Jebel Abyad, Sinai. Common.

HETEROSTEGINA, d'Orbigny [1826].

*Heterostegina depressa*, d'Orbigny. (Pl. XIII, Fig. 7a.)

*Heterostegina depressa*, d'Orb., 1826: Ann. Sci. Nat., vol. vii, p. 305, No. 2, pl. xvii, figs. 5-7; Modèles, No. 99.

The specimens now under description are very distinctly coiled at the commencement, and in general aspect resemble those specimens which belong to the microspheric form; and which are rare in

<sup>1</sup> Abhandl. bayer. Akad. Wiss., vol. x (1868), 1870, p. 664, pl. ii, figs. 112a, b.



our modern marine dredgings. This species is more commonly found in the later Tertiaries, but it is not entirely absent from the base of the Eocene.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer, Sinai. Rare.

#### NUMMULITES, Lamarck [1801].

*Preliminary remarks on the genus.*—The interesting observations on the dimorphism of the genus *Nummulites*, which have been made from time to time by special investigators, such as Von Hantken, Munier-Chalmas & Schlumberger, De la Harpe, Rupert Jones, and Van den Broeck, have resulted in the establishment of couples of so-called species, constituting a species in the zoological sense, in which the smaller form, with a large central chamber, is referred to as form A, whilst form B usually has a larger test and invariably possesses a diminutive central chamber. The two forms are otherwise spoken of as the megalospheric and microspheric forms. In some cases there may be little doubt as to the accuracy of the assignment of the two forms to one species, especially since they may be the only examples present in the rock. In the case of a stratum containing more than two species, however, there may be no small difficulty in coupling the actual forms which constitute the species, for there is often little in either the internal or external characters to guide one in linking the forms. In our present state of knowledge, therefore, it appears to be most convenient to describe the forms under their specific denominations as already known, at the same time pointing out their relationship to one another. Some good suggestions as to the naming of Nummulites and other Foraminifera which exhibit the two modes of growth and shell form have lately been made by Dr. A. Silvestri.<sup>1</sup>

With regard to the older method of grouping the Nummulites according to their superficial appearance and texture, this can be at the best only an artificial method of arrangement, for it sometimes happens that two different forms constituting a zoological species may be found to belong to two of the separated so-called groups; as, for instance, *N. curvispira*, which has been placed in the granulate group, and *N. complanata* or *N. complanata*, var. *Pachoi*, in the group of smooth forms. Moreover, it will be seen by referring to Rupert Jones' Catalogue of Fossil Foraminifera in the British Museum,<sup>2</sup> that *N. curvispira* is an example of the granulate group which does not invariably exhibit the characters ascribed to it.

#### *Nummulites planulata* (Lamarck). (Pl. XIII, Fig. 2a.)

*Lenticulites planulata*, Lamarck, 1804: Annales du Muséum, vol. v, p. 187.

*Nummulites planulata* (d'Orb.), d'Archiac & Haime, 1853: Deser. Anim. groupe nummulitique Inde, vol. i, p. 142, pl. ix, figs. 5a, 6a-c, 7a-h, 8a-d, 9a, b, 10a-c.

One recognizes this form by the minute or almost invisible central chamber, and the flatness of the test. In section it exhibits from

<sup>1</sup> Atti dell' Accad. Pont. Nuovi Lincei, Anno liii (1900), pp. 1-10. See also Van den Broeck: Bull. Soc. Belge Géol. Pal. Hydr., vol. x (1896), 1899.

<sup>2</sup> Op. cit., pp. 46, 47, specimens P 1014 and P 890.

four to six whorls, which increase rapidly in breadth (in median section), especially towards the last.

The specimens here dealt with are very typical when compared with d'Archiac's figures. Those forms of the same group or type recorded by De la Harpe from Egypt<sup>1</sup> differ chiefly in their umbonate centre and comparatively sharp peripheral edge.

*N. planulata* appears to be distributed chiefly through the Lower and Middle Eocene beds of Europe, but it is occasionally found with a higher range. This species has been recorded by Dr. Fraas from Egypt.

Coll. Geol. Surv. Egypt, No. 4,112, Box No. 2l. ? Bartonian (Upper Eocene) or ? top of Mokattam Series (Middle Eocene): Jebel Abyad, beach deposit (later). Common.

*Nummulites Guettardi*, d'Archiac & Haime, var. *antiqua*, De la Harpe. (Pl. XIII, Fig. 6b.)

