CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

VOLUME XVIII, Part 1
January, 1967

Contents

		PAGE
No. 326.	*Globotruncana caliciformis* in the Maestrichtian Sharawna Shale of Egypt Zaghloul El-Naggar and John Haynes	1
No. 327.	Planktonic foraminifera from the Miocene rocks of the Gulf of Suez region, Egypt Rushdi Said and Ihab El-Heiny	14
No. 328.	A taxonomic reinterpretation and emendation of the genus *Technitella* Norman 1878 Drew Haman	27
Recent Literature on the Foraminifera Ruth Todd		31

1967

CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

Volume XVIII (1967)

Editor

ZACH M. ARNOLD

1967

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVIII, PART 1, JANUARY, 1967

326. *GLOBOTRUNCANA CALICIFORMIS* IN THE MAESTRICHTIAN SHARAWNA SHALE OF EGYPT

ZAGHLOUL EL-NAGGAR and JOHN HAYNES
University College of Wales, Aberystwyth

ABSTRACT

Globotruncana caliciformis (de Lapparent), 1918 occurs abundantly in the Sharawna Shale of Egypt, and proves to be an excellent guide fossil for the Maestrichtian. Detailed study of this species has proved the name to be a senior synonym for both **G. contusa** (Cushman), 1926 and **G. plicata** White, 1928. This study has also indicated that **G. caliciformis** includes a group of related forms which are worthy of subspecific distinction: **G. caliciformis caliciformis** (de Lapparent), **G. caliciformis patelliformis** Gandolfi, **G. caliciformis scutilla** Gandolfi, **G. caliciformis galeoidis** Herm, and **G. caliciformis witwickae** El-Naggar. Other forms previously attached to **G. caliciformis**, such as **G. caliciformis sarmientoi** Gandolfi and **G. caliciformis trinidadensis** Gandolfi, are proved to be different, and therefore should be treated separately. The collective treatment of all these forms under **G. caliciformis**, or under any of the several invalid names (**G. contusa, G. conica** var. **plicata, G. conica caliciformis, G. plicata caliciformis** or **G. plicata** s.s.) has confused the identity of the species and its true stratigraphical dstribution. To clear up this confusion, each of these forms is here described in detail.

INTRODUCTION

In a recent study (El-Naggar, 1963, 1966*a, b*) the type Esna Shale (in the Esna-Idfu region, Nile Valley, Egypt) is shown to comprise two distinct formations: a lower "Sharawna Shale" of Maestrichtian age, and an upper "Owaina Shale" of Paleocene age, separated by a pronounced break and a well-developed conglomerate. This break marks the Cretaceous-Tertiary boundary.

The succession is flooded with excellently preserved planktonic Foraminifera which facilitate its zonation and its correlation with similar successions in other parts of the world. Among these, *G. caliciformis* occurs abundantly in the Sharawna Shale and proves to be an excellent guide fossil for the Maestrichtian. Nevertheless, the stratigraphical importance of this index fossil was masked by the controversy amongst the various authors concerning its morphological features and stratigraphical range. This is mainly due to the fact that the holotype was described in thin section only and that its description was very short and incomplete. The rich population encountered, together with the topotypic and paratypic material examined, has enabled the authors to redefine the "*G. caliciformis* group."

Globotruncana caliciformis was first described by de Lapparent (1918), from thin section only, as *Rosalina linnei* d'Orbigny mutation *caliciforme*, from the Maestrichtian of the Hendaye region of southwestern France.

Vogler (1941) removed this mutation to the genus *Globotruncana* and raised it to subspecific rank, changing its name to *G. linnei caliciformis* (de Lapparent); but, again, his description was based on thin section only.

Cita (1948), realizing the great difference between *G. linneiana* (d'Orbigny) and the subspecies *caliciformis,* suggested their separate treatment and hence raised this subspecies to specific rank, changing its name to *G. caliciformis* (de Lapparent). However, her figures (*op. cit.,* pl. III, figs. 4*a-c*) appear to be different from both the holotype of de Lapparent and the hypotype of Vogler, as well as from specimens in the present study, the thin sections of which conform well with that of the holotype. Those figures are probably of *G. adamsi* El-Naggar or of specimens transitional between the latter species and *G. caliciformis.* Cita (*op. cit.*) also mentioned that *G. caliciformis* is closely related to *G. conica* White, *G. contusa* (Cushman) and *G. plicata* White.

Bolli (1951, p. 194, pl. 34, figs. 4-6) described as *G. caliciformis,* a form which, though different from that of de Lapparent, may possibly belong to *G. adamsi* El-Naggar. However, his figured thin section of *G. contusa* (Cushman) (*op. cit.,* p. 196, text-fig. 1*f*) conforms well with those of *Rosalina linnei* mut. *caliciforme* de Lapparent (1918) and *G. linnei caliciformis* (de Lapparent) of Vogler (1941) (see pl. 3).

Tilev (1952), confused by the various records of both *G. caliciformis* (de Lapparent) and *G. conica* White, introduced *G. conica-caliciformis* as a new name, but his figures are different from both forms and may possiby belong to *G. orientalis* El-Naggar.

Subbotina (1953, p. 188, pl. 10, figs. 6a-c) described as *G. caliciformis* a form which is different from de Lapparent's original description and figure. However, her *G. conica* White (*op. cit.,* pl. 11, figs. 1*a-c*) is probably *G. caliciformis scutilla* Gandolfi; the other (*loc. cit.,* figs. 2*a-c*), is transitional between *G. caliciformis patelliformis* Gandolfi and *G. caliciformis galeoidis* Herm, and probably so is her *G. contusa* (Cushman) (*loc. cit.,* pl. 11, figs. 3*a-c*; pl. 12, figs. 1*a-*2*c*).

Ayala-Castañares (1954) used Cita's (1948) figures of *G. caliciformis* (de Lapparent), stating that it differs from *G. conica* White by its double keel and from *G. contusa* (Cushman) by the fact that the latter species has a pyramidal rather than a conical dorsal side.

Gandolfi (1955) considered *G. caliciformis* (de Lapparent) of Cita (1948) as the holotype (being the first whole specimen presented of the species) and divided *G. caliciformis* into three subspecies: *G. caliciformis caliciformis* (de Lapparent), 1918; *G. caliciformis trinidadensis* Gandolfi, 1955; and *G. caliciformis sarmientoi* Gandolfi, 1955. However, his forms are different from de Lapparent's original description and figures and from those of Vogler (1941). They also differ from hypotypes in the present study, the thin sections of which are identical to those of de Lapparent. His figured *G. caliciformis caliciformis* is probably related to *G. adamsi* El-Naggar, but his other two subspecies are quite distinct and should be treated separately.

Herm (1962, p. 68, pl. 7, fig. 6) described as *G. caliciformis* (de Lapparent) a form which is much smaller and less raised on the dorsal side than the holotype. This form may also belong to *G. adamsi* El-Naggar, although it lacks the globigerine, strongly inflated early chambers characteristic of the latter species. However, his figured *G. contusa* (*loc. cit.*, pl. 1, figs. 3, 4*b*, not 4a, not 4c; pl. 9, figs. 3-11; not 1, not 2) should be partly assigned to *G. caliciformis*.

Borsetti (1962, p. 48, pl. 7, figs. 3, 4; text-figs. 213, 219, 233, 244) described as *G. caliciformis caliciformis* (de Lapparent), from thin section only, forms which agree well with de Lapparent's original description and figures. She (*op. cit.*, p. 50, pl. 7, figs. 5, 6, text-figs. 235, 245) distinguished thin sections of *G. contusa* from those of *G. caliciformis* on the basis of the polygonal, irregular equatorial periphery and the folded dorsal side of the former; otherwise the two species are identical.

Van Hinte (1963, pp. 64, 65, pl. 3, figs. 2*a-c*) wrongly considered *G. contusa* (Cushman), 1926 as a junior synonym of *G. plicata* White, 1928, on the basis that Cushman did not figure his holotype until 1946. He also regarded *G. caliciformis* (which he referred to Vogler, 1941, not to de Lapparent, 1918) as a subspecies of *G. plicata*, transitional in character between *G. fornicata* s.s. and *G. plicata* s.s., and thus changed its name to *G.* (*G.*) *plicata caliciformis* Vogler. However, his figured specimen (*op. cit.*) is identical with *G. caliciformis patelliformis* Gandolfi (= *G. contusa patelliformis* Gandolfi, 1955).

This rapid historical review of *G. caliciformis* shows clearly that the very brief description of the holotype, in addition to the fact that it was described from thin section only, has led to the confusion of the true identity of the species. As a result the various records of the species (other than those in thin section only) are incorrect, and the literature is now filled with several figures of *G. caliciformis* which are different not only from the holotype of de Lapparent but also from each other.

In his original description of *G. caliciformis*, de Lapparent (1918, p. 8) only stated "C'est une variété caliciforme à ombilic profond. Chaque loge a les charactères de celle de *Rosalina linnei*, mais la coquille parait complétement deformée. Je la considère comme une mutation de *Rosalina linnei*, mais afin de bien marquer qu'elle n'en diffère pas essentiellement je la désignerai par le même nom, me contenant, pour la différencier, d'ajouter a ce nom le qualificatif mutation *caliciforme*." However, from his figures (*loc. cit.*, p. 5, fig. 2j, pl. 1, fig. 2) such mutation appears to be different from *G. linneiana* (d'Orbigny). It is distinguished by its highly spiroconvex, cone-shaped, entirely double-keeled test, relatively wide peripheral band, which lies at an angle to the axis of coiling (approaching a nearly horizontal position), and a wide umbilicus, contrary to the much smaller, parallel-sided test, almost vertical peripheral band, and relatively narrower umbilicus of *G. linneiana*. Again, *G. caliciformis* is recorded from the Maestrichtian, while *G. linneiana* dies out before the Maestrichtian.

The only known *Globotruncana* species with a highly spiroconvex, cone-shaped, entirely double-keeled test are *G. caliciformis* (de Lapparent), *G. contusa* (Cushman) and *G. plicata* White, which were all recorded from the Maestrichtian.

Globotruncana contusa was first described by Cushman (1926) as a variety of *Pulvinulina arca* from the Mendez formation of Mexico, but no figures were given. Cushman (*op. cit.*) only stated "Variety differing from the typical in the greater size, much greater elevation of the spire on the dorsal side, and, particularly striking, the concave appearance of the chambers on the dorsal side, those of one coil coming in line with the preceding ones so that the entire test develops something of a pyramidal form. This variety has much the appearance of a conical soft hat in which dents have been made running from the apex to the border. This variety is often very abundant in certain horizons, replacing to a large measure the typical form."

Cushman (1927) introduced *Globotruncana* as a new genus, with *Pulvinulina arca* as the type species. Therefore, he changed the name of his variety to *G. arca* var. *contusa*, but again he gave no figures.

Glaessner (1937) raised Cushman's variety to specific rank, changing its name to *G. contusa* (Cushman), but he also gave no figures until Morozova (1939, p. 80, pl. 1, figs. 1-3) gave the first figure of the species.

It was not until 1946 that Cushman figured the holotype of his *G. arca* var. *contusa* for the first time, but in dorsal and lateral view only. He overlooked the fact that this variety had already been raised to specific rank (Glaessner, 1937) and added (*op. cit.*, p. 150): "The variety resembles *Globotruncana conica* White var. *plicata* White, but, as figured, that form has many fewer whorls." However, from his figures and description *G. contusa* appears identical with both *G. plicata* White and *G. caliciformis* (de Lapparent), although the latter was described from thin section only. It is distinguished by a large, highly spiroconvex, cone-shaped test; folded surface, roughly angular, polygonal periphery; distinctly elongated chambers on the dorsal side; raised, undulating dorsal sutures, and two, well developed marginal keels, characters which generally distinguish the other two species. Cushman (*op cit.*) neither commented on the shape of the ventral side of his variety nor figured that side.

Confirming Glaessner's (1937) proposition, Cita (1948), followed by Bolli (1951), Noth (1951), Subbotina (1953), Hamilton (1953), Nakkady and Osman (1954), Ayala-Castañares (1954), Troelsen (1955), Gandolfi (1955), Dalbiez (1955), Hofker (1956, 1960, 1962), Wicher (1956), Edgell (1957), Bieda (1958), Olsson (1960), Vinogradov (1960), Berggren (1962), Herm (1962), van Hinte (1963), Brönnimann and Rigassi (1963), and El-Naggar (1963, 1966a, b), considered Cushman's variety as a distinct species.

Cita (1948) stated that *G. contusa* is somewhat closer to *G. conica* White, *G. plicata* White and *G. caliciformis* (de Lapparent). She also added (*op. cit.*) that the thin section of *Globotruncana* reported by Renz (1936) from the central Appennines and attributed by Glaessner (1937, pl. 13, fig. 4c) to *G. conica* is actually of *G. contusa*.

Bolli (1951, p. 196, pl. 34, figs. 7-9) figured as *G. contusa* (Cushman) forms which agree well with Cushman's original description and figures. However, as mentioned above, his figured thin section of *G. contusa* (*op. cit.*, text-fig. 1*f*) conforms well with those of *Rosalina linnei* mutation *caliciforme* de Lapparent, 1918 and *Globotruncana linnei caliciformis* (de Lapparent) of Vogler (1941) (see Pl. 3).

Subbotina (1953, pls. 11, 12) described as *G. conica* White and *G. contusa* (Cushman) forms which agree well with Cushman's concept of *G. contusa*.

Ayala-Castañares (1954, p. 390) stated that *G. contusa* is distinguished from *G. caliciformis* by its pyramidal dorsal side and that it is probably a senior synonym of *G. conica* var. *plicata* White. He also added that the latter form was described as being single-keeled, but examination of material from the Mendez formation (where this variety was first recorded) proved that no such forms as *G. conica* var. *plicata* with single keel occur.

Gandolfi (1955) described two new subspecies of *G. contusa* which he named *G. contusa patelliformis* and *G. contusa scutilla* respectively, thus changing the name of the central form to *G. contusa contusa*.

Hofker (1956, 1960, 1962) assigned the species to his *Marginotruncana*, a junior synonym of *Globotruncana* Cushman, as reasoned by Bolli, Loeblich and Tappan (1957) and by El-Naggar (1966*a*).

Herm (1962, pp. 72-75) considered *G. conica* var. *plicata* White to be a junior synonym of *G. contusa* (Cushman) and included *G. contusa patelliformis* Gandolfi within *G. contusa contusa*. He described a new subspecies of *G. contusa* (*G. contusa galeoidis*) and divided the species into three subspecies only: *G. contusa contusa* (Cushman), 1926; *G. contusa scutilla* Gandolfi, 1955; and *G. contusa galeoidis* Herm, 1962. However, his figured *G. contusa contusa* (*op. cit.*, pl. 1, figs. 4*a, c*; pl. 9, figs. 1-5) appears to be different from the holotype and the known hypotypes. His *G. contusa galeoidis* (*op. cit.*, pp. 74-75, pl. 1, figs. 3, 4*b*; pl. 9, figs. 6-14) appear to be identical with what was described by El-Naggar (1963, 1966*a*) as *G. contusa sensu* Troelsen, and is here considered as a valid subspecies.

El-Naggar (1966*a*, p. 92) stated that "*Globotruncana conica* var. *plicata* White, 1928 is probably a junior synonym of *G. contusa contusa* (Cushman), but White's brief description does not allow a definite decision without examination of his holotype." However, examination of several samples from the Mendez formation of Mexico has shown that the only *Globotruncana* species with a large, highly spiroconvex, cone-shaped test and two well-developed marginal keels in the Mendez formation is *G. contusa* (Cushman); this substantiates the consideration of *G. plicata* White as a junior synonym of *G. contusa*.

El-Naggar (*loc. cit.*) also stated: "Comparison of oriented thin sections of *G. contusa* (Cushman) with the holotype of *Rosalina linnei* mut. *caliciforme* de Lapparent, 1918 and with *Globotruncana linnei caliciformis* (de Lapparent) of Vogler (1941), showed the possibility that *G. contusa* (Cushman), 1926 may be a junior synonym of *G. caliciformis* (de Lapparent), 1918. However, examination of several samples from the type locality of de Lapparent (The Hendaye region of southwestern France) is needed before any decision can be taken, as his original description is very brief and his figure is only of a thin section." The first author collected several samples from the Maestrichtian rocks of southwestern France; these samples were both thin sectioned and processed for foraminiferal analysis. The thin sections showed forms identical to the holotype of *G. caliciformis* (de Lapparent) 1918 and to the hypotype of Vogler (1941), while the washed residues provided several forms identical with the holotype of *G. contusa* (Cushman) and the known hypotypes. This has clearly proved that *G. contusa* (Cushman) is a junior synonym of *G. caliciformis* (de Lapparent), that the name *contusa* has to be dropped, and that forms previously assigned to it have to be transferred to *G. caliciformis*. *Globotruncana caliciformis* itself has to be refined and redivided, as several of its subspecies were described under other names, while other species completely unrelated to *G. caliciformis* were wrongly assigned to it (*cf.* Gandolfi, 1955).

In the present study five distinct subspecies of *G. caliciformis* have been recognized and traced among forms previously described by various authors as *G. caliciformis, G. contusa, G. plicata* or *G. conica*. The main distinguishing features of each of these subspecies can be summarized as follows:

1. Forms with a roughly angular, polygonal periphery; sharply cut, rectangular chambers on the ventral side; radial, depressed ventral sutures, and usually plicate surface on the dorsal side (*e.g.* Plate 1, figs. 2a-3c).
2. Forms with a more regular test; unfolded or very delicately folded surface; subcircular to subrectangular equatorial periphery; short, strongly curved forward, raised and beaded ventral sutures; and distinctly elongated, strongly overlapping, *fornicata*-type chambers on the ventral side (*e.g.* Plate 1, figs. 1a-c).
3. Forms with a greater number of chambers in the last whorl, delicately to moderately plicated surface, subglobular, chambers on the ventral side and radial, depressed ventral sutures (*e.g.* Plate 2, figs. 3a-5c).
4. Forms with a much lower spire, less raised dorsal side, and less plicated surface than those included in the first category (*e.g.* Plate 1, figs. 4a-c).
5. Forms closely related to those included in the second category, but with a much smaller and less regularly convex test (*e.g.* Plate 2, figs. 1a-c).

As can be seen from the above, the five major distinct types are mainly differentiated on the basis of the great variation in the size of test, degree of elevation of the dorsal side, and the shape of both chambers and sutures on the ventral side, all of which influence the general shape of the test. However, as the holotype of *G. caliciformis* was described in thin section only, very little is known about its detailed morphological characteristics, but the forms recorded from the Maestrichtian rocks of southwestern France agree well with those of the first type, and their thin sections are identical to that of the holotype. Again, Cushman (1946) did not figure the ventral view of his *G. contusa,* and thus it was rather difficult to judge which of these forms is *G. contusa* of Cushman. Moreover, Troelsen (1955) figured as *G. contusa* (Cushman) forms identical with those of the third type above and stated that his specimens agree very well with Cushman's holo- and para- types which he had examined. However, as far as can be seen from Cushman's original brief description and figures, his form apparently belongs to those of the first type. Examination of topotype material of *G. contusa* (Cushman) kindly sent us by Dr. E. A. Pessagno, Jr., of the University of California at Davis, clearly showed its identity with the forms here included in the first type above. The fact that Cushman (1926) chose his holotype with a highly plicated dorsal side, made authors restrict the name to such folded forms. However, such plication has been found to be a variational character of no real taxonomic importance. Forms with a highly plicated dorsal side (*e.g.* Plate 1, figs. 3a-c) occur together with very slightly or non-plicated forms (*e.g.* Plate 1, figs. 2a-c).

The forms included in the second and fifth categories were described by Gandolfi (1955) as *G. contusa patelliformis* and *G. contusa scutilla* respectively, and our specimens conform very well with the topotypes he has kindly sent us. However, these two subspecies are now assigned to *G. caliciformis* and hence their names are changed to *G. caliciformis patelliformis* and *G. caliciformis scutilla* respectively.

The forms included in the third type were recorded by Troelsen (1955) as *G. contusa* (Cushman) from the White Chalk of Denmark. These were later considered by Herm (1962) as a distinct subspecies of *G. contusa* which he named *G. contusa galeoidis.* It is here removed to *G. caliciformis,* as reasoned above, and thus its name is changed to *G. caliciformis galeoidis.*

The forms included in the fourth type were considered by the first author (El-Naggar, 1966*a*) as a subspecies of *G. contusa* which he named *G. contusa witwickae* in honour of Dr. E. Witwicka, who had mentioned (Pozaryski and Witwicka, 1956) the occurrence of transitional stages between *G. fornicata* and *G. contusa.* The subspecies, *witwickae,* with all possible transitional stages to *G. fornicata* Plummer, appears slightly lower in the succession than typical *G. caliciformis caliciformis* and proves to be a transitional stage between it and typical *G. fornicata* Plummer with a closer relationship to *G. caliciformis.* Thus, it is here removed to *G. caliciformis* as explained above, whereby its name is changed to *G. caliciformis witwickae*.

Therefore, *Globotruncana caliciformis* (de Lapparent), 1918 includes:

1. *Globotruncana caliciformis caliciformis* (de Lapparent), 1918
2. *Globotruncana caliciformis patelliformis* Gandolfi, 1955.
3. *Globotruncana caliciformis scutilla* Gandolfi, 1955.
4. *Globotruncana caliciformis galeoidis* Herm, 1962.
5. *Globotruncana caliciformis witwickae* El-Naggar, 1966.

SYSTEMATIC DESCRIPTIONS

Superfamily GLOBIGERINACEAE Carpenter, Parker and Jones, 1862

Family GLOBOTRUNCANIDAE Brotzen, 1942

Genus **Globotruncana** Cushman, 1927

(Type species: *Pulvinulina arca* Cushman, 1926)

Globotruncana caliciformis caliciformis (de Lapparent)

(Plate 1, figures 2a-3c; Plate 4, figures 1-6)

1918 *Rosalina linnei* d'Orbigny mutation *caliciforme* DE LAPPARENT, Mem. Carte géol. detail. de la France, p. 8, fig. 2j, pl. 1, fig. 2.

1926 *Pulvinulina arca* Cushman var. *contusa* CUSHMAN, Contr. Cush. Lab. Foram. Res., vol. 2, pt. 1, p. 23, (no figs.).

1927 *Globotruncana arca* Cushman var. *contusa* (Cushman), CUSHMAN, J. Paleont., vol. 1, p. 169, (no figs.).

?1928 *Globotruncana conica* White var. *plicata* WHITE, J. Paleont., vol. 2, no. 4, pp. 285-286, pl. 38, figs. 8a-c.

1939 *Globotruncana arca* (Cushman) var. *contusa* (Cushman), MOROZOVA, Soc. Nat. Moscou 1939, ns.s., vol. 47, sect. Geol., vol. 17, no. 4-5, p. 80, pl. 1, figs. 1-3.

1941 *Globotruncana linnei caliciformis* (de Lapparent), VOGLER, Palaeontographica, Bd. 4, Suppl. Bd. 4, pp. 288-289, pl. XXIV, fig. 23.

1946 *Globotruncana arca* (Cushman) var. *contusa* (Cushman), CUSHMAN, U. S. Geol. Surv. Prof. Paper 206, pp. 150-151, pl. 62, figs. 6a, b.

?1946 *Globotruncana conica* var. *plicata* White, CUSHMAN, ibid., p. 151, pl. 61, figs. 21a-c.

1946 *Globotruncana conica* White, KELLER, Bull. Soc. Naturalistes de Moscou, nouv. ser., Tome LI, sect. géol., Tome XXI, (3), pp. 102-103, pl. III, figs. 4, 5.

not 1947 *Globotruncana conica* var. *plicata*, White, CUSHMAN and RENZ, Contr. Cush. Lab. Foram. Res., vol. 23, pt. 3, p. 50, pl. 12, fig. 13.

1948 *Globotruncana arca* var. *contusa* (Cushman), DI NAPOLI, Riv. Ital. Paleont. Stratigr., vol. 54, fasc. 1, pp. 21-22, figs. 2a-c.

?1948 *Globotruncana contusa* (Cushman), CITA, Riv. Ital. Paleont. Stratigr., vol. 54, fasc. 4, p. 150, pl. III, figs. 6a-c.

not 1948 *Globotruncana caliciformis* (de Lapparent), CITA, ibid., p. 148, pl. III, figs. 4a-c.

1951 *Globotruncana* (*Globotruncana*) *contusa* (Cushman), NOTH, Geol. Bundesanst. Jb., Sonderbd. 3, p. 79, tab. 8, figs. 17a-c.

1951 *Globotruncana contusa* (Cushman), BOLLI, J. Paleont., vol. 25, no. 2, p. 196, pl. 34, figs. 7-9, text-fig. 1f.

not 1951 *Globotruncana caliciformis* (de Lapparent), BOLLI, ibid., p. 194, pl. 34, figs. 4-6.

not 1952 *Globotruncana conica* var. *plicata* White, DE CIVRIEUX, Minist. Minas e Hirocarburos, Venezuela, Bol. geog., vol. 2, no. 5, pp. 282, pl. IX, figs. 10a-c.

not 1953 *Globotruncana caliciformis* (de Lapparent), SUBBOTINA, Trudy VNIGRI, n. ser., vol. 67, p. 188, pl. X, figs. 6a-c.

1953 *Globotruncana contusa* (Cushman), SUBBOTINA (pars), ibid., pp. 192-194, pl. XI, figs. 3a-c; pl. XII, figs. 2a-c; not figs. 1a-c.

not 1953 *Globotruncana contusa* (Cushman), HAMILTON, J. Paleont., vol. 27, pp. 232, pl. 29, figs. 14-16.

not 1953 *Globotruncana caliciformis* (de Lapparent), HAMILTON, ibid., p. 232, pl. 29, figs. 6-8.

?1954 *Globotruncana contusa* (Cushman), NAKKADY and OSMAN, Congress Geol. Internat., Alger, sec. XIII, fasc. XV, pp. 78-79, figs. Aa-c.

not 1954 *Globotruncana caliciformis* (de Lapparent), NAKKADY and OSMAN, ibid., pp. 77, 78, pl. XX, figs. 22a-c.

1954 *Globotruncana caliciformis* (de Lapparent), AYALA-CASTANARES, Assoc. mex. geol. petr. Bol., vol. 6, p. 386, pl. 3, figs. 1a-c.

1954 *Globotruncana contusa* (Cushman), AYALA-CASTANARES, (pars), ibid., p. 389, pl. 4, figs. 1a-b (Cushman's holotype), not 1c (Cita's form).

not 1955 *Globotruncana contusa* (Cushman), TROELSEN, Micropaleont., vol. 1, no. 1, pp. 80-81, text figs. 2a-9.

1955 *Globotruncana contusa contusa* (Cushman), GANDOLFI, Bull. Amer. Palaeont., vol. 36, no. 155, p. 53, pl. 4, figs. 3a-c.

not 1955 *Globotruncana caliciformis caliciformis* (de Lapparent), GANDOLFI, ibid., p. 46, pl. 3, figs. 1a-e.

not 1956 *Globotruncana caliciformis* Vogler, SAID and KENAWY, Micropaleont., vol. 2, no. 2, p. 150, pl. 5, figs. 18a-c.

1956 *Globotruncana contusa* (Cushman) WICHER, Palaeont. Zeitschr., Bd. 30, sonderheff, p. 136, pl. 12, figs. 5, 6.

1956 *Marginotruncana contusa* (Cushman), HOFKER, Natuurh. Maandbl., vol. 45, nos. 5, 6, p. 53, text fig. 9.

not 1957 *Globotruncana* (*Globotruncana*) *contusa* (Cushman), EDGELL, Micropaleont., vol. 3, no. 2, pp. 111-112, pl. 2, figs. 10-12; pl. 3, figs. 7-9, pl. 4, figs. 1-3.

not 1958 *Globotruncana contusa* (Cushman), BIEDA, Inst. Geol., Biul. 121, tom. 3, pp. 63-65, text figs. 26a-c.

1960 *Globotruncana* (*Marginotruncana*) *contusa* (Cushman), HOFKER, Dansk. geol. Foren., Bd. 14, H. 3, p. 225, text figs. 22a-c.

?1960 *Globotruncana contusa* (Cushman), HOFKER, J. Paleont., vol. 34, no. 3, p. 586, text fig. 1, drawing no. 15.

1960 *Globotruncana contusa* (Cushman), OLSSON, J. Paleont., vol. 34, no. 1, p. 50, pl. 10, figs. 25, 26.

1960 *Globotruncana contusa* (Cushman), VINOGRADOV, Acad. republ. pop. Romina, Sect. Geol., Geogr. si Inst. de Geol., Geofiz si Geogr., tom. 5, no. 2, p. 311, pl. 4, figs. 23a-24c; pl. 5, figs. 25a-c.

?1962 *Globotruncana* (*Marginotruncana*) *contusa* (Cushman), HOFKER, J. Paleont., vol. 36, no. 5, p. 1,062, text-fig. 7, A.

not 1962 *Globotruncana* (*Globotruncana*) *contusa* (Cushman), BERGGREN, Stockholm Contr. In Geology, vol. IX, no. 1, pp. 51-54, pl. IX, figs. 3a-4b.

not 1962 *Globotruncana caliciformis* (de Lapparent), HERM, Bayer. Akad. Wiss. math.-naturwiss. Kl. Abb. n.F., H. 104, pp. 68, 69, pl. 7, fig. 6.

1962 *Globotruncana contusa contusa* (Cushman), HERM (pars), ibid., pp. 72, 73, pl. 9, ? figs. 3, 4, not figs. 1, 2, 5, not pl. 1, figs. 4a, c.

not 1963 *Globotruncana contusa* (Cushman), BRÖNNIMANN and RIGASSI, Eclog. geol. Helv., vol. 56, no. 1, pl. XVI, figs. 2a-c.

1966*a* *Globotruncana contusa contusa* (Cushman), EL-NAGGAR, Bull. B.M. (N.H.), Geol. Suppl. 2, pp. 90-93, pl. 7, figs. 2a-3c; pl. 11, figs. 1a, b).

Description (Plate 1, figs. 3a-c).—Test large, robust, very strongly spiroconvex, with a sharply angular, polygonal outline and a folded surface of peculiar shape; dorsal side very highly trochospirally coiled, with bluntly curved convex folds radiating from the apex and broader shallowly concave depressions between the folds, widening away towards the base; ventral side concave, with the sharply-cut polygonal periphery gently sloping towards the umbilicus; equatorial periphery roughly pentagonal or rather stellate with blunt corners, gently undulating and very weakly, if at all, lobate, with two well-developed, much-thickened and heavily beaded keels enclosing a relatively wide, almost horizontal, slightly depressed peripheral band; axial periphery sub-angular, distinctly truncate; 23 chambers visible on dorsal side, arranged in 4 dextrally coiled whorls, they increase moderately and regularly in size till shortly before the beginning of the last whorl, where they start to increase very rapidly in size and change in shape; the initial chambers are small, inflated, globigerine, increase moderately in size and are followed by relatively large, globular inflated chambers which increase more rapidly in size, and become highly undulating and strongly elongated in the direction of coiling towards the end of the penultimate whorl; the last whorl is composed of 4 very long, very narrow, broadly curved, roughly oblong, undulating chambers which are extremely elongated in the direction of coiling; 4 chambers on the ventral side, very large, angular, roughly oblong, very narrow, strongly elongated in the direction of coiling, with their surfaces gently sloping towards the umbilicus; sutures on the dorsal side slightly curved, faintly raised and delicately beaded in the early part, strongly curved, undulating, raised, thickened and heavily beaded in the later part; on the ventral side the sutures are straight, radial and depressed; umbilicus rhomboidal in outline, relatively wide, deep, surrounded by beaded umbilical ridges and covered by complex tegilla of which remnants are still preserved; primary apertures interiomarginal, umbilical; tegilla have accessory apertures, but poorly preserved; wall calcareous, perforate except for the keels, peripheral band and tegilla; surface delicately papillose, especially on the early part and on the ventral side; the two keels are well developed, much thickened, raised, heavily beaded and enclose a relatively wide, slightly depressed, nearly horizontal peripheral band as the ventral keel is strongly shifted towards the ventral side; the peripheral band becomes gradually narrower, and the ventral keel tends to fade out towards the last chamber (slightly damaged and slightly shifted towards the umbilicus in the figured specimen); the dorsal keel encircles entire periphery of each chamber and then extends anteriorly onto the dorsal side of test as a highly undulating sutural ridge which joins the spiral suture; although the ventral keel, strongly shifted towards the ventral side of test, is no longer peripheral, it defines the chamber boundary from the peripheral band that lies in the same plane and then abruptly disappears into the ventral sutural depression to reappear again as a slightly raised, beaded umbilical ridge which runs roughly parallel to the keels and is slightly indistinct because the chambers slope gently towards the umbilicus; the two keels slightly diverge from each other as they extend onto each side of the test.

Dimensions.—

Maximum diameter = 0.70 mm.
Minimum diameter = 0.50 mm.
Thickness = 0.45 mm.