*Nummulites Guettardi*, d'Archiac, var. *antiqua*, De la Harpe, 1833: Palæontographica, vol. xxx, Pal. Theil, p. 172, pl. xxx (i), figs. 37-42.

The central chamber in our specimens from Sinai is fairly large, agreeing in this particular with the typical examples of the species figured by d'Archiac.<sup>2</sup> De la Harpe, however, states that his specimens have a small central chamber, so that it is possible that we have here the two forms A and B confused by the above-named authors.

The variety *antiqua* differs from the typical *N. Guettardi* in having a lenticular and more compressed shell. The type form was found by De la Harpe only in the Upper Eocene beds of Egypt.

The above variety was found by De la Harpe in rocks of the Libyan Series (Lower Eocene) of Nekeb, east of Farâfrah, and of El-Guss-Abu-Said.

Coll. Geol. Surv. Egypt, No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer, Sinai (same range as Jebel Abyad). Common.

*Nummulites Ramondi*, DeFrance. (Pl. XIII, Figs. 3b, 4b.)

*N. Ramondi*, DeFrance, 1825: Dict. Sci. Nat., vol. xxxv, p. 224. D'Archiac & Haime, 1853: Descr. Anim. groupe nummulitique Inde, vol. i, p. 128, pl. vii, figs. 13a-d, 14a, 15a, 16a, 17a, b.

This is a small species, but has no large central chamber. The peripheral edge is sharper than that of *N. Guettardi*, and the test is much thinner.

*N. Ramondi* is one of the most widely distributed of the nummulites; amongst many localities it has been found in France, the Alps, the Pyrenees, Egypt, the Crimea, and India. From Egypt De la Harpe obtained it in the Lower Libyan Series of Jebel Têr.

Coll. Geol. Surv. Egypt, Nos. 4,113 and 4,135, Box Nos. 4l and 3l respectively. Libyan Series (Lower Eocene): junction of Wadi

<sup>1</sup> Palæontographica, vol. xxx (1833), Pal. Theil, pp. 161-4, pl. xxx, figs. 1-18: *N. Fraasi*, *N. Rütimeyeri*, and *N. Chavannesi*.

<sup>2</sup> Descr. Anim. groupe nummulitique Inde, vol. i (1853), p. 130, pl. vii, figs. 18a-c, 19a, b.

Baba and Wadi Shellál, Sinai. Common. ? No. 3,598, Box No. 13l. Mokattam Series (Middle Eocene): Wadi Khadáhid. Rare.

*Nummulites Heberti*, d'Archiac & Haime.

*Nummulites Heberti*, d'Archiac & Haime, 1853: Descr. groupe nummulitique Inde, vol. i, p. 147, pl. ix, figs. 14a-g, 15a. De la Harpe, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 178, pl. xxxi (ii), figs. 26, 27.

This is a very minute nummulite, having an umbonate centre and a sharp peripheral edge. The central chamber is almost invisible. The specimens from Sinai measure about 2 mm. in diameter and .85 mm. in thickness. *N. Heberti* was found by Schwager in both the Libyan and Bartonian Series of Egypt.

Coll. Geol. Surv. Egypt, No. 4,112, Box No. 2l. ? Bartonian (Upper Eocene) or ? top of Mokattam Series (Middle Eocene): Jebel Abyad, Sinai, beach deposit (later). Frequent. Also No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer (same range as Jebel Abyad), Sinai. Rare.

*Nummulites variolaria* (Lamarck). (Pl. XIII, Fig. 2b.)

*Lenticulites variolaria*, Lamarck, 1804: Ann. du Muséum, vol. v, p. 187, No. 2. *Nummularia variolaria* (Lam.), Sowerby, 1829: Mineral Conchology, vol. vi, p. 76, pl. dxxxviii, fig. 3.

*Nummulites variolaria* (Sow.), d'Archiac & Haime, 1853: Descr. Anim. groupe nummulitique Inde, vol. i, p. 146, pl. ix, figs. 13a-g.

*N. variolaria* (Lam.), De la Harpe, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 179, pl. xxxi (ii), figs. 28-36.

This is one of the most widely distributed nummulites. It occurs in Hampshire, near Brussels, Biarritz, in Hungary, Asia Minor, Kurdistan, etc. It is usually characteristic of the Middle and Upper Eocene. In Egypt it has been found in the Lower and Upper Eocene (De la Harpe).

It is fairly common in the specimen from Sinai, No. 4,112, and is associated with *N. planulata*. The characters by which one recognizes it in section are the lenticular outline and sharp peripheral edges. In the tangential aspect the sections exhibit the regularly striated shell surface. The central chamber is moderately large.

Coll. Geol. Surv. Egypt, No. 4,112, Box No. 2l. ? Bartonian Series (Upper Eocene) or ? top of Mokattam Series (Middle Eocene): beach deposit, Jebel Abyad, Sinai. Frequent.

*Nummulites subdiscorbina*, De la Harpe. (Pl. XIII, Fig. 1.)

*Nummulites subdiscorbina*, De la Harpe, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 185, pl. xxxii (iii), figs. 8-15.

This species is not unlike *N. Guettardi*, var. *antiqua*, but differs in the greater proportionate breadth of the test; it also exhibits strongly developed double cones of tubuli at the umbilical axis. This species is relatively larger than *N. Guettardi*, var. *antiqua*.

De la Harpe states that *N. subdiscorbina* usually accompanies the larger species *N. discorbina*, but this is not the case with those of the Sinaitic limestones. The Egyptian specimens were found near Cairo, at Beni Hassan and Minieh.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1l. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharaudel, Sinai. Abundant.

The group of *Nummulites Gizehensis* (Forskål), Ehrenberg.

From a zoological standpoint the various forms of nummulites so closely associated in certain beds of the Mokattam Series in Egypt and neighbouring areas, referred to under the name of *N. Gizehensis* and its varieties, are clearly local modifications of the more widely distributed *Nummulites complanata*, Lamarck. In consideration of the practical use of distinctive terms for local varieties in relation to their stratigraphical distribution, it is here proposed to retain the grouping of this series so minutely and carefully worked out by Dr. De la Harpe.

*Nummulites Gizehensis* (Forskål), Ehrenberg, var. *Ehrenbergi*,  
De la Harpe. (Pl. XIV, Fig. 15.)

*Nautilus Gizehensis*, Forskål, 1775: *Descriptiones Animalium*, p. 140. 1776: *Icones rerum naturalium*, etc.

*Nummulites Gizehensis*, Ehrenberg, 1838: *Abhandl. Akad. Wiss. Berlin*, p. 93.

*N. Gizehensis*, Ehr., d'Archiac & Haime, 1853: *Deser. Anim. groupe nummulitique Inde*, vol. i, p. 94, pl. ii, figs. 6a-f, 7a, 8.

*N. Gizehensis Ehrenbergi*, De la Harpe, 1883: *Palæontographica*, vol. xxx, Pal. Theil, p. 190, pl. xxxii, figs. 16-25; pl. xxxiii, figs. 1, 2.

This is the well-known form with the thick disc and rounded edge. The septa between each chamber are unusually thick and inclined.

This variety has been chiefly obtained from Egypt, but it has also been recorded from Sinai, Syria, Anatolia, and Vicentin. In Sinai it occurred at Wady Gharandel (Rupert Jones and Bauerman). It has also been doubtfully recorded from Biarritz.

Coll. Geol. Surv. Egypt, No. 4,163, Box No. 5l. Mokattam Series (Middle Eocene): near top of Jebel Safariat, Sinai. Several specimens.

*Nummulites Gizehensis* (Forskål), Ehrenberg, var. *Lyelli*, d'Archiac & Haime. (Pl. XIV, Fig. 14.)

*Nummulites Lyelli* (pars), d'Archiac & Haime, 1853: *Deser. Anim. groupe nummulitique Inde*, vol. i, p. 95, pl. iii, figs. 1a, b, 2. Fraas, 1867: *Aus dem Orient*, p. 129.

*N. Gizehensis Lyelli*, d'Archiac, De la Harpe, 1883: *Palæontographica*, vol. xxx, Pal. Theil, p. 192, pl. xxxiii (iv), figs. 3-10.

This is a large variety, and perhaps approaches the type *N. complanata* most closely. It is rather regular in outward form, and has the peripheral edge fairly sharp and thin. The septa, seen in section, run nearly straight across from whorl to whorl, especially in the later turns of the shell, instead of being arcuate and inclined, as in the variety previously mentioned. The chambers are irregularly spaced. The specimens from Sinai measure as much as 38 mm. in diameter and about 6 mm. in thickness.