Variation.—The main variations observed in specimens of *G. caliciformis caliciformis* can be summarized as follows:

1. Test medium in size and moderately trochospirally coiled to very large, robust and very highly trochospirally coiled.
2. Dorsal side moderately to very highly raised, roughly dome shaped, with a somewhat pointed apex, slightly or distinctly folded, crenulate and undulate; some not crenulate (*e.g.* plate 1, figs. 3a-c).
3. Ventral side flat to concave.
4. Equatorial periphery roughly quadrate, pentagonal, hexagonal stellate, roughly polygonal or even irregular; very weakly lobate or even continuous, although the undulating surface makes it appear slightly lobate.
5. Axial periphery truncate, subangular or even acute.
6. Chambers on the dorsal side 16-25, arranged in 3-4 or rarely 5 whorls, usually dextrally coiled, but sinistral forms also occur (out of 25 specimens picked at random, 1 coiled sinistrally).
7. Chambers in the last whorl 4-5, usually very large, narrow, highly undulating and strongly elongated in the direction of coiling, but may be roughly quadrangular, angular and weakly curved.
8. Sutures on the dorsal side are either curved and gently undulate or highly irregular and strongly undulate; sutures on the ventral side are always radial and depressed.
9. The two keels are either equally developed throughout or the ventral one becomes slightly reduced on the last chamber.
10. The surface is either delicately or distinctly papillose or even nodose, especially in the early part and on the ventral side, the rugosity fading out gradually towards the last chamber.

Remarks.—*Globotruncana caliciformis caliciformis* (de Lapparent) is distinguished by: its large, robust, distinctly spiroconvex test; sharply angular, polygonal outline; occasionally folded surface; flat to slightly concave ventral side; sharply cut rectangular chambers on the ventral side; radial, depressed ventral sutures; two well-developed marginal keels; and an almost horizontal peripheral band.

It is believed to have evolved from *G. fornicata fornicata* Plummer through *G. caliciformis witwickae* El-Naggar, as suggested by the morphological characters and stratigraphical ranges of these forms, and as mentioned, in part, by both Cita (1948) and Bolli (1951). However, Gandolfi (1955) suggested the lineage *G. fornicata manaurensis* - *G. caliciformis scutilla* - *G. caliciformis patelliformis* - *G. caliciformis caliciformis*. Nevertheless, the present study indicates the possibility of 4 main lineages, briefly summarized as:

1. *G. fornicata fornicata* - *G. caliciformis witwickae* - *G. caliciformis caliciformis.*
2. *G. fornicata fornicata* - *G. adamsi* - *G. caliciformis patelliformis.*
3. *G. fornicata fornicata* - *G. fornicata cesarensis* - *G. caliciformis scutilla.*
4. *G. fornicata fornicata* - *G. fornicata globulocamerata* - *G. caliciformis galeoidis.*

Berggren (1962) described as *G.* (*G.*) *contusa* (Cushman) two morphologically distinct forms which appear to be completely different from this subspecies. One of his forms (pl. IX, figs. 3a-c) appears to be a single keeled concavo-convex form, quite unrelated to *G. caliciformis*. The other (figs. 4a, b), with its far more numerous chambers, and these much shorter and less elongated in the direction of coiling, may possibly belong to *G. caliciformis galeoidis.*

Specimens of *G. caliciformis caliciformis,* from the Sharawna Shale of Egypt, and from the Maestrichtian rocks of southwestern France conform well with de Lapparent's original description and figures, and with those of Cushman (1926).

Type and Occurrence.—The figured specimens (Plate 1, figs. 2a-3c) are from sample no. 18, W. El-Sharawna section, Esna-Idfu Region, Nile Valley, Egypt, U.A.R.

Stratigraphical Range.—*Globotruncana caliciformis caliciformis* (de Lapparent), 1918 was first described from the Maestrichtian rocks of the

Hendaye region of Southwestern France. It was later recorded from the Maestrichtian of East Indonesia (Vogler, 1941) and from the Upper Campanian Maestrichtian of the Marche region, Italy (Borsetti, 1962). The species was also recorded under the name *G. contusa* from the Maestrichtian Mendez Shales of Mexico (Cushman, 1926, 1927, 1946; White, 1928; and Hay, 1960); from the Maestrichtian of the U.S.S.R. (Morozova, 1939, Keller, 1946, Subbotina, 1953); from the Campanian - Maestrichtian of Austria and Switzerland (Noth, 1951); the Maestrichtian of Trinidad (Bolli, 1951, 1957*a*); the Maestrichtian of the Qabeliat and the Campanian - Maestrichtian of the Sudr section, Sinai, Egypt (Nakkady and Osman, 1954); from the upper Campanian - Maestrichtian, Colon shale of North-Eastern Colombia (Gandolfi, 1955); the lower and upper Maestrichtian of the Gamsa Basin, Austria (Wicher, 1956); the lower-upper Maestrichtian boundary, Cr_4 - Mb, at Loen, Belgium (Hofker, 1956); the lower and upper Maestrichtian of the Atlantic Coastal Plain (Olsson, 1960); the Maestrichtian of the Prahova Basin, Romania (Vinogradov, 1960); from the type Maestrichtian of Holland (Hofker, 1960, 1962).

In the Esna-Idfu region, *G. caliciformis caliciformis* appears in the basal part of the Middle Maestrichtian "*G. gansseri* Zone" and increases in abundance upward in the section to flood this zone, then fades out gradually, dying out completely in the overlying Upper Maestrichtian *G. esnehensis* Zone.

No typical forms of this subspecies were recorded in the underlying Lower Maestrichtian "*G. fornicata* Zone," which is flooded with transitional stages between the *G. fornicata* and *G. caliciformis* groups. All reliable references show clearly that *G. caliciformis caliciformis* ranges through the Middle and Upper Maestrichtian. All records of this subspecies from rocks older than the Middle Maestrichtian are probably a result of confusion with other subspecies.

Globotruncana caliciformis galeoidis Herm

(Plate 2, figures 3a-5c)

1955 *Globotruncana contusa* (Cushman), TROELSEN, Micropaleontology, vol. 1, no. 1, pp. 80, 81, text-figs. 2*a-g*.

1962 *Globotruncana contusa galeoidis* HERM, Bayer. Akad. Wiss. math.-naturwiss. Kl. Abb., n.F., H. 104, pp. 74, 75; pl. 1, figs. 3, 4*b*.

1962 *Globotruncana (Globotruncana) contusa* (Cushman), BERGGREN (pars), Stockh. Contr. Geol. vol. 9, no. 1, pp. 51-54, pl. IX, figs. 4*a, b;* not figs. 3*a-c*.

1966a *Globotruncana contusa* (Cushman) sensu Troelsen, EL-NAGGAR, Bull. B.M. (N.H.), Geol. Suppl. 2, p. 92, text-fig. 10.

Remarks.—*Globotruncana caliciformis galeoidis* was described by Herm (1962) as a new subspecies of *G. contusa* (Cushman), but it is here removed to *G. caliciformis,* a senior synonym of *G. contusa* as mentioned above. The species was repeatedly assigned to *G. contusa* (Cushman) or included within it (*cf*. Troelsen, 1955; Berggren, 1962; and El-Naggar, 1966*a*).

Herm (1962) distinguished this subspecies on the basis of its large number of chambers (in the test, and in the last whorl) and its distinct stratigraphic range, being only limited to the upper part of the Maestrichtian. Moreover, as mentioned above, this subspecies is also distinguished by its subglobular chambers on the ventral side and radial, depressed ventral sutures.

The subspecies *galeoidis* was described from the Upper Maestrichtian of Salzburg (Herm, 1962), of Denmark (Troelsen, 1955, and Berggren, 1962); and of the Nile Valley, Egypt (El-Naggar, 1966*a*). Rare specimens were recorded in the Sharawna Shale, and these conform well with Troelsen's and Herm's figures.

Globotruncana caliciformis patelliformis Gandolfi

(Plate 1, figures 1a-c)

?1953 *Globotruncana conica* White, SUBBOTINA, (pars), Trudy VNIGRI, n. ser., vol. 67, p. 190, pl. XI, figs. 2a-c; not figs. 1a-c.

1955 *Globotruncana (Globotruncana) contusa patelliformis* GANDOLFI, Bull. Amer. Paleont., vol. 36, no. 155, pp. 54-55, pl. 4, figs. 2a-c.

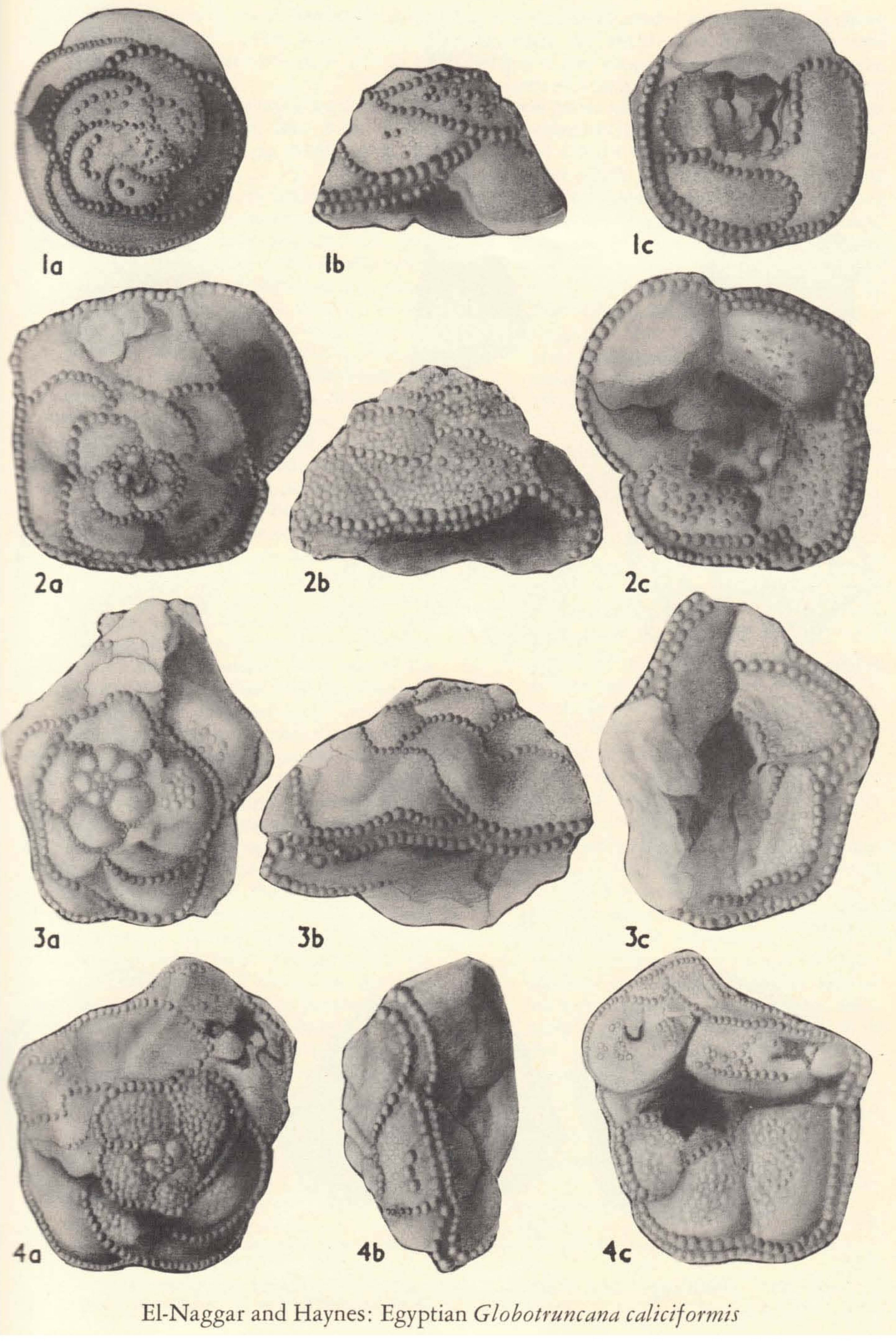
1961 *Globotruncana contusa* cf. *patelliformis* Gandolfi, CORMINBOEUF, Eclog. geol. Helv., vol. 54, no. 1, p. 112, pl. 1, figs. 1a-c.

EXPLANATION OF PLATE 1

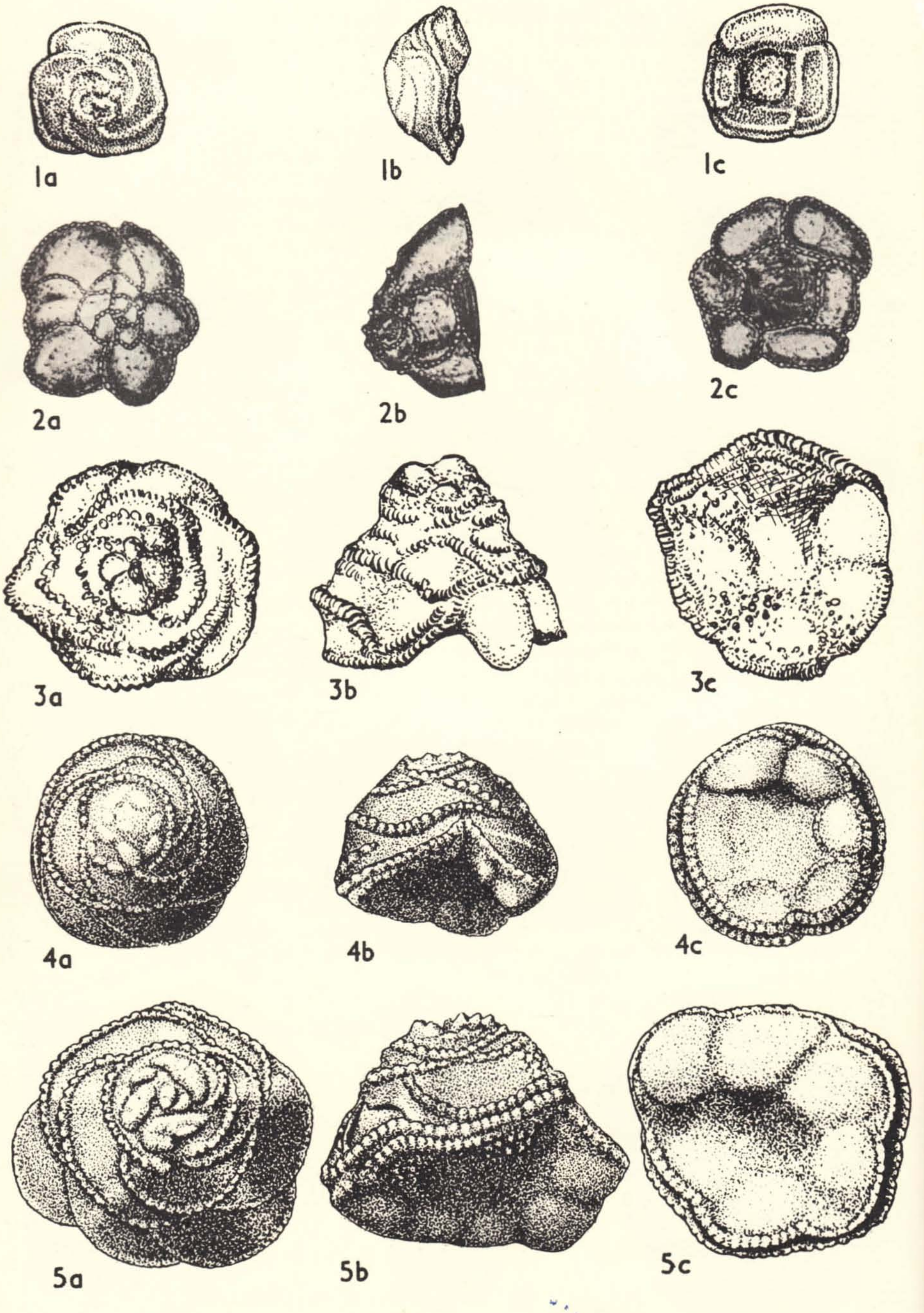
(All figures approximately × 80)

a. dorsal view; b. side view; c. ventral view.

FIGS.		PAGE
1a-c.	*Globotruncana caliciformis patelliformis* Gandolfi.	8
2a-3c.	*Globotruncana caliciformis caliciformis* (de Lapparent).	5
4a-c.	*Globotruncana caliciformis witwickae* El-Naggar.	10



El-Naggar and Haynes: Egyptian *Globotruncana caliciformis*



El-Naggar and Haynes: Egyptian *Globotruncana caliciformis*

1963 *Globotruncana* (*Globotruncana*) *plicata caliciformis* Vogler; VAN HINTE, Jb. Geol., B.A., Sonderband 8, pp. 64, 65, pl. 3, figs. 2a-c.

1966*a* *Globotruncana contusa patelliformis* Gandolfi, EL-NAGGAR, Bull. B.M. (N.H.), Geol. Suppl. 2, pp. 93-95, pl. 8, figs. 1a-c.