*N. Gizehensis*, var. *Lyelli*, has been recorded from Egypt, near Cairo; and from Syria, in the white limestone of Gerizhem.

Coll. Geol. Surv. Egypt, No. 4,163, Box No. 5l. Mokattam Series (Middle Eocene): near top of Jebel Safariat, Sinai. Very common.

*Nummulites Gizehensis* (Forskål), Ehrenberg, var. *Pachoi*, De la Harpe.

*Nummulites Gizehensis Pachoi*, De la Harpe, 1883: *Palæontographica*, vol. xxx, Pal. Theil, p. 193, pl. xxxiii (iv), figs. 14-18; pl. xxxiv (v), figs. 1-5.

This variety is large, or moderately large compared with others of the same type; discoid, compressed, and with rounded, blunt, or sharp edges. The cross section shows the sides to be parallel.

De la Harpe has recorded this variety from the Pyramids of Gizeh, in the Wadi Emsid-el-Flûs, between Mêr and Farâfrah, on the Gâret-el-Dalleh, and near Rajân, between the Fajûm and Beharieh.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Frequent. No. 4,163, Box No. 51. Mokattam Series (Middle Eocene): near top of Jebel Safariat, Sinai. Frequent. Also No. 3,598, Box No. 131. Mokattam Series (Middle Eocene): Wadi Khadâhid, Sinai. Frequent.

*Nummulites curvispira*, Savi & Meneghini. (Pl. XIII, Fig. 5.)

*Nummulina curvispira*, Savi & Meneghini, 1851: Consid. Geol. Toscana, p. 137.

*Nummulites curvispira* (Menegh.), d'Archiac & Haime, 1853: Deser. Anim. groupe nummulitique Inde, p. 127, pl. vi, figs. 15a-d. Fraas, 1867: Aus dem Orient, p. 130. De la Harpe, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 200, pl. xxxiv (v), figs. 42-67.

This nummulite, although very variable, is generally of a flattened lenticular shape, with rounded peripheral edge, sometimes more or less sharp. In the latter feature it approaches *N. Rouaulti*, d'Arch. and Haime. Clean fresh specimens often show the flexuose striation which is characteristic of *N. Gizehensis*. The surface of specimens slightly weathered is radially or sinuously striate, with granulations sparsely scattered between them. The central chamber is usually very large, and is followed by a semilunar segment. The whorls are somewhat irregular, and there are usually six turns on a radius of 3 mm. The chambers are elongate and greatly curved.

*N. curvispira* has already been recorded from Sinai (Wadi Gharandel) by Rupert Jones. It is commonly found at most of the localities in Egypt in the Mokattam Series, at Mokattam, Gizeh, Minieh, Beni Hassan, and the Libyan Desert.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Frequent. No. 3,598, Box No. 131. Mokattam Series (Middle Eocene): Wadi Khadâhid, Sinai. Very common.

*Nummulites Barroni*, sp. nov. (Pl. XIV, Figs. 16a, b, c.)

Test lenticular, swollen in the centre, hollowed near the periphery, edge quite sharp. Surface striate and sometimes feebly granulate. Average diameter, 5 mm.; thickness at the centre, 2 mm.; shell with from 4 to 5 whorls; 4 turns in a radius of 2 mm. Septa strongly arched. Central chamber subspherical and very large, one measuring .75 mm.

This species recalls *N. Rouaulti* by its general shape, but the edge is much sharper, and the thickness at the centre is greater in relative proportion to size.

The three species *N. curvispira*, *N. Rouaulti*, and *N. Barroni* are probably related, and represent a group of the megalospheric type which has a dimorphic relationship with *N. Gizehensis* and its varieties.

This species is named after Mr. T. Barron, F.G.S., who collected the specimens during his work in Sinai, January to June, 1899.

Coll. Geol. Surv. Egypt, No. 3,598, Box No. 13l. Mokattam Series (Middle Eocene): Wadi Khadáhí, Sinai. Common.

ORBITOIDES, d'Orbigny [1847].

*Orbitoides (Discocyclina) dispansa* (Sowerby). (Pl. XIII, Figs. 6c, 7c.)

*Lycophris dispansus*, Sowerby, 1837 [1840]: Trans. Geol. Soc. Lond., ser. II, vol. V, pp. 327, 718, pl. xxiv, figs. 16, 16a, b.