Description.—Test large, robust, very highly trochospirally coiled in the form of a truncated cone with a wide subcircular base and a narrow, truncated top; dorsal side highly trochospirally coiled, very strongly raised and distinctly domed; ventral side flat or even slightly concave because the sides gently slope towards the umbilicus; equatorial periphery almost circular, slightly lobate, with two well-developed, much-thickened and heavily-beaded marginal keels which become much closer on the penultimate chamber and are reduced to a single, limbate, non-beaded keel on the last one; axial periphery subangular, truncate; chambers on the dorsal side are not clear, but appear to be 14, arranged in 3 dextrally coiled whorls; the initial ones are small, indistinct, roughly globular, weakly inflated, increase slowly in size and are followed by crescentic, inflated chambers which are strongly elongated in the direction of coiling and increase very rapidly in size; the last whorl is composed of 4 very long, narrow, slightly undulating crescentic chambers which are distinctly elongated in the direction of coiling and increase slowly in size; on the ventral side the chambers are 4, very long, narrow, distinctly elongated and strongly overlapping; the very long sutures on the dorsal side are distinctly curved, strongly raised and heavily beaded, especially in the early part; on the vertical side the sutures are short, strongly curved forward, raised and beaded; umbilicus roughly rectangular in outline, wide, deep, surrounded by raised, beaded ridges (umbilical flange or "bourrelet ombilical") and covered by complex tegilla of which remnants are still preserved; primary apertures interiomarginal, umbilical; tegilla (with accessory apertures) only poorly preserved; wall calcareous, perforate except for the imperforate keels, peripheral band and tegilla; surface generally smooth with few scattered papillae on the dorsal side especially in the early part; the two marginal keels are well developed and distinctly beaded except on the last chamber, where the ventral keel is reduced and the beading of the dorsal one fades out completely, they enclose a relatively wide, almost horizontal peripheral band, which narrows gradually towards the last chamber; the dorsal keel is reflected onto the dorsal side of the test as a curved, beaded sutural ridge which joins the spiral suture, while the ventral keel extends onto the ventral side as a raised, beaded ventral suture which curves backward around the umbilicus as a raised beaded umbilical ridge; the umbilical ridge of the last chamber is slightly reduced and is reflected along its apertural face to join the dorsal suture.

Dimensions.—

Maximum diameter = 0.52 mm.
Minimum diameter = 0.49 mm.
Thickness = 0.40 mm.

Variation.—The main variations observed in the studied specimens of *G. caliciformis patelliformis* Gandolfi can be summarized as follows:

1. Test medium to large in size, highly to moderately conical, subcircular to ovoid or even rectangular in outline.
2. Dorsal side moderately to distinctly raised, conical to pyramidal or even irregularly trochospirally coiled.
3. Ventral side flat to slightly concave.
4. Equatorial periphery subcircular, subovoid or even angular, compressed, with two distinctly developed marginal keels, the ventral of which is sometimes reduced on the last one or two chambers.
5. Chambers on the dorsal side 14-21, arranged in 3-4 whorls, which are generally dextrally coiled.
6. Chambers in the last whorl 4-5, most commonly 4, slightly to moderately undulate and slowly to moderately increasing in size. The last chamber is sometimes slightly smaller than the penultimate.
7. The surface is generally smooth, with few scattered papillae on the dorsal side of the early chambers, but sometimes these papillae become so well developed as to give the early part a rough, papillose appearance.

EXPLANATION OF PLATE 2

a. dorsal view; b. side view; c. ventral view

FIGS.		PAGE
1a-c.	*Globotruncana caliciformis scutilla* Gandolfi, Holotype approximately × 60 after Gandolfi, 1955.	10
2a-c.	Holotype of *Globotruncana conica* var. *plicata* White *G. caliciformis caliciformis* (de Lapparent), × 40, after White.	3
3a-5c.	*Globotruncana caliciformis galeoidis* Herm. 3a-c, Holotype × 50, after Herm, 1962. 4a-5c, Hypotypes × 50, after Troelsen, 1955.	8

Remarks.—*Globotruncana caliciformis patelliformis* was described as a new subspecies of *G. contusa* from the Colon shale of North-Eastern Colombia by Gandolfi (1955). He included in its synonymy the form previously described by Bolli (1951) as *G. contusa* (Cushman). Although Bolli gave no description, his figured specimens appear to be more related to the central type. This subspecies is here removed to *G. caliciformis,* of which *G. contusa* has been proved to be a junior synonym.

Globotruncana caliciformis patelliformis is distinguished from *G. caliciformis caliciformis* by: its more regular, far less plicated, sub-conical test; its narrow elongate, *fornicata*-type chambers on the ventral side; its strongly anteriorly curved, raised and beaded ventral sutures; and its distinctly elongate early chambers. It is also distinguished from the other members of the *G. caliciformis* group by its robust, regular test and by the shape of its ventral chambers and sutures.

The form described by Corminboeuf (1961) as *G. contusa* cf. *patelliformis* falls well within the range of variation of this subspecies. It differs from the holotype only in being slightly compressed laterally.

On the basis of morphological characters and stratigraphical distribution, *Globotruncana caliciformis patelliformis* is believed to have evolved from *G. fornicata fornicata* Plummer through *G. adamsi* El-Naggar. The early part of *G. caliciformis patelliformis* closely resembles the adult *G. adamsi,* and the ventral side of the two forms is also very similar, while *G. caliciformis scutilla* can be considered a very small *G. caliciformis patelliformis.*

Specimens of *G. caliciformis patelliformis* Gandolfi from the Esna-Idfu region conform well with Gandolfi's original description and figures and with types kindly forwarded to the present authors by Dr. R. Gandolfi.

Type and Occurrence.—Figured specimen, Plate 1, figs. 1a-c, from sample no. 18, W. El-Sharawna section, Esna-Idfu region, Nile Valley, Egypt, U.A.R.

Stratigraphical Range.—Gandolfi (1955) described *G. caliciformis patelliformis* as a new subspecies of *G. contusa* from the Colon shale of North-Eastern Colombia. He recorded it to range throughout the *Pullenia cretacea* and the *Siphogenerinoides bramlettei* zones, considered by him to be Campanian - Maestrichtian, but on his range chart (*op. cit.,* pl. 9) he showed its range as lower and middle "*Pullenia cretacea* zone" only. However, an analysis of the planktonic Foraminifera of the Colon shale, which were described by Gandolfi (1955), suggests a Maestrichtian age for the whole formation.

Corminboeuf (1961) and van Hinte (1963) recorded the present subspecies from the Maestrichtian of Switzerland and of Austria respectively, and it was previously recorded as *G. conica* from the Maestrichtian of the U.S.S.R. (Subbotina, 1953).

In the Esna-Idfu region, *G. caliciformis patelliformis* was recorded in the basal part of the Middle Maestrichtian "*G. gansseri* Zone"; it increases gradually upward in the section to flood the middle and upper parts of this zone and then fades out gradually in the overlying Upper Maestrichtian "*G. esnehensis* Zone" where it dies out completely.

This is the first record of *G. caliciformis patelliformis* in Egypt, North Africa and the Middle East, or indeed outside Colombia, Switzerland, Austria and the U.S.S.R.

Globotruncana caliciformis scutilla Gandolfi

?1953 *Globotruncana conica* White, SUBBOTINA (pars), Trudy VNIGRI, n. ser., vol. 67, p. 190, pl. XI, figs. 1a-c, not 2a-c.

1955 *Globotruncana* (*Globotruncana*) *contusa* (Cushman) *scutilla* GANDOLFI, Bull. Amer. Paleont., vol. 36, no. 155, p. 54, pl. 4, figs. 1a-c.

Remarks.—A few specimens of this subspecies were recorded from the Lower Maestrichtian "*G. fornicata* Zone." Morphologically, they appear to be so closely related to *G. caliciformis patelliformis,* in spite of the great difference in size, that they could be considered as small forms of it. However, Gandolfi (1955) recorded this form to start very early in his section, and it was only recorded in the "*G. fornicata* Zone" of the present study, thus it was found advisable to treat it separately.

G. caliciformis scutilla is believed to have evolved from *G. fornicata fornicata* (Plummer) through *G. fornicata cesarensis* Gandolfi, as suggested by the morphological features and stratigraphical ranges of these forms.

Gandolfi (*op. cit.*) recorded the present subspecies as ranging throughout the upper part of the Manaure Shale and the basal part of the Colon Shale of North-Eastern Colombia, considered by him to be Coniacian - Lower Campanian. However, as previously mentioned, the Colon Shale most probably belongs to the Maestrichtian.

In the Esna-Idfu region *G. caliciformis scutilla* was found to occur only in the *G. fornicata* Zone where it is a common to rare form.

Globotruncana caliciformis witwickae El-Naggar

(Plate 1, figures 4a-c)

1966 *Globotruncana contusa witwickae* EL-NAGGAR, Bull. Brit. Mus. (N.H.), Geol. Suppl. 2, pp. 95-97; pl. 7, figs. 1a-c.

Description—Test large, robust, spiroconvex, coiled in a relatively high trochospire; dorsal side moderately convex, gently plicate and undulate; ventral side almost flat and weakly inflated; equatorial periphery bluntly polygonal, with two well-developed, heavily beaded, marginal keels which enclose a narrow, slightly inclined peripheral band and tend to weaken towards the last chamber where the ventral keel is completely reduced; axial periphery subangular, subtruncate; chambers on the dorsal side 17, arranged in 3 dextrally coiled whorls; the initial ones are very small, globular, weakly inflated; they increase very slowly in size and are followed by much larger, subglobular, inflated chambers which tend to be roughly crescentic towards the last whorl and increase moderately in size; the last whorl is composed of 5 large, narrow, distinctly elongated chambers which are roughly crescentic in the early part, irregular, folded and undulate in the last two chambers and increase moderately in size, although the last chamber is slightly smaller than the penultimate; the 5 chambers on the ventral side are large, angular, roughly rectangular, strongly elongated, and, except for the last one, increase moderately in size; sutures on the dorsal side short, curved and beaded in the early part, distinctly elongated, curved, undulated, raised, thickened and beaded in the later part; on the ventral side the sutures are slightly curved in the early part, straight, radial and depressed in the later; umbilicus roughly stellate in outline, relatively wide, deep, bordered by thick beaded ridges which fade out gradually towards the last chamber; umbilicus covered by complex tegilla of which remnants are still preserved; primary apertures interiomarginal, umbilical; tegilla, with accessory apertures, only poorly preserved; wall calcareous, perforate except for the imperforate keels, peripheral band and tegilla; surface delicately papillose, especially in the early part and on the ventral side; the two marginal keels are well developed, heavily beaded and enclose a narrow, slightly inclined peripheral band, but their beading fades out gradually towards the last chamber, where the ventral keel is completely reduced; the dorsal keel encircles the entire periphery of each chamber and then curves forward on to the dorsal side of test as a sutural ridge which joins the spiral suture, while the ventral keel disappears into the ventral sutural depression to reappear again as an umbilical ridge that joins the suture of the preceding chamber.

Dimensions.—

Maximum diameter	= 0.70 mm.
Minimum diameter	= 0.54 mm.
Thickness	= 0.31 mm.

Remarks.—This form was first described by El-Naggar (1966*a*) as a subspecies of *G. contusa,* but is here removed to *G. caliciformis,* a senior synonym of *G. contusa.* It represents the maximum development of a whole series of transitional stages between *G. fornicata fornicata* Plummer and *G. caliciformis caliciformis* (de Lapparent). It could neither be included in the former species, although they occur together, nor in the latter, as it is morphologically slightly different and stratigraphically older. It represents an intermediate stage between these two species both in its morphological characters and in its stratigraphical range; because it resembles *G. caliciformis caliciformis* (de Lapparent) more closely, it is considered a subspecies of it.

Pozaryski and Witwicka (1956) mentioned the occurrence of what they described as *G. fornicata* var. *contusa* in the Upper Campanian of the Lublin Basin, Central Poland, but they gave no figure or description. Their form may belong to the present subspecies or be a transitional stage between it and *G. fornicata fornicata* Plummer. Since all forms of *G. fornicata* which show characters transitional to that of *G. caliciformis* are included in the present subspecies, however, Pozaryski and Witwicka's form is considered to belong to it and is here named *G. caliciformis witwickae* in honour of Dr. E. Witwicka of the Geological Institute, Rakowiecka, Poland.

Type and Occurrence.—Holotype, Plate 1, figs. 4a-c, from sample no. 4, Abou Saboun section, Esna-Idfu region, Nile Valley, Egypt, U.A.R.

Stratigraphical Range.—*Globotruncana caliciformis witwickae* occurs only in the "*G. fornicata* Zone" of lower Maestrichtian age where it is common to abundant.

The form described by Pozaryski and Witwicka (1956) as *G. fornicata* var. *contusa* (which may belong to the present subspecies) was recorded from the Upper Campanian of Central Poland.

Records of *G. caliciformis caliciformis* (de Lapparent) from rocks older than the Middle Maestrichtian may possibly refer to *G. caliciformis witwickae.*

REFERENCES

AYALA-CASTANARES, A., 1954. El Genero *Globotruncana* Cushman, 1927 y su Importancia en Estratigrafia: Bol. Assoc. Mex. Geol. Petrol., vol. 6, no. 11-12, pp. 353-474, 16 pls., Mexico City.

BERGGREN, W. A., 1962. Some Planktonic Foraminifera from the Maestrichtian and type Danian Stages of Southern Scandinavia: Stockholm Contr. in Geology, vol. IX, 1, pp. 1-160, pls. I-XIV, text-figs. 1-14.

BIEDA, E., 1958. Index Foraminifers and the Age of the Mielnik Chalk (Eastern Poland): Inst. Geol., Biul. 121, Tom. 3, pp. 17-70 (Polish); pp. 71-79, (Russian summary); pp. 81-89 (English summary), 27 text figs., 1 pl., Warsaw.

BOLLI, H. M., 1951a. The Genus *Globotruncana* in Trinidad, B.W.I.: Journ. Paleont., vol. 25, no. 2, pp. 187-199, pls. 34, 35.

BORSETTI, A. M., 1962. Foraminiferi Planctonici di una serie Cretacea dei dintorni di Piobbico: Giornale di Geologia, vol. XXIX, pp. 19-75.

BRÖNNIMANN, P., and RIGASSI, D., 1963. Contribution to the Geology and Paleontology of the Area of the City of La Habana, Cuba, and its surroundings: Eclog. Geol. Helv., vol. 56, no. 1, pp. 13-480, pls. I-XXVI, text figs. 1-75.

CITA, M. B., 1948. Richerche stratigrafiche e micropaleontologiche sul Cretacico e sull' Eocene di Tignale (Lago di Garda): Riv. Ital. Pal. Strat., Milan, 1948, vol. 54, no. 4.

DE CIVRIEUX, J. M. SELLIER, 1952. Estudio de la microfauna de la sectiontipo del miembro socuy de la formacion Colon, distrito Mara, Estado Zulia: Ministerio de Minas e Hidrocarburos Bolletin de Geologia, vol. 11, no. 5, pp. 231-310, pls. 1-11, text fig. 1-12.

CUSHMAN, J. A., 1926. Some Foraminifera from the Mendez shale of Eastern Mexico: Contr. Cush. Lab. Foram. Res., vol. 2, pt. 2, pp. 16-28.

———, 1927. Some Characteristic Mexican Fossil Foraminifera: J. Paleont., vol. 1, pp. 147-172, 6 pls., Sharon, Mass.

———, 1946. Upper Cretaceous Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas: U. S. Geol. Surv. Prof. Pap. 306, pp. 1-241, pls. 1-66.

———, 1947. A Foraminiferal Fauna from the Santa Anita Formation of Venezuela: Contr. Cush. Lab. Foram. Res., vol. 23, pt. 1, pp. 1-18, pls. I-IV, Sharon, Mass.

DI NAPOLI, ALLIATA, E., 1948. *Globotruncana* nell'-Eocene della Sicilia centrale: Riv. Ital. Pal. Strat., vol. 54, no. 1, pp. 19-28, 1 text fig., Milan.

EDGELL, H. S., 1957. The Genus *Globotruncana* in North-West Australia: Micropaleontology, vol. 3, no. 2, pp. 101-126, pls. 1-4, text figs. 1-4, table 1, April, 1957.

EL-NAGGAR, Z. R., 1963. Geology and Stratigraphic Palaeontology of the Esna-Idfu region (Nile Valley, Egypt, U.A.R.): Ph.D. thesis, University of Wales, U. K.

———, 1966*a*. Stratigraphy and Planktonic Foraminifera of the Upper Cretaceous - Lower Tertiary succession in the Esna-Idfu region, Nile Valley, Egypt, U.A.R.: Bull. British Mus. (Nat. Hist.), Geol. Suppl. 2, pp. 1-291, pls. 1-23, text-figs. 1-18.