*Orbitoides dilabida*, Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 140, pl. xxix, figs. 7a-e.

Schwager records this species under the name of *O. dilabida* from both the Libyan and the Mokattam Series of Egypt; Dr. Carter found it in Scinde, Kutch, and Arabia.

Nearly all our Sinaitic examples are slightly abraded, as if rolled by current agency, and in one of the specimens, No. 4,112, of later age, they are quite fragmentary.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1l. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Frequent. No. 4,112, Box No. 2l. (Derived) ? Bartonian Series (Upper Eocene) or ? top of Mokattam Series (Middle Eocene): beach deposit, Jebel Abyad, Sinai. Rare, broken. No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer, Sinai. Common.

*Orbitoides (Discocyclina) papyracea* (Boubée).

*Nummulites papyracea*, Boubée, 1832: Bull. Soc. géol. France, ser. II, p. 445.

*Orbitoides (Discocyclina) papyracea* (Boubée), Gümbel, 1868 [1870]: Abhandl. M. ph. Cl. k. bayer. Ak. Wiss., vol. x, p. 690, pl. iii, figs. 3-12, 19-29.

*O. papyracea* (Boubée), Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 139.

*O. nudimargo*, Schwager, 1883: op. cit., p. 139, pl. xxix, figs. 8a-e.

The specimens in the Sinaitic limestones show every deviation between the forms figured by Schwager as *O. nudimargo* and ordinary specimens of *O. papyracea*, which sometimes have a slightly thicker test. Our examples are seen in section and are generally more or less fragmentary.

*O. papyracea* has been found in both the Libyan and Mokattam Series in Egypt.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 1l. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Frequent. No. 3,902, Box No. 15l. Libyan Series (Lower Eocene): Jebel Krer, Sinai. Rare.

*Orbitoides (Discocyclina) ephippium* (Schlotheim).

*Lenticulites ephippium*, Schlotheim, 1820: Die Petrefactenkunde, p. 89.

*Orbitoides (Discocyclina) ephippium* (Schlotheim), Gümbel, 1868 [1870]: Abhandl. m. ph. Cl. k. bayer. Ak. Wiss., vol. x, p. 696, pl. iii, figs. 15, 16, 38, 39.

*Orbitoides ephippium* (Schlotheim), Schwager, 1883: Palæontographica, vol. xxx, Pal. Theil, p. 139.

A few characteristic examples of the above species occur in our sections. It was recorded by Schwager from the Mokattam Series of Egypt.

Coll. Geol. Surv. Egypt, No. 4,111, Box No. 11. Mokattam Series (Middle Eocene): top of Jebel Abyad, south of Wadi Gharandel, Sinai. Rare, somewhat fragmentary.

SPECIES DESCRIBED IN THIS PAPER.