———, 1966*b*. Stratigraphy and classification of the type Esna Group of Egypt: A.A.P.G., July, 1966. (in press)

GANDOLFI, R., 1955. The Genus *Globotruncana* in North-Eastern Colombia: Bull. Amer. Paleont., vol. 36, no. 155, pp. 1-118, pls. 1-10, text figs. 1-12.

GLAESSNER, M. F., 1937. Planktonforaminiferen aus der Kreide und dem Eozän und ihre stratigraphische Bedeutung: Public. Lab. Paleont., Moscow Univ., Studies in Micropaleontology, Moscow, vol. 1, pp. 27-46, pls. 1, 2.

HAMILTON, E. L., 1953. Upper Cretaceous, Tertiary and Recent Planktonic Foraminifera from Mid-Pacific flat-topped seamounts: Journ. Paleont., vol. 27, no. 2, pp. 204-237, pls. 29-32.

HINTE, J. E. VAN, 1963. Zur Stratigraphie und Mikropaläontologie der Oberkreide und das Eozäns des Krappfeldes (Karnten): Jb. Geol. B.A., Sonderband 8, pp. 1-147, pls. 1-27.

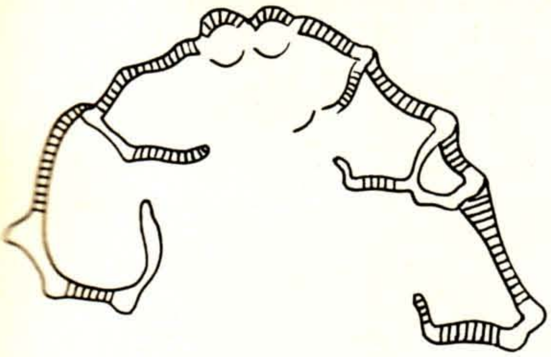
HOFKER, J., 1956. Foraminifera from the Cretaceous of Southern Limberg, Netherland, 19, Planktonic Foraminifera of the Chalk Natuurhist: Maandblad, v. 45, pp. 51-57.

———, 1960. The type localities of the Maestrichtian (Maestrichtian chalk tuff) and the Montian (Tuffeau de Ciply, Calcaire de Mons, Lagunar and Lacustre Montian): Journ. Paleontology, vol. 34, no. 3, pp. 584-588, 1 text fig., 1 tab., Menasha, Wisconsin (May).

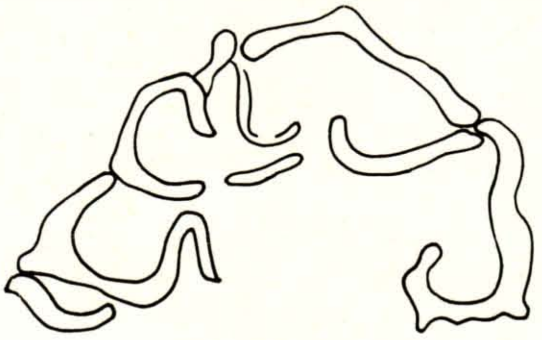
———, 1962. Correlation of the Tuff Chalk of Maestricht "Type Maestrichtian with the Danske Kalk of Denmark." Type Danian, the strati-

EXPLANATION OF PLATE 3

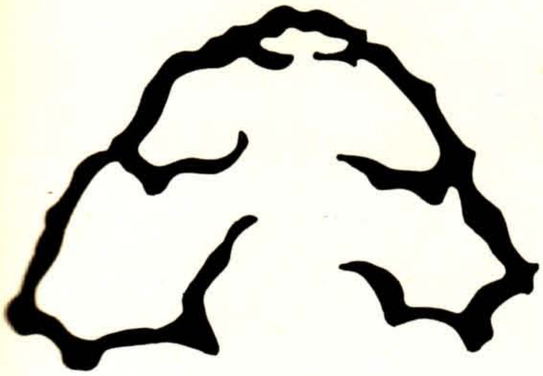
FIGS.		PAGE
1.	Axial section of the Holotype of *Rosalina linnei* d'Orbigny mutation *caliciforme* de Lapparent, approximately × 100, after de Lapparent, 1918.	3
2.	Axial section of *Globotruncana linnei caliciformis* de Lapparent ~~Vogler, Vogler~~, approximately × 100, after Vogler, 1941.	3
3.	Axial section of *Globotruncana contusa* (Cushman) = *G. caliciformis caliciformis* (de Lapparent), after Bolli. 1951	3
4-6.	Axial section of *G. caliciformis caliciformis* (de Lapparent) from the Maestrichtian rocks of Biarritz region, southwestern France, approximately × 100.	5
7, 8.	Axial and Tangential sections of *G. caliciformis* caliciformis (~~de~~ Lapparent) from the Maestrichtian Sharawna Shale ~~rocks of Biarritz, southwestern France~~ of Egypt, approximately × 100, × 120 respectively	5



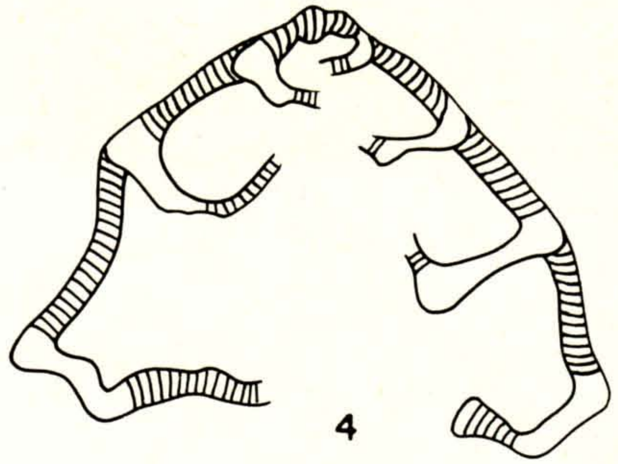
1



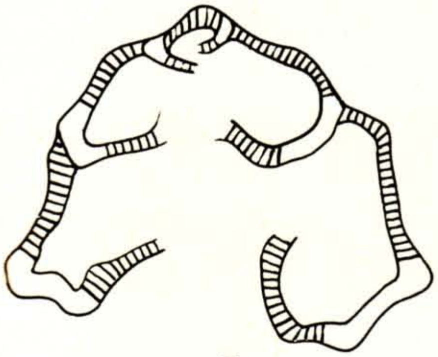
2



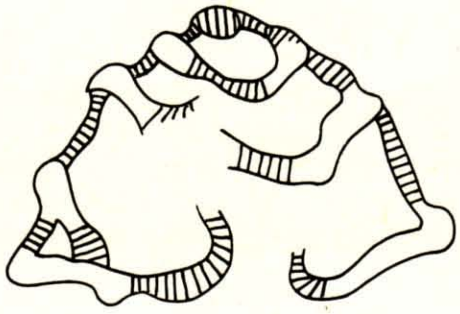
3



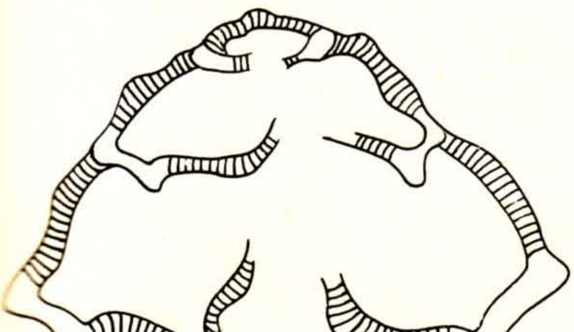
4



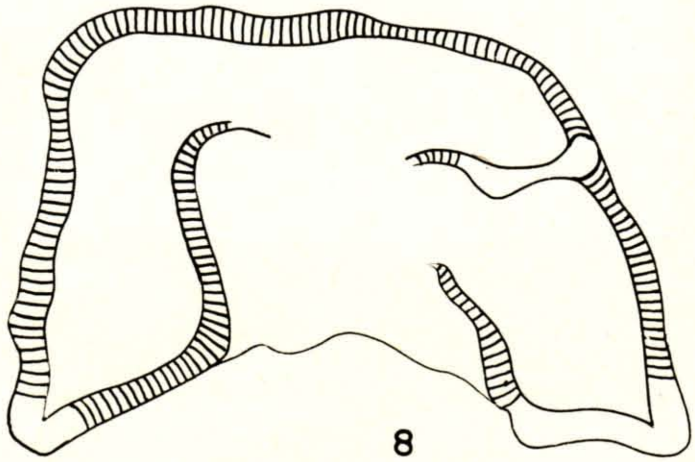
5



6

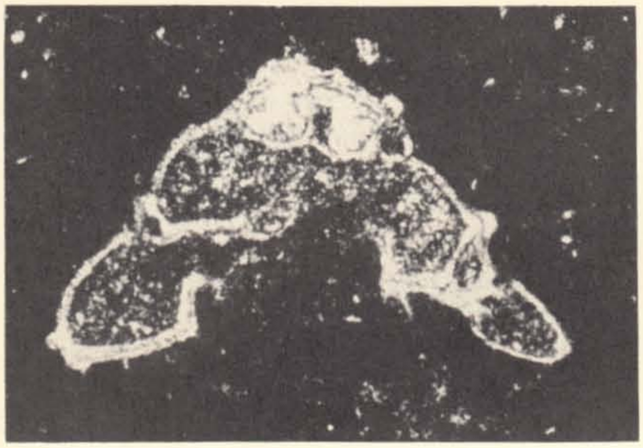


7



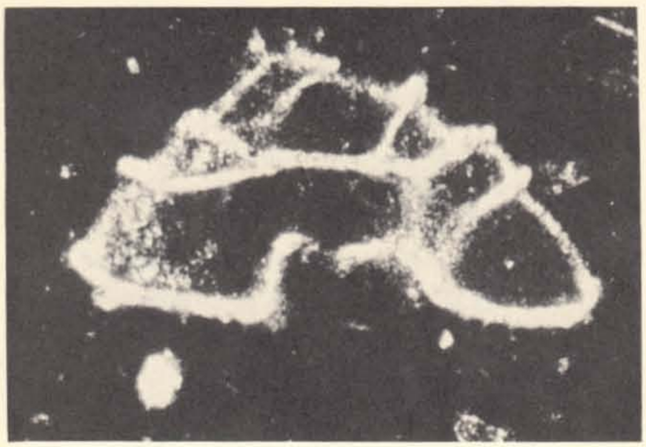
8

El-Naggar and Haynes: Egyptian *Globotruncana caliciformis*



1

2



3

4

5

6

El-Naggar and Haynes: Egyptian *Globotruncana caliciformis*

graphic position of the type Montian and the planktonic Foraminifera fauna break: J. Paleont., vol. 36, no. 5, pp. 1051-1089, 28 text figs.

KELLER, B. M., 1946. The foraminifera of the Upper Cretaceous deposits in the Sotchi region. Bull. Mosk. obsc. ispyt. prir. (Ber. naturforsch Ges.) 51 otd. geol. 21, pp. 83-108, 3 pls., 2 tables, Moscow, (Russian with English summary): Bulletin de la Société des Naturalistes de Moscou, Nouvelle Série, Tome LI, Section Géologique, tome XXI.

NAKKADY, S. E. and OSMAN, A., 1954. The genus *Globotruncana* in Egypt, Taxonomy and stratigraphical value: Congress. Geol. Intern., 1952, sec. 13, fasc. 15, pp. 75-95.

NOTH, R., 1951. Foraminiferen aus Unter-and Oberkreide des österreichischen Anteils an flysch, Helvetikum und Vorlandvorkommen: Geol. Bundesanstalt, Jarb., Sonderbd. 3, pp. 1-91, pls. 9, 2 charts.

OLSSON, R. K., 1960. Foraminifera of the latest Cretaceous and earliest Tertiary age in the New Jersey Coastal Plain: Journ. Paleontology, vol. 34, no. 1, pp. 1-58, pls. 1-12.

POZARYSKI, W. and WITWICKA, E., 1956. *Globotruncana* of the Upper Cretaceous in Central Poland: Biul. Inst. Geol., 102, 5-30, 1 tab., Warszawa, Poland. (Polish with Russian and English summary).

SAID, R. and KENWAY, A., 1956. Upper Cretaceous and Lower Tertiary Foraminifera from Northern Sinai, Egypt: Micropaleontology, vol. 2, no. 2, pp. 105-173, pls. 1-7, text figs. 1-6.

SUBBOTINA, N. N., 1953. Fossil Foraminifera from the U.S.S.R., Globigerinidae, Hantkeninidae and Globorotaliidae: Trudy Vses. Neft. geol. rav. Inst. (n. Ser.), Fasc. 76, pp. 1-294, pls. I-XXV, 1 chart.

TROELSEN, J. C., 1955. *Globotruncana contusa* in the White Chalk of Denmark: Micropaleontology, vol. 1, no. 1, pp. 76, 82, text figs. 1-2.

VINOGRADOV, C., 1960. Limita cretacic-paleogen in bazinul vaii Prahova: Acad. republ. pop. Romina, sect. Geol., Geogr. si Inst. de Geol., Geofiz, si Geogr., Tom. 5, no. 2, pp. 299-321 (Russian and French summaries on pp. 321 and 322 respectively). Bibliography pp. 322-324, 6 pls., 1 tab., Bucharest.

VOGLER, J., 1941. Beitrage zur geologie von Niederlaendisch Indien. Ober Jura und Kreide von Misol (Niederlaendisch-Ostindien): Palaeontographica, suppl. Bd. IV, Abt. 4, Lief. 4, pp. 243-293, 13 text figs., 2 pls., Stuttgart.

WHITE, M. P., 1928. Some index Foraminifera of the Tampico Embayment Area of Mexico. Part II: Journ. Paleontology, vol. 2, no. 4, pp. 280-317, pls. 38-42, 1 table.

WICHER, C. A., 1956. Die Gosau Schichten im Becken von Gams (Osterreich) und die Foraminiferengliederung der hoheren Oberkreide in der Tethys: Paläont. Zeitschr., vol. 30, pp. 87-136.

WITWICKA, E., 1958. Micropalaeontological stratigraphy of Upper Cretaceous of the Chelm Borehole (Lublin Upland): Inst. Geol. Biul. 121, tom. 3, pp. 117-232 (Polish); pp. 233-249 (Russian summary); pp. 251-267 (English summary), 14 pls., Warsaw.

EXPLANATION OF PLATE 4

FIGS. Random PAGE

1-6. Sections of *G. caliciformis* ~~caliciformis~~ (de Lapparent) from the Maestrichtian of the Biarritz region (Southwestern France), plane polarized light, approximately × 100. 5

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVIII, PART 1, JANUARY, 1967

327. PLANKTONIC FORAMINIFERA FROM THE MIOCENE ROCKS OF THE GULF OF SUEZ REGION, EGYPT[1]

RUSHDI SAID and IHAB EL-HEINY
Cairo University and Compagnie Orientale des Pétroles

ABSTRACT

This paper lists and discusses the stratigraphic value of the planktonic foraminifera from the Abu Rudeis well no. 2, Gulf of Suez, Egypt. The analysis of a large number of samples makes possible the zonation of this Miocene section in a manner which has never been attempted before in Egypt. This zonation establishes the correlatability of the Egyptian section with other parts of the world. The section is divided into the following zones from top to bottom: the **Orbulina universa**, the **Globorotalia fohsi fohsi**, the **G. fohsi barisanensis**, the **Globigerinoides bispherica-transitoria**, the **Globigerinoides subquadrata-Globigerinita stainforthi**, the **Globorotalia kugleri-Globoquadrina altispira globosa** and the **Globigerina parva** zones. In spite of the fact that the age of these zones is still a matter of controversy, the authors accept the views expressed by Eames, Banner, Blow and Clark (1962) on the subject. The upper two zones are of Burdigalian, the underlying five of Aquitanian age. An attempt is made to discuss the ecological significance of the species with regard to the evolution of the basin of deposition.

INTRODUCTION

This paper lists the planktonic foraminifera from Miocene rocks of the Abu Rudeis well no. 2, drilled in the Sinai coastal plain of the Gulf of Suez, Egypt (text fig. 1). This paper discusses the stratigraphic value of these species and zones the section in a way which has never been attempted before in Egypt and which makes it correlatable with other Miocene sections of the world.

The Miocene rocks of the Gulf of Suez crop out on both sides of the Gulf in a strip that shows that they were deposited in an arm of the sea that must have covered this region after its formation by faulting in Oligocene time.

In spite of the fact that the Miocene rocks of the Gulf of Suez show great lateral lithological and isopachous variation, the section may be subdivided into a number of well-defined rock units that can be traced over most of the area of the Gulf of Suez graben. These, first recognised in the surface Miocene section of Wadi Gharandal by Moon and Sadek (1923) and Sadek (1959), can also be noted in the Abu Rudeis well no. 2.