1. *Miliolina circularis* (Bornemann). Libyan Series: Jebel Krer.
2. *Alveolina Boscii* (Defrance). Libyan Series: Jebel Krer.
3. *A. decipiens*, Schwager. Libyan Series: Jebel Krer.
4. *Textularia agglutinans*, d'Orbigny. Libyan Series: junction of Wadi Baba and Wadi Shellál.
5. *Bigenarina nodosaria*?, d'Orb. Libyan Series: Jebel Krer.
6. *Bolivina punctata*?, d'Orb. Mokattam Series: Jebel Abyad.
7. *Globigerina bulloides*, d'Orb. Bartonian or top of Mokattam Series: Jebel Abyad.
8. *G. conglobata*, Brady. Mokattam Series: Jebel Abyad.
9. *G. cretacea*?, d'Orb. Mokattam Series: Jebel Abyad. Also Libyan Series: Jebel Krer.
10. *Discorbina rugosa* (d'Orb.). Mokattam Series: Jebel Abyad.
11. *D. globularis* (d'Orb.). Mokattam Series: Jebel Abyad.
12. *Truncatulina umbonifera* (Schwager). Mokattam Series: Wadi Khadáhí.
13. *Rotalia calcariformis* (Schwager). Mokattam Series: Jebel Abyad.
14. *Operculina complanata* (Defrance), var. *canalifera*, d'Archiac. Libyan Series: junction of Wadi Baba and Wadi Shellál; Jebel Krer.
15. *O. complanata*, var. *discoidea*, Schwager. ? Bartonian or top of Mokattam Series: Jebel Abyad.
16. *Heterostegina depressa*, d'Orb. Libyan Series: Jebel Krer.
17. *Nummulites planulata* (Lamarck). ? Bartonian or top of Mokattam Series: Jebel Abyad.
18. *N. Guettardi*, d'Arch. & Haime, var. *antiqua*, De la Harpe. Libyan Series: Jebel Krer.
19. *N. Ramondi*, Defrance. Libyan Series: junction of Wadi Baba and Wadi Shellál.
20. *N. Heberti*, d'Arch. & Haime. ? Bartonian or top of Mokattam Series: Jebel Abyad. Also Libyan Series: Jebel Krer.
21. *N. variolaria* (Lamarck). ? Bartonian or top of Mokattam Series: Jebel Abyad.
22. *N. subdiscorbina*, De la Harpe. Mokattam Series: Jebel Abyad.
23. *N. Gizehensis* (Forskál), var. *Ehrenbergi*, De la Harpe. Mokattam Series: Jebel Safariat.
24. *N. Gizehensis*, var. *Lyelli*, d'Arch. & Haime. Mokattam Series: Jebel Safariat.
25. *N. Gizehensis*, var. *Pachoi*, De la Harpe. Mokattam Series: Jebel Abyad; Jebel Safariat; Wadi Khadáhí.
26. *N. curvispira*, Savi & Meneghini. Mokattam Series: Jebel Abyad; Wadi Khadáhí.
27. *N. Barroni*, sp. nov. Mokattam Series: Wadi Khadáhí.
28. *Orbitoides dispansa* (Sow.). ? Bartonian or Mokattam Series: Jebel Abyad. Libyan Series: Jebel Krer.
29. *Orbitoides papyracea* (Bouée). Mokattam Series: Jebel Abyad. Libyan Series: Jebel Krer.
30. *O. ephippium* (Schlotheim). Mokattam Series: Jebel Abyad.

EXPLANATION OF PLATE XIII.

- FIG. 1.—*Nummulites subdiscorbina*, De la Harpe. Mokattam Series: in nummulitic limestone top of Jebel Abyad, Sinai. No. 4,111. × 16.
- FIG. 2a.—*Nummulites planulata* (Lam.). { ? Bartonian or ? Mokattam Series: in foraminiferous limestone, Jebel Abyad,  
 FIG. 2b.—*N. variolaria* (Lam.). { Sinai. No. 4,112. × 12.
- FIGS. 3a, 4a.—*Operculina complanata* (Defr.), var. *canalifera*, d'Archiac. }  
 FIGS. 3b, 4b.—*Nummulites Ramondi*, Defrance. }  
 Libyan Series: in dolomitized foraminiferous limestone, junction of Wadi Baba and Wadi Shellál, Sinai. Nos. 4,135 and 4,113. × 16.
- FIG. 5.—*Nummulites curvispira*, Savi & Meneghini. Wadi Khadáhí, Sinai. No. 3,598. × 4½.