STRATIGRAPHY

After penetrating a section of 3376′ of sands, gravels and minor clay interbeds, the well enters an 800′ section of alternating thin anhydrite and thicker sand-gravel beds which are nonfossiliferous and which are referred to as the "Upper Evaporite Formation." In the absence of fossils, the age of this latter unit and the overlying sand-gravel unit is difficult to ascertain, but it is assumed to cover the interval from late Burdigalian to Recent.

The Miocene section of the Abu Rudeis well no. 2 lies underneath (text fig. 2) and is made up of three distinct units, the upper two of which are of group status. These are from top to bottom:

Evaporite Group {
- Evaporite no. 5
- Δ Interevaporite Marls (or Nullipore rock)
- Evaporite no. 4
- γ Interevaporite Marls
- Evaporite no. 3
- β Interevaporite Marls
- Evaporite no. 2
- α Interevaporite Marls
- Evaporite no. 1

Gharandal Group = (*Globigerina* Marl) { upper sand-shale unit; lower shale unit

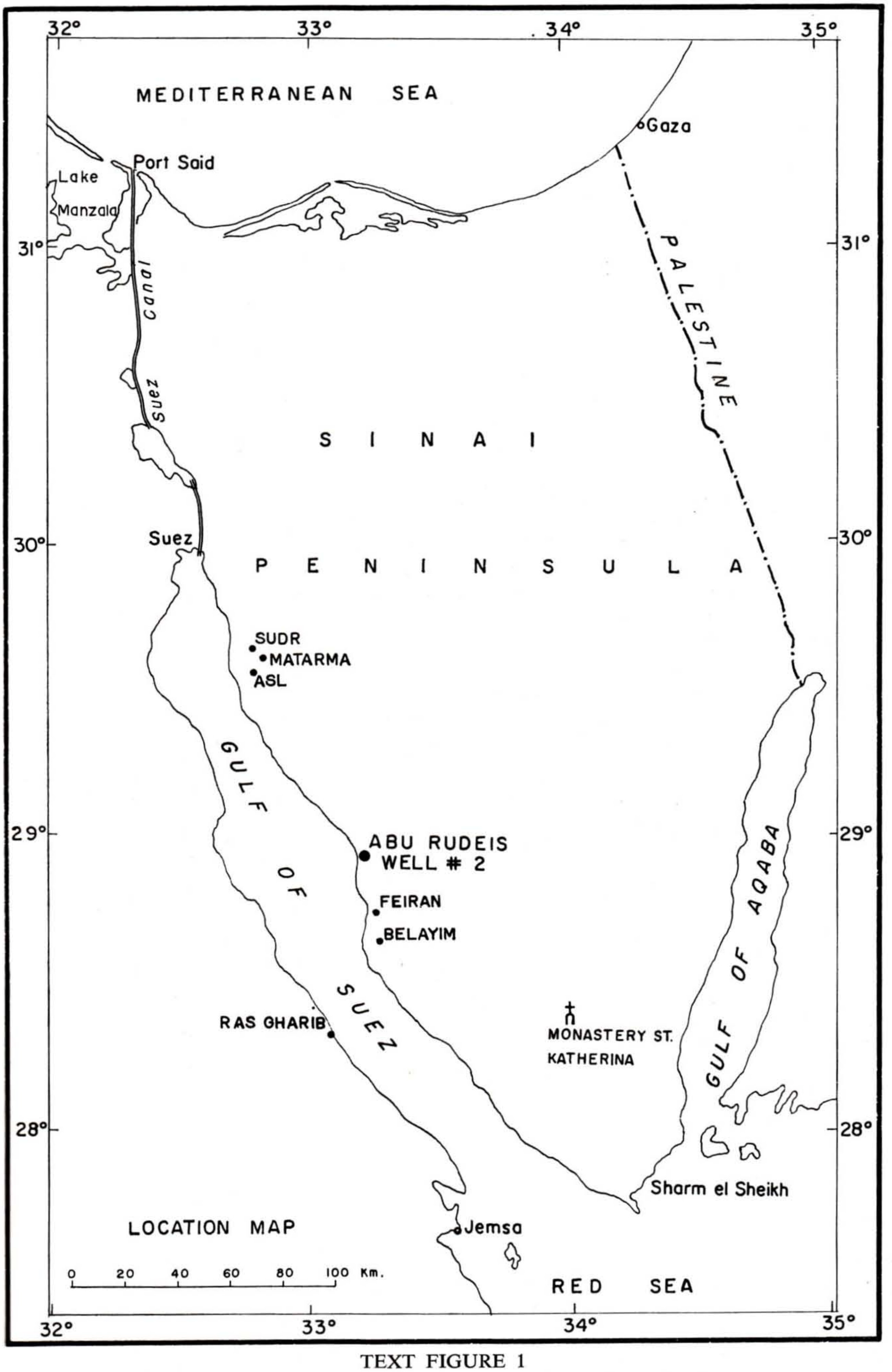
Nukul Formation = (Basal Miocene)
— Unconformity —
Redbeds

Evaporite Group

The Evaporite Group forms a succession of evaporites alternating with sands, shales and minor carbonate beds which in the well are about 1855′ in thickness. The unit crops out on the surface and has been studied by Hume *et al* (1920), Moon and Sadek (1923) and Sadek (1959). In the Wadi Gharandal surface section the unit assumes 2241′ in thickness. There the unit overlies the *Globigerina* marls (or the Gharandal Group). In outcrop the evaporite members of this group are almost always made up of gypsum. Below the surface, however, the evaporites are usually in the form of anhydrite; there are also some halite beds. In the well, as in the nearby surface sections, the Evaporite Group falls into a number of distinct units which are, from top to bottom:

Evaporite no. 5: A unit made up of a top halite bed followed underneath by a number of anhydrite and halite beds alternating with comparatively thin sandy shale interbeds. These shale interbeds yielded *Orbulina universa, Biorbulina bilobata, Globigerinoides triloba immatura* and others. This forma-

1 This manuscript was submitted January 20, 1964.



TEXT FIGURE 1
Map showing location of the Abu Rudeis well no. 2.

tion is referred to by some authors (*e.g.* the geologists of the Compagnie Orientale des Pétroles) as the "Evaporite series." The formation assumes about 625′ in thickness in the well.

Δ *Interevaporite Marls* (*Nullipore rock*): A unit of sandy shale which assumes about 120′ in thickness. In the surface section this unit becomes calcareous and contains abundant algal remains, hence the name "Nullipore rock." The lower part of the unit yielded a fauna with *Globorotalia fohsi fohsi*.

Evaporite no. 4: A unit made up of anhydrite beds with minor shale and more rarely gravel interbeds. The thickness of this unit is 310′. The shale interbeds in this unit are poorly fossiliferous.

γ *Interevaporite Marls* (Moon and Sadek's Upper Intergypseous Marls): A unit formed of marls which yielded a foraminiferal fauna not different from that found in the Δ Intergypseous Marls. The thickness of this unit is 75′.

Evaporite no. 3: A solid anhydrite-halite unit with one minor thin carbonate interbed. The thickness of this unit is 220′. The unit is nonfossiliferous.

β *Interevaporite Marls* (Moon and Sadek's Lower Intergypseous Marls): A unit made up of sandy shales with thin carbonate bands. It has a basal conglomerate and a top sand member. The thickness of the unit is 300′. The unit is rich in planktonic foraminifera; in the upper part the assemblage is dominated by *Globorotalia fohsi barisanensis* and in the lower part includes, among others, *Globigerinoides bispherica*.

Evaporite no. 2: A thin unit of anhydrite which assumes a thickness of 110′. The thin sandy shale interbeds of this unit include a fauna which is not different from that found in the lower part of the β Interevaporite Marls.

α *Interevaporite Marls*: A solid marl unit which is 70′ in thickness.

Evaporite no. 1: A solid anhydrite unit which is 35′ in thickness.

Gharandal Group

Underlying the Evaporite Group is a solid calcareous shale section which assumes in the well a thickness of 2000′. This is the unit which is known in the literature as the "*Globigerina* Marl." In the well the group can be subdivided into two units separated by a relatively thin conglomerate cut by a thin limestone bed in the middle. The upper unit includes several sand and conglomerate members, while the lower unit is of uniform lithological characteristics, being formed of sandy shales in its upper parts and becoming shaly in the lower part by the loss of the sandy ingredient.

The upper unit includes a planktonic foraminiferal assemblage which is not different from that found in the overlying Interevaporite Marl units although it is characterized by the influx of *Globigerinoides transitoria*.

The lower unit is characterized in its upper part by a flood of *Globigerinoides subquadrata* and *Globigerinita stainforthi*. This is followed by another zone dominated by *Globorotalia kugleri* and *G. opima opima*. Beneath this latter zone is one characterized by the presence of *Globigerina parva* and *G. ampliapertura*.

Nukhul Formation

This is a unit which assumes in the well about 340′ in thickness. This formation is made up of a basal conglomerate about 100′ thick and a succession of sandstones, conglomerates and marls. The unit rests unconformably over red marls that could be correlated with the Tayiba Redbeds, which crop out under the basalts in the nearby Wadi Tayiba and are believed to be of Oligocene age.

The Nukhul includes many reworked pre-Miocene foraminifera as well as an indigenous assemblage of shallow to brackish-water forms. These fossils do not give a conclusive answer as to the age of this formation, which could be of basal Aquitanian or Upper Oligocene age.

FORAMINIFERA

Previous Work

The Miocene foraminifera of the Gulf of Suez region have attracted the attention of many workers. Macfadyen (1930) described 185 species of foraminifera, mostly illustrated, which were obtained from the Miocene rocks of 23 sections and wells in the vicinity of Suez, and he attempted to correlate these forms with those found in equivalent beds in Europe and Africa. Stainforth (1949) studied the pelagic foraminifera of many sections in the Gulf of Suez region and recognized a break in the succession of pelagic species which he correlated with the break found at the top of the Aquitanian in the Caribbean region. Stainforth's subdivisions of the *Globigerina* Marl unit into "an Upper *Globigerina* Marl" and a "lower *Globigerina* Marl" was accepted by many micropaleontologists working in the field for over a decade. The two units which Stainforth recognized are:

(1) A lower zone (Lower *Globigerina* Marl) characterized by the abundance of one or more of the following pelagic foraminiferal species: *Globigerina concinna, G. venezuelana,* and *Globigerinoides conglobata*.

(2) An upper zone (Upper *Globigerina* Marl) characterized by the abundance of *Globigerinoides rubra* and/or *Candorbulina universa*.

It is to be noted here that Stainforth used the term *Globigerina* Marl in a sense that is different from that used by earlier workers, having incorporated in it the lower *Globigerina*-bearing parts of the overlying Evaporite formations, the Evaporite formation being restricted only to Gypsum no. 5 of Moon and Sadek's classification.

In a later paper Stainforth (1960) attempted to correlate the Egyptian Miocene faunal assemblages which he studied earlier with other sections from both sides of the Atlantic and especially with those of the Mediterranean region. He rectified his earlier identifications, recognizing in Egypt several index species, such as: *Globigerina ampliapertura* (previously recorded by him as *Globorotalia centralis* var.); *Globigerina ciperoensis* (previously recorded by him as *Globigerina concinna*); *Globigerinita dissimilis; Globigerinoides bispherica* (previously recorded by him as *G. conglobata*); and *Orbulina universa*. According to Stainforth a large part of the so-called Miocene section of the Gulf of Suez belongs, in fact, to the Oligocene, while the *Globigerinoides bispherica* and *Orbulina*-bearing rocks belong to the Aquitanian and Burdigalian respectively.

Said and Basiouni (1958) described the foraminifera from two sections in the Gulf of Suez, followed Stainforth's earlier zonation, and attempted to explain the spatial distribution of foraminifera in the Gulf in relation to the tectonics that affected this part of Egypt. Said (1962) assigned the "Lower *Globigerina* Marl" to the Oligo-Miocene, and the "Upper *Globigerina* Marl" to the Middle Miocene.

Souaya (1963) studied the foraminifera separated from some Miocene sections in the Cairo - Suez district. These came from a different facies from that of the Gulf of Suez and belonged to the northern epicontinental Miocene sea which flanked the Gulf of Suez basin. The fauna separated from this facies included mostly benthonic species.

Foraminifera of Abu Rudeis Well No. 2

The Miocene rocks of the Abu Rudeis well no. 2 can be divided by their planktonic foraminiferal

ZONES	DEPTH RANGE OF ZONES (in feet)	DEPTH (in feet) OF SAMPLES STUDIED IN DETAIL
Orbulina universa	4600-4900	4605, 4610, 4615, 4620, 4630, 4635, 4745, 4790, 4800, 4805, 4815, 4820, 4825, 4835, 4840, 4845, 4855, 4865, 4875, 4885, 4890, 4895.
Globorotalia fohsi fohsi	4900-5300	4900, 4905, 4910, 5190, 5200, 5230, 5235, 5240, 5245, 5250, 5255, 5265, 5270, 5275, 5285, 5290, 5425.
Globorotalia fohsi barisanensis	5520-5730	5525, 5530, 5535, 5540, 5545, 5550, 5555, 5560, 5565, 5570, 5575, 5580, 5585, 5590, 5595, 5600, 5605, 5610, 5625, 5630, 5650, 5670, 5690, 5710.
Globigerinoides bispherica transitoria	5730-6630	5730, 5740, 5750, 5770, 5790, 5810, 5850, 5870, 5930, 5950, 5970, 6040, 6063, 6070, 6110, 6130, 6150, 6160, 6170, 6175, 6190, 6210, 6230, 6240, 6250, 6275, 6290, 6315, 6330, 6355, 6360, 6370, 6390, 6410, 6420, 6430, 6450, 6470, 6490, 6505, 6515, 6520, 6525, 6530, 6535, 6550, 6555, 6560, 6590, 6615, 6620.
Globigerinoides subquadrata Globigerinita stainforthi	6630-7725	6670, 6690, 6710, 6730, 6750, 6800, 6858, 6915, 6985, 7030, 7075, 7125, 7190, 7305, 7345, 7405, 7450, 7500, 7530, 7605, 7665.
Globorotalia kugleri Globoquadrina altispira globosa	7725-8080	7725, 7775, 7825, 7875, 7955, 8000.
Globigerina parva	8080-8630	8080, 8120, 8185, 8225, 8275, 8285, 8300, 8360, 8428-45 (core No. 1) 8505.

content into several zones which can be correlated with other classic Miocene sections in the Caribbean region, as revealed by the pioneer works of Bolli (1950, 1951, 1957), Beckmann (1953) and Blow (1959), and with other sections in other parts of the world, as shown by the work of Eames, Banner, Blow and Clarke (1962). Many of the zones delimited in Trinidad can be clearly seen in the Egyptian section. The distribution of the planktonic foraminifera from the well is shown in Table 1.

The material upon which this work is based was raised from the well at 5′ intervals in the form of ditch samples. Although this work is based on a study of all the samples covering the section from the top of the Evaporite Group to the top of the Nukhul Formation (806 samples), only 150 samples were thoroughly examined. The tabulation on page 17 gives the depths of the samples that were studied in detail from each zone.

While the authors are fully aware of the fact that the study of ditch samples cannot give a true picture of the vertical distribution of the species, the zonation has been based on the principle of the first appearance of species. It is, therefore, obvious that the range of the species appearing in Table I should be taken with the precaution that the lower limit of distribution of species could be incorrect. The upper limit of the vertical distribution, on the other hand, is correct.[1]

In the following paragraphs a description of each of the zones recognized is given:

I. *Orbulina universa* Zone:

This zone extends from the lower part of Evaporite no. 5, where a fair number of planktonic species occur in the shale stringers that intercalate this massive evaporite, to the lower part of the Δ Interevaporite Marls (*i.e.* between depths 4600-4900′). The zone is characterized by the presence of the following fossils: *Orbulina universa, O. suturalis, Biorbulina bilobata, Globigerinoides rubra, G. triloba immatura, G. triloba sacculifera, Globorotalia obesa* and *Globigerina juvenilis.*

II. *Globorotalia fohsi fohsi* Zone:

This zone extends from the lower part of the Δ Interevaporite Marls (depth 4900′) to the bottom of the γ Interevaporite Marls (depth 5300′). This zone exhibits an assemblage of keeled *Globorotalia* species: *G. fohsi fohsi, G. mayeri, G. praemenardii, G. archeomenardii* and *G. opima continuosa* as well as the extended presence of *Orbulina universa.* This zone is one of the most persistent biostratigraphic units throughout the world.

In spite of the fact that the above-mentioned two zones are assigned a Helvetian age by most geologists working in Egypt (Said, 1962), the planktonic assemblage contained in them correlates them with the Burdigalian. The vertical distribution of *Orbulina universa* in the Egyptian section coincides exactly with that known from Sicily (Blow, 1957). Since LeRoy's (1948) recognition of the value of the first appearance of *Orbulina* as a middle Tertiary indicator, researches have proven that this datum is coincident with the Burdigalian-Aquitanian boundary. Di Napoli (1952), Cita and Silva (1960), Bandy (1963) and others described *Orbulina universa* from beds which are comparable to the Burdigalian. Glaessner (1959) postulated that in temperate faunas the genus *Orbulina* is somewhat retarded and seems to appear only in the Helvetian. However, since the Gulf of Suez Miocene was deposited in the Tethyan tropical regions (Blanckenhorn, 1901; Said and Basiouni, 1958), it is reasonable to assume that this part of the Egyptian section belongs to the Burdigalian rather than the Helvetian, as is the case in the northern parts of Italy which seem to mark the southern boundary of the boreal planktonic foraminifera of the Miocene Period.

Furthermore Eames *et al* (1962) showed from their study of many Miocene sections from widely separated areas that the *Globorotalia fohsi fohsi* zone of the Trinidad classification belongs to the Burdigalian.

The assignment of this part of the Gulf of Suez Miocene section to the Burdigalian necessitates a re-evaluation of the age assignments of the Egyptian Miocene sections which have been hitherto relegated to the Helvetian. Although Stainforth (1949, 1960) insisted on a Burdigalian age for the upper part of the Gulf of Suez Miocene section, all authors refuted this age assignment and some questioned even the presence of Burdigalian except in limited areas. Macfadyen (1930), for example, expressed doubts on the presence of Aquitanian in Egypt and showed that the Burdigalian is developed in limited areas in the north of the Gulf, where it is represented by shallow-water sandy and gritty limestones with abundant fragmental fossils. With the extensive survey carried out by many authors on the vertical distribution of the index planktonic foraminifera first worked out by Bolli (1957) in Trinidad and the contribution of Eames *et al* (1962), it is now possible not only to recognize the same zones in the Egyptian section, but also to rectify the age assignments of this section in a manner that would bring marked changes in the paleogeographic reconstructions of the Egyp-

1 While this paper was in press, one of the authors (I.E.) attempted to apply the zonation arrived at in this work on three other nearby wells: Feiran, Belayim land, Belayim marine. These wells are amply cored. The zonation applies almost to detail, although some refinement could be made on the Burdigalian - Aquitanian boundary. The evidence from these wells is that the occurrence of **Globigerinita** spp. is anomalous and it might well be preferable to name the **Globigerinoides subquadrata - Globigerinita stainforthi** zone the **Globigerinoides subquadrata** zone.

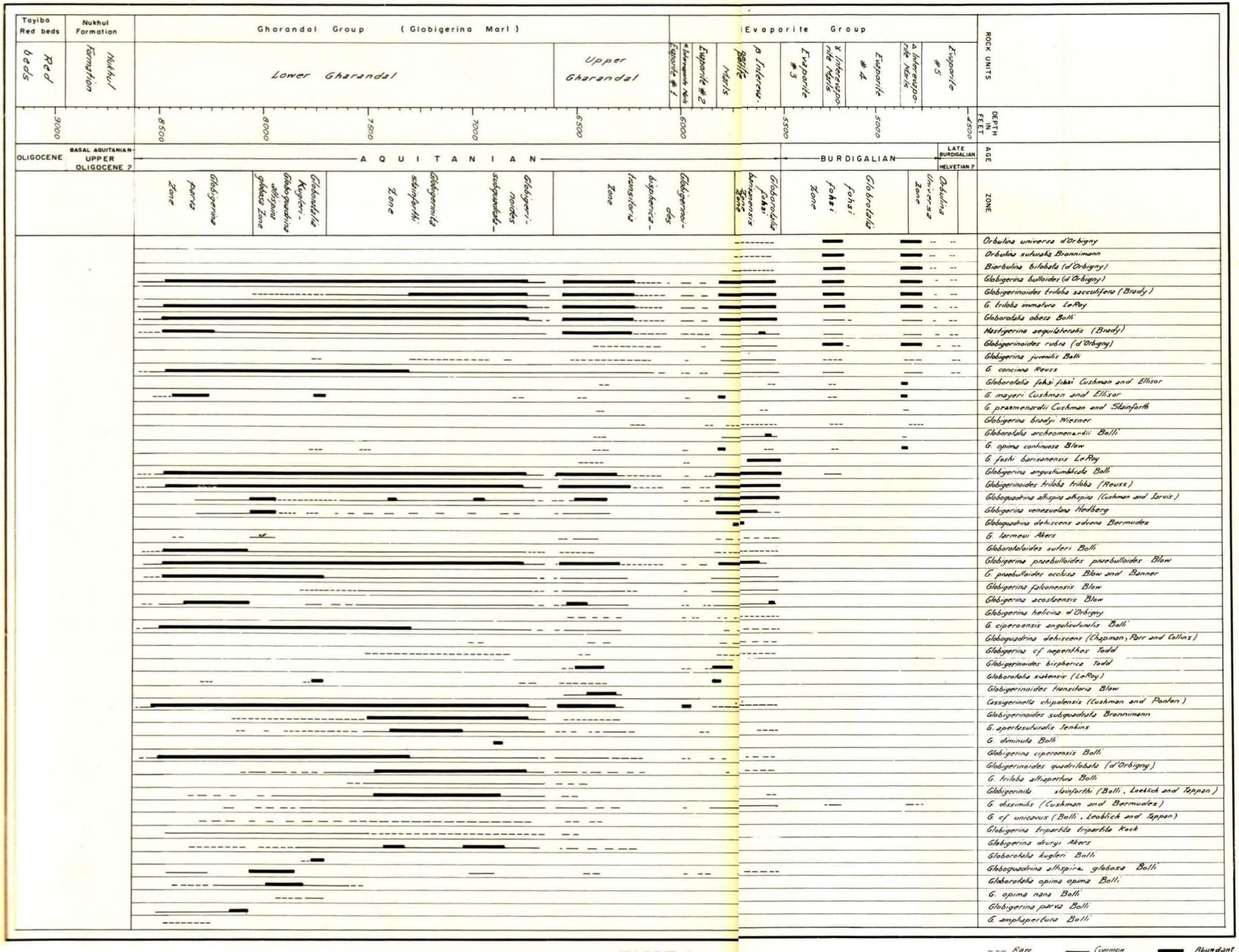


TABLE 1

Distribution of planktonic foraminifera in the Abu Rudeis well no. 2.

tian Miocene. It is indeed possible that the Marmarica Limestone of the northern Western Desert of Egypt (Said, 1962a) and the upper *Borelis melo* zone of the Cairo-Suez district (Souaya, 1963) are not of Helvetian but are rather of Burdigalian age.

The fact that the *Globorotalia fohsi fohsi* zone is represented by a rich assemblage of planktonics only in the lower 15′ of the Δ Interevaporite Marls can be explained by the fact that in *fohsi fohsi* time the conditions of the basin of deposition were not open marine, but rather lagoonal—permitting the deposition of the almost non-fossiliferous Evaporites no. 4 and 3, or paralic, (a condition which preceded and followed the lagoonal phase) permitting the deposition of parts of the Interevaporite Marls. The γ Interevaporite Marl includes relatively fewer planktonic foraminifera and abundant paralic species, such as *Ammonia beccarii, Bolivina* spp. and *Nonion* sp., which are especially abundant in the lower part of this unit just above Evaporite no. 3. The Δ Interevaporite Marl likewise shows the same pattern of the dominance of paralic conditions after the deposition of Evaporite no. 4. The lower part of the Δ Interevaporite Marl includes abundant faecal pellets of pelecypods probably belonging to the genus *Leda minuta.*

III. *Globorotalia fohsi barisanensis* Zone:

This zone extends from below Evaporite no. 3 (depth 5520′) to depth 5730′ within the β Interevaporite Marl. It is one of the most distinctive zones, being characterized by the influx of a large number of planktonic foraminiferal species: *Globorotalia fohsi barisanensis, G. acostaensis, Globorotaloides suteri, Globoquadrina altispira altispira, G. dehiscens, Globigerina venezuelana, G. angustiumbilicata, G. praebulloides praebulloides, G. praebulloides occlusa* and *Globigerinoides triloba triloba.*

The faunal break shown by this zone was recognized by earlier workers. The top of the *Globorotalia fohsi barisanensis* zone coincides with the Upper - Lower *Globigerina* Marl boundary of Stainforth (1949) and with the Helvetian - Schlier boundary of Macfadyen (1930).

IV. *Globigerinoides bispherica - transitoria* Zone:

This zone extends from within the β Interevaporite Marl (depth 5730′) to the limestone bed which cuts through the *Globigerina* Marl (Gharandal) at depth 6630′. It is characterized by the presence of the following species: *Globigerinoides bispherica, G. transitoria, Globorotalia siakensis,* and *Cassigerinella chipolensis.* This assemblage is similar to that recorded from many Mediterranean countries [compare for example the assemblage interpreted as late Aquitanian by Stainforth (1960) from Greece (Hagn, 1958); Spain (Durand-Delga and Magne, 1958; Colom, 1958) and Italy]. In the top part of this zone is a thin bed with abundant *Amphistegina* spp.

The assemblage seems to replace that of the *Globigerinatella insueta* zone in the Trinidad classification. Jenkins (1960) did not record *Globigerinatella insueta* from the Australian Miocene, but, as in Egypt, he recorded *Globorotalia siakensis* from a comparable horizon. Todd, Cloud, Low and Schmidt (1954) emphasized the value of *Globigerinoides bispherica* in the *Globigerinatella insueta* zone in the Pacific. *Globigerinoides bispherica* and *G. transitoria* were shown to be present in the *Globigerinatella insueta* zone in Trinidad (Bolli, 1957) and Venezuela by Blow (1956). Blow showed that *Orbulina suturalis* and *O. universa* could have been evolved from a *Globigerinoides bispherica-transitoria* lineage. The absence of the *Globigerinoides glomerosa* plexus from the Egyptian section gives proof to the suggested lineage given by Blow in his charts showing the origin of *Orbulina* and *Biorbulina* spp. in the Miocene.

It is of interest to point out here that the planktonic foraminifera in this zone, which extends for 900′, are found only in localized bands in the section. This may be due to the fact that a large part of the sediments belonging to this part of the section was deposited under lagoonal or paralic conditions. Evaporites no. 1 and 2 lie within this unit and the base of the zone is marked by a conglomerate and a limestone bed.

V. *Globigerinoides subquadrata - Globigerinita stainforthi* Zone:

This zone lies within the Gharandal and extends from depth 6630′ to depth 7730′. It is characterized by the presence of the following species: *Globigerinoides subquadrata, G. diminuta, G. apertasuturalis, G. quadrilobata, G. triloba altiapertura, Globigerina druryi, Globigerinita stainforthi, G. unicavus* and *G. dissimilis. Globigerina ciperoensis ciperoensis* is also recorded here at a level higher than its record in many parts of the world. Jenkins (1960) gives a similar anamolous record in the Australian Miocene.

This zone replaces the *Globigerinita dissimilis* and the *G. stainforthi* zones of Bolli's classification of the Caribbean Miocene. According to Stainforth's classification (1960), the *Globigerinita dissimilis* and the *G. stainforthi* are distinctly subdivided, the former belonging to his *G. dissimilis* zone and the latter forming part of his *Globigerinatella insueta* zone. In the Abu Rudeis well no. 2, these zones are difficult to differentiate, for the *Globigerinita* spp. are scattered throughout the section and *G. dissimilis* extends to the upper part of the section, being recorded in the *Globorotalia fohsi fohsi* zone. A further difference between this and the Trinidad section, is the presence of *Globi-*

gerinoides diminuta here at a level lower than that recorded in Trinidad. Blow (1959) and Cole, Todd and Johnson (1960) were among the first to recognize the value of *Globigerinoides subquadrata* in their studies of Venezuelan and Yap sections respectively.

The Gulf of Suez *Globigerinoides subquadrata* - *Globigerinita stainforthi* zone is a well-defined unit which seems to be correlatable with the *Globigerinita dissimilis* and *G. stainforthi* zones in other parts of the world. However, it is difficult to explain the fact that several of the associated species have different ranges from those recorded from other parts of the world.

VI. *Globorotalia kugleri* - *Globoquadrina altispira globosa* Zone:

This zone lies within the Gharandal Formation and extends from depths 7725′ to 8080′. It is characterized by the presence of the following species: *Globorotalia kugleri, Globoquadrina altispira globosa, Globorotalia opima opima* and *G. opima nana*. The zone is characterized in its upper part by the presence of *Globorotalia kugleri,* together with *G. siakensis* and *G. mayeri*. This is followed underneath by a zone having a flood of *Globoquadrina altispira, G. altispira globosa* and *Globigerina venezuelana*. The *Globorotalia kugleri* - *Globoquadrina altispira globosa* zone, therefore, could be correlated with the *Globorotalia kugleri* and *G. opima opima* zones of the Trinidad classification, although the intervening *Globigerina ciperoensis* does not show in the Gulf of Suez section. In this part of the Egyptian section there is no indication whatsoever of the presence of a lithological break, and it is difficult to conceive of the presence of a paleontological break in it. At this stage of our knowledge of the distribution of the pelagic foraminiferal species in Egypt it is difficult to assess the significance of the absence of this zone in what seems to be a continuous succession. It is possible that the retarded appearance of *Globigerina ciperoensis* in the Egyptian section is due to homotaxy.

VII. *Globigerina parva* Zone:

This zone lies within the Gharandal Formation and extends from depth 8080′ to depth 8630′. It is characterized by the presence of the following: *Globigerina parva, G. tripartita tripartita, G. ampliapertura* (rare), and many other species that seem to have their origin in this zone, such as *Globigerina ciperoensis ciperoensis, Globorotaloides suteri* and others.

The zone is correlatable with the *Globigerina ampliapertura* zone of the Trinidad classification, although in Egypt the assemblage is dominated by *G. parva*.

Zones III - VII were previously given a Schlier age by Macfadyen (1930); Helvetian, Schlier and Upper Burdigalian by Moon and Sadek (1923), and Aquitanian (up to and including zone IV) and Oligocene (zones V - VII) by Stainforth (1960). Said (1962) gave to the entire section below the Evaporite no. 3 the noncommittal age of Oligo-Miocene. Table 2 gives the ages of the different rock units according to different authors.

The age of these zones in other parts of the world is controversial. Bolli (1957) and other workers in the Caribbean believed that the zones of *Globorotalia kugleri* to *Globigerina ampliapertura* inclusive were of Oligocene age, while the higher zones were of Miocene age. Drooger (1956) showed that part of the so-called Oligocene of the Caribbean region was of Miocene age. Eames (1953), Eames, Banner, Blow and Clarke (1960, 1962) and Eames and Clarke (1957) showed that all these zones belonged to the Aquitanian. These authors gave evidence from many parts of the world and documented their argument by typing the ranges of the planktonic foraminifera with those of the larger foraminifera and the Mollusca. The present authors believe that Eames *et al.'s* conclusions regarding the age of the different zones of the Miocene are not only backed by abundant evidence, but that their subdivisions coincide with some of the most conspicuous faunal changes, as shown in the Abu Rudeis well. Eames *et al.'s* Burdigalian - Aquitanian boundary coincides with the appearance of the *Globorotalia fohsi barisanensis* zone. In Egypt this boundary is one of the most conspicuous in the whole section. From a paleogeographic point of view it seems that the Gulf of Suez section could not be much earlier than the Miocene, for evidence from many parts of Egypt shows that the whole basin was not in existence except in late Oligocene time.