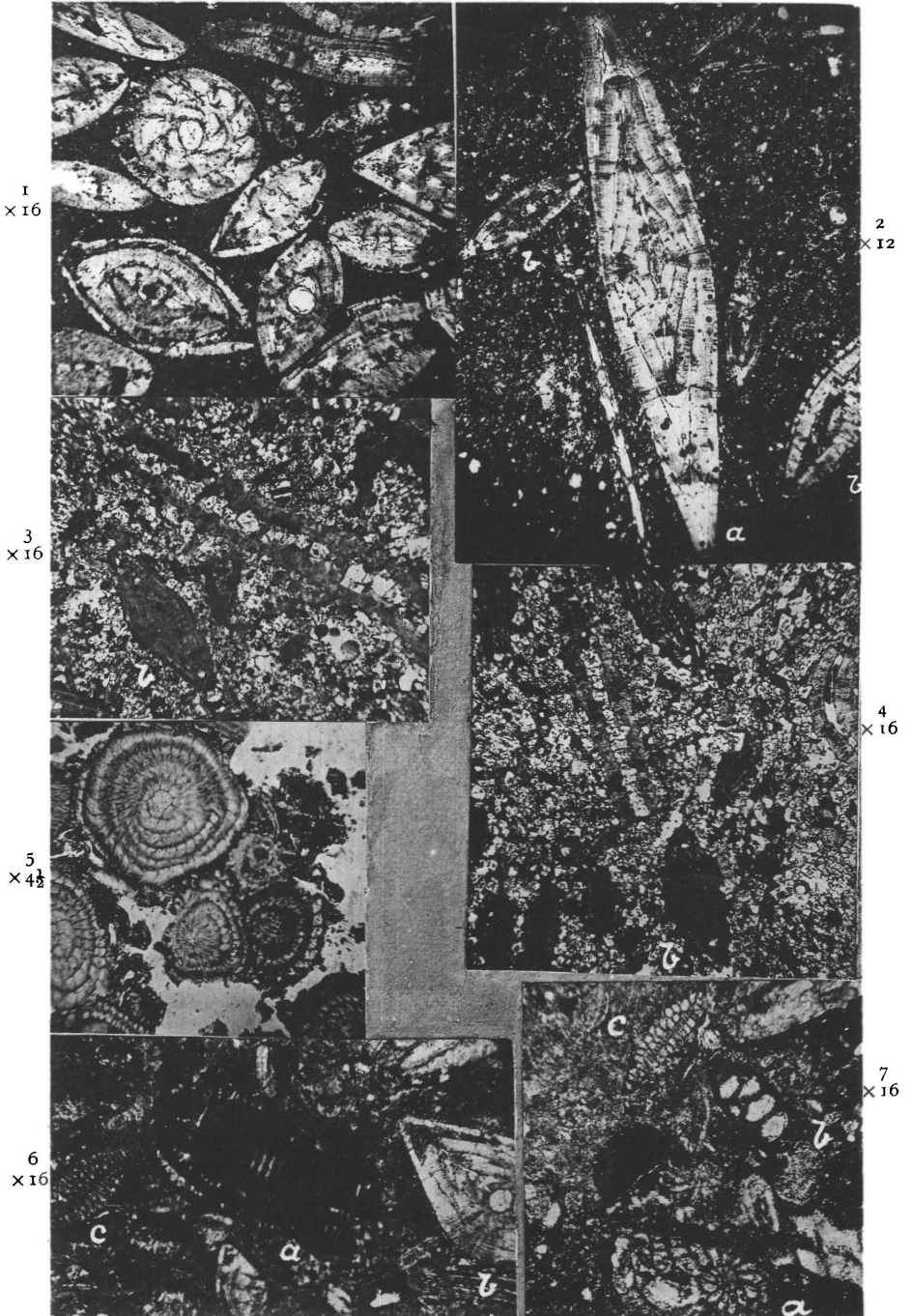
16 *F. Chapman—Tertiary Foraminifera in Limestones, Sinai.*

FIGS. 6, 7.—Libyan Series: foraminiferal limestone, Jebel Krer, Sinai. No. 3,902.  
 6*a*, *Alveolina Boscii* (Defrance); 6*b*, *Nummulites Guettardii*, d'Arch.  
 and Haime, var. *antiqua*, De la Harpe; 6*c*, 7*c*, *Orbitoides dispansa* (Sow.);  
 7*a*, *Heterostegina depressa*, d'Orb.; 7*b*, *Bigenerina? nodosaria*, d'Orb.  
 × 16.

EXPLANATION OF PLATE XIV.

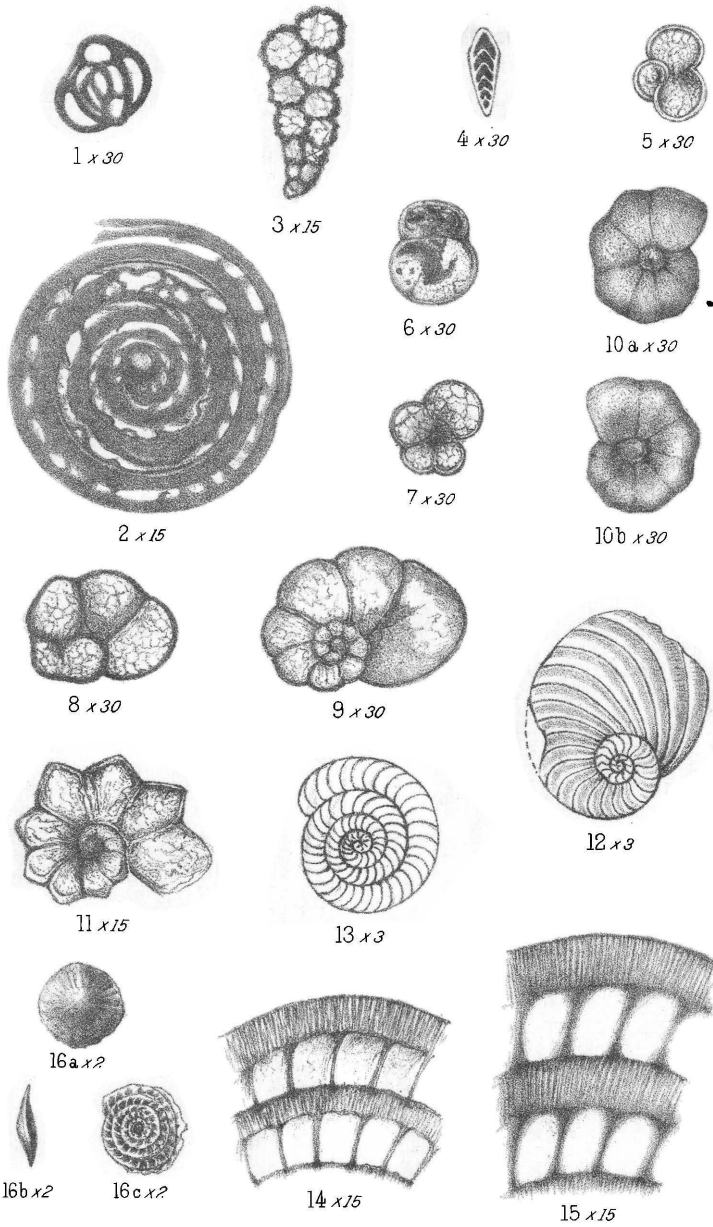
- FIG. 1.—*Miliolina circularis* (Bornemann). Transverse section. Libyan Series: Jebel Krer, Sinai. No. 3,902. × 30.  
 FIG. 2.—*Alveolina decipiens*, Schwager. Transverse section. Libyan Series: Jebel Krer, Sinai. No. 3,902. × 15.  
 FIG. 3.—*Textularia agglutinans*, d'Orb. Longitudinal section. Libyan Series: junction of Wadi Baba and Wadi Shellál, Sinai. No. 4,113. × 15.  
 FIG. 4.—*Bolivina punctata?*, d'Orb. Longitudinal, peripheral section. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIG. 5.—*Globigerina bulloides*, d'Orb. Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIG. 6.—*Globigerina conglobata*, Brady. Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIG. 7.—*G. cretacea?*, d'Orb. Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIG. 8.—*Discorbina globularis* (d'Orb.). Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIG. 9.—*D. rugosa* (d'Orb.). Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 30.  
 FIGS. 10*a*, *b*.—*Truncatulina umbonifera* (Schwager). Mokattam Series: Wadi Khadáhí, Sinai. No. 3,598. × 30.  
 FIG. 11.—*Rotalia calcariformis* (Schwager). Section of test. Mokattam Series: Jebel Abyad, Sinai. No. 4,111. × 15.  
 FIG. 12.—*Operculina complanata* (Defrance), var. *canalifera*, d'Archiac. Libyan Series: junction of Wadi Baba and Wadi Shellál, Sinai. No. 4,135. × 3.  
 FIG. 13.—*O. complanata* (Defr.), var. *discoidea*, Schwager. ? Bartonian or ? Mokattam Series: Jebel Abyad, Sinai. No. 4,112. × 3.  
 FIG. 14.—*Nummulites Gizehensis* (Forskál), var. *Lyelli*, d'Archiac & Haime. Section on the fifth and sixth whorls. Mokattam Series: Jebel Safariat, Sinai. No. 4,163. × 15.  
 FIG. 15.—*Nummulites Gizehensis* (Forskál), var. *Ehrenbergi*, De la Harpe. Section on the eleventh and twelfth whorls. Mokattam Series: Jebel Safariat, Sinai. No. 4,163. × 15.  
 FIGS. 16*a*, *b*, *c*.—*Nummulites Barroni*, sp. nov. 16*a*, superficial aspect of test; 16*b*, edge view; 16*c*, median section. Mokattam Series: Wadi Khadáhí, Sinai. No. 3,598. × 2.





F. C. Photo.

TERTIARY FORAMINIFERAL LIMESTONES FROM SINAI.



F. Chapman del. ad nat.  
G. M. Woodward lith.

West, Newman imp.

Eocene Foraminifera from Sinai.