It is of interest to point out here that beneath the *Globigerina parva* zone in the Abu Rudeis section is a 340′ section (Nukhul Formation) made up of an upper unit of sandstones, conglomerates and some marl interbeds and a lower unit of solid conglomerate about 100′ thick. This whole section rests over the Oligocene Tayiba Redbeds (Moon and Sadek, 1923). The upper unit is rich in benthonic species, most of which belong to a limited number of genera especially known from the neritic zone with its influx of fresh water. Most of the species belong to the genera *Bulimina, Virgulina, Bolivina, Ammonia, Hopkinsina* and others. Rare planktonic foraminifera are recorded. Both the upper and lower units are rich in reworked pre-Miocene foraminifera, including *Nummulites* species. The lithofacies, faunal content and stratigraphic position of this part of the section below the Aquitanian indicate that it is of terrestrial to shallow-water origin and must have been deposited immediately following the Erythrean movements

SAID & HEINY			MOON & SADEK (1923)			MACFADYEN (1930)		STAINFORTH (1949)	
Rock unit		Age	Rock unit	Age		Rock unit	Age	Rock unit	Age
Evaporite V	Evaporite Group	Late Burdigalian-Helvetian ?	Gypsum V		Vindobonian	Gypsum V	Tortonian	Evaporite series	Burdigalian – Helvetian
Δ Interevaporite Marls		Burdigalian	Nullipore Rock			Nullipore Rock		Upper Globigerina Marl	
Evaporite IV			Gypsum IV	Helvetian		Gypsum IV	Helvetian		
γ Interevaporite Marls			Upper Intergypseous Marls			Nullipore Intergypseous Marls			
Evaporite III			Gypsum III			Gypsum III			
β Interevaporite Marls		Aquitanian	Lower Intergypseous Marls and Gypsum II			Lower Intergypseous Marls and Gypsum II	Schlier ?	Lower Globigerina Marl	Oligo Miocene / Aquitanian and Pre-Aquitanian
Evaporite II									
α Interevaporite Marls									
Evaporite I			Gypsum I			Gypsum I			
(Globigerina Marl)	Gharandal Group		Miocene Marls	Schlier		Miocene Marls			
			Miocene Grits			Miocene Grits			
			Miocene Clays		Upper Burdigalian	Miocene Clays			
Basal Miocene	Nukhul Formation	Basal Aquitanian-Upper Oligocene?							
Unconformity			Unconformity						
Red beds		Oligocene			Upper Eocene		Eocene		

TABLE 2

Table showing age and classification of rock units of the Miocene rocks of the Gulf of Suez according to different authors.

that were responsible for the formation of the Gulf of Suez graben. It is possible, since the Nukhul Formation lies conformably below the *Globigerina* Marls, that it is of basal Aquitanian age, but an Upper Oligocene age is also likely.

SUMMARY AND CONCLUSONS

The study of the planktonic foraminiferal assemblages separated from the Miocene rocks of the Abu Rudeis well no. 2 results in the following interesting conclusions:

1. It is possible to divide this section into a number of zones that are of world-wide distribution. The Interevaporite Marls and the thin marly beds that intercalate the massive evaporites of the section are of Burdigalian age in their upper part (up to and including Evaporite no. 3) and of Upper Aquitanian age in their lower part. The Burdigalian section contains *Orbulina universa, Orbulina suturalis, Biorbulina bilobata* and *Globigerinoides triloba immatura. Globorotalia fohsi fohsi* and other keeled *Globorotalia* spp. appear in the lower part of this section. The Burdigalian-Aquitanian boundary is one of the most clearly delimited time surfaces in the Egyptian section; the Aquitanian is characterized by the appearance of a large number of species. The lower part of the Evaporite Group and the entire Gharandal Marls are of Aquitanian age. It can be divided into five zones: the *Globorotalia fohsi barisanensis,* the *Globigerinoides bispherica - transitoria,* the *Globigerinoides subquadrata - Globigerinita stainforthi,* the *Globorotalia kugleri - Globoquadrina altispira globosa* and the *Globigerina parva* zones.

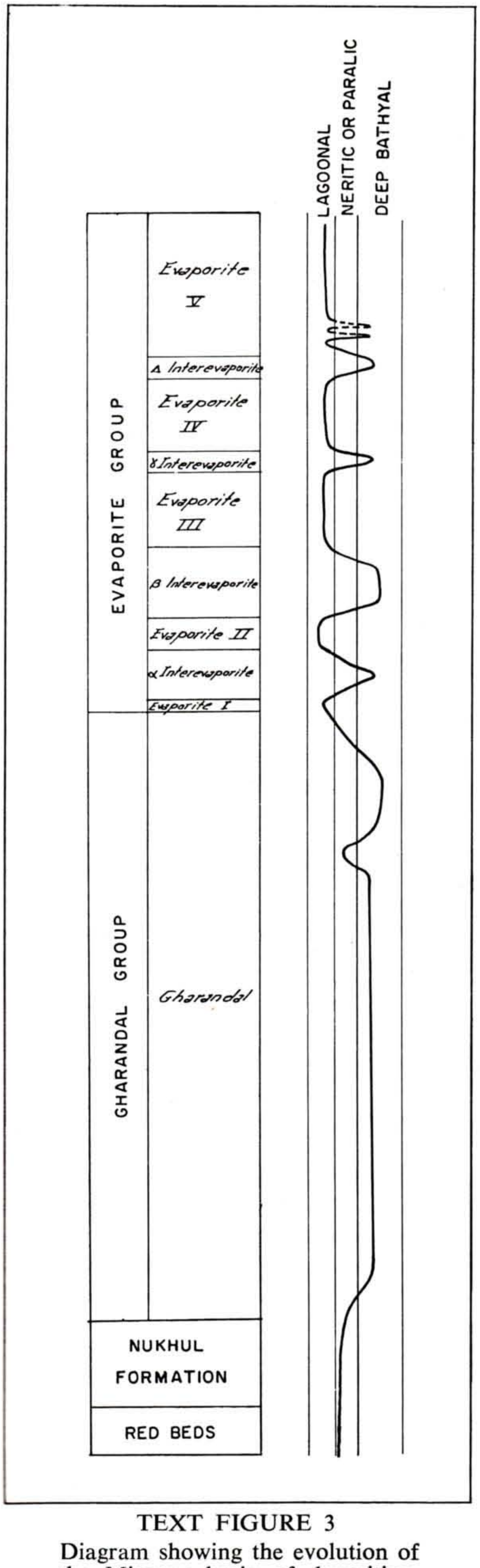
2. In spite of the fact that these zones coincide almost to detail with those described by Bolli (1957) from Trinidad, certain anomalous occurrences are worth emphasizing. The *Globigerinatella insueta* zone of the Trinidad classification is replaced by the *Globigerinoides bispherica - transitoria,* as in many other parts of the world. The *Catapsydrax stainforthi* and the *C. dissimilis* zones of the Trinidad classification cannot be separated in the Egyptian section. Both these zones appear in the Egyptian section as the *Globigerinoides subquadrata - Globigerinita stainforthi* zone. The value of *Globigerinoides subquadrata* for this part of the section was emphasized by Blow (1959) and Cole, Todd and Johnson (1960). *Globigerinita dissimilis* has a wide range in the Egyptian section and seems to have no particular value in zonation. The *Globorotalia kugleri, Globigerina ciperoensis* and the *Globorotalia opima opima* zones of the Trinidad classification cannot be separated as distinct units in the Egyptian section. They are represented by one zone, here termed the *Globorotalia kugleri - Globoquadrina altispira globosa* zone. *Globigerina ciperoensis* has a wide range in the Abu Rudeis section and extends upward into the entire *Globigerinita stainforthi* zone, while *Globorotalia opima opima* extends to the basal part of the overlying *Globigerinita stainforthi* zone.

3. In spite of the fact that these zones have been given different ages by different workers, we have followed Eames *et al.'s* age assignments relegating the *Orbulina universa* and the *Globorotalia fohsi fohsi* zones to the Burdigalian and the remaining zones to the Aquitanian. Berggren (1963) considered the *Globigerina parva* and part of the *Globorotalia opima opima* zones as of Rupelian age. These age assignments differ from those given by almost all authorities working in Egypt (Table 2). The bulk of the Miocene Evaporites are now shown to be of Burdigalian age, and it is possible that the upper non-fossiliferous part of this group (including the top part of Evaporite no. 5 and the "Upper Evaporite Formation") are of late Burdigalian to Helvetian age. The lower part of the Evaporite Group, as well as the entirety of the well-known *Globigerina* Marls of the Gulf of Suez (Gharandal), are of Aquitanian age.

The acceptance of these age assignments will necessitate the re-evaluation of the fossil data known from other biotopes of the Miocene seas of Egypt. Souaya's Burdigalian and Helvetian of the Cairo - Suez sections could well be of Aquitanian and Burdigalian ages respectively. In the Cairo - Suez sections representatives of the Miogypsinidae and Alveolinidae dominate the foraminiferal assemblage. These have been given new age assignments by Eames *et al.* (1962).

4. The Gulf of Suez Miocene was deposited in a narrow arm of the old Tethys which covered this graben after its formation in Oligocene time. The Miocene rocks reflect not only the conditions of this tectonically formed and continuously rejuvenated bottom and its bounding cliffs but also the arid climate that dominated Egypt during most of the Miocene Epoch. The section has several conglomerates that indicate not only breaks in sedimentation but significant paleontologic breaks. The boundary between the *Globigerinoides bispherica - transitoria* and the *Globigerinita stainforthi* zones coincide with a conglomerate that cuts through the Gharandal, dividing it into two units.

The Miocene transgression started with a basal conglomerate and coarse-grained sediments (Nukhul Formation). These latter include a large number of reworked pre-Miocene foraminifera and an indigenous benthonic foraminiferal fauna which must have thrived in a shallow neritic zone that seems to have been affected by the influx of fresh water. Soon this changed to a condition in which the *Globigerina* Marls, with their abundance of planktonics, were deposited. Then followed the deposition of the evaporites. These consist of a number of solid anhydrite-halite beds interbedded



TEXT FIGURE 3
Diagram showing the evolution of the Miocene basin of deposition.

with marls and shales. The evaporites seem to have been deposited in lagoons which succeeded each other and were separated by phases of open marine conditions in which the Interevaporite Marls were deposited. It is of interest to point out here that the phase of evaporite deposition was ushered in by an uplift that started at the end of the *Globigerinoides subquadrata* - *Globigerinita stainforthi* zone and produced a conglomerate and coarse-grained sediments. This uplift was preceded by paralic conditions in which *Trochammina* species abounded and was followed by shallow neritic conditions, the latter attested to by the presence of numerous faecal pellets of *Leda minuta*. The termination of this phase was the deposition of Evaporite no. 1. Almost all succeeding evaporites were preceded and followed by episodes in which paralic conditions dominated. Text fig. 3 shows diagrammatically the evolution of the Miocene basin of deposition.

FAUNAL REFERENCE LIST

Biorbulina bilobata (d'Orbigny) = *Globigerina bilobata* D'ORBIGNY, 1846, Foraminifères fossiles du bassin tertiare de Vienne (Autriche), p. 164, pl. 9, figs. 11-14.

Cassigerinella chipolensis (Cushman and Ponton) = *Cassidulina chipolensis* CUSHMAN and PONTON, Florida Geol. Surv. Bull. 9, p. 98, pl. 15, figs. 2a-c, 1932.

Globigerina ampliapertura BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 108, pl. 22, figs. 4a-7b.

Globigerina bradyi WIESNER, 1901-1903, Deutsche Südpolar-Expedition 1901-1903, Vol. 20 (Zool., Vol. 12), p. 133 (for figs. see Brady) = *Globigerina* sp., BRADY, Rep. Voy. Challenger, Zool., Vol. 9, p. 603, pl. 82, figs. 8, 9, 1884.

Globigerina bulloides D'ORBIGNY, 1826, Ann. Sci. Nat., vol. 7, p. 277; Modèles nos. 17, 76.

Globigerina ciperoensis BOLLI, 1954, Contr. Cushman Found. Foram. Research, Vol. 5, p. 1, text figs. 3-6.

Globigerina ciperoensis angulisuturalis BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 109, pl. 22, figs. 11a-c.

Globigerina ciperoensis angustiumbilicata BOLLI, U. S. Natl. Mus. Bull. 215, p. 109, pl. 22, figs. 12a-13c.

Globigerina concinna REUSS, 1850, Denkschr. K. AK. Wiss., Wien, vol. 1, p. 373, pl. 47, fig. 8.

Globigerina druryi AKERS, 1955, Jour. Paleontology, vol. 29, no. 4, p. 654, pl. 65, fig. 1.

Globigerina falconensis BLOW, of Cole, W. S., Todd, R. and Johnson, C. G., 1960, Bull. Amer. Paleontology, vol. 41, no. 186, p. 105, pl. 13, fig. 1.

Globigerina helicina D'ORBIGNY, in Fornasini, 1898, Pal. Italica, Mem., Pal., vol. 4, p. 209, Text fig. 4, (after d'Orbigny, "disegno inedito"). After Brady, 1884, pl. 81, fig. 4.

Globigerina juvenilis BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 110, pl. 24, figs. 5a-6.

Globigerina nepenthes TODD, 1956, U. S. Geol. Survey Prof. Paper 280-H, p. 301, pl. 78, fig. 7.

Globigerina praebulloides occlusa BLOW and BANNER, 1962, Fundamentals of Mid-Tertiary stratigraphical correlation by Eames et al., p. 93, pl. 9, fig. U-W, text figs. 14 (i-ii). = *Globigerina* cf. *trilocularis* d'Orb., BOLLI, 1957 (not *G. trilocularis* Deshayes, 1832), U. S. Natl. Mus. Bull. 215, p. 110, 163, pl. 22, fig. 9a-c (not fig. 8a-c), pl. 36, figs. 3a-b.

Globigerina praebulloides praebulloides BLOW, 1962, Fundamentals of Mid-Tertiary stratigraphical correlation by Eames et al., p. 92, pl. 9, fig. O-Q. = *G.* cf. *trilocularis* BOLLI, 1957 (part) (not *G. trilocularis* Deshayes, 1832), U. S. Natl. Mus. Bull. 215, p. 110, pl. 22, figs. 8a-c (not figs 9a-c).

Globigerina parva BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 108, pl. 22, figs. 14a-c.

Globigerina tripartita tripartita KOCH = *Globigerina bulloides* d'Orbigny var. *tripartita* KOCH, 1926, Ecl. geol. Helv., vol. 19, no. 3, p. 746, text-figs. 21a-b. = *Globigerina rohri* BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 109, pl. 23, figs. 1a-4b.

Globigerina venezuelana HEDBERG, 1937, Jour. Paleontology, Vol. 11, no. 8, p. 681, pl. 92, figs. 7a-b.

Globigerinita dissimilis (Cushman and Bermudez), 1937, Contr. Cushman Lab. Foram. Research, vol. 13, p. 25, pl. 3, figs. 4-6 = *Globigerina dissimilis* CUSHMAN and BERMUDEZ, 1937.

Globigerinita stainforthi (Bolli, Loeblich and Tappan) = *Catapsydrax stainforthi* BOLLI, LOEBLICH and TAPPAN, 1957, U. S. Natl. Mus. Bull. 215, p. 37, pl. 7, fig. 11.

Globigerinita unicava (Bolli, Loeblich and Tappan), 1957, U. S. Natl. Mus. Bull. 215, p. 37, pl. 7, fig. 9.

Globigerinoides apertasuturalis JENKINS, 1960, Micropaleontology, Vol. 6, no. 4, p. 352, pl. 2, figs. 3a-c.

Globigerinoides bispherica Todd, 1954, in TODD, CLOUD and SCHMIDT, Amer. Jour. Sci., Vol. 252, p. 681, pl. 1, figs. 1, 4.

Globigerinoides diminuta BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 114, pl. 25, figs. 11a-c.

Globigerinoides quadrilobata (d'Orbigny), 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 164, pl. 9, figs. 7-10. BANNER, F. T. and BLOW, W. H., 1960, Contr. Cushman Found. Foram. Research, Vol. 11, pt. 1, p. 17, pl. 4, figs. 3a-b.

Globigerinoides rubra (d'Orbigny), BERMUDEZ, Cushman Lab. Foram. Research, Spec. Publ. 25, p. 281, pl. 21, fig. 52, 1949.

Globigerinoides subquadrata BRONNIMANN, 1954, in Todd, Cloud, Low and Schmidt, Amer. Jour. Sci., Vol. 252, p. 680, pl. 1, figs. 5, 8a-c.

Globigerinoides transitoria BLOW, 1956, Micropaleontology, Vol. 2, no. 1, p. 65, text-fig. 2, Nos. 12-15.

Globigerinoides triloba altiapertura BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 113, pl. 25, figs. 7a-8, text-fig. 21, no. 3.

Globigerinoides triloba immatura Le Roy = *Globigerinoides sacculiferus* (Brady) var. *immatura* LE ROY, Natuurk. Tijdschr. Nederl.-Indie, Batavia, Vol. 99, pt. 6, p. 263, pl. 3, figs. 19-21, 1939.

Globigerinoides triloba sacculifera (Brady) = *Globigerina sacculifera* BRADY, Geol. Mag., n.s., decade 2, vol. 4, No. 12, p. 535, 1877 (type figure in Rep. Voy. Challenger, Zool., Vol. 9, pl. 80, figs. 15, 16, 1884).

Globigerinoides triloba triloba (Reuss) = *Globigerina triloba* REUSS, Denkschr. Akad. Wiss. Wien, Math.-Nat. Classe, Vol. 1, p. 374, pl. 47, figs. 11a-d, 1850.

Globoquadrina altispira altispira (Cushman and Jarvis) = *Globigerina altispira* CUSHMAN and JARVIS, 1936, Contr. Cushman Lab. Foram. Research, vol. 12, p. 5, pl. 1, figs. 13a-c, 14.

Globoquadrina altispira globosa BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 111, pl. 24, figs. 9, 10.

Globoquadrina dehiscens (Chapman, Parr and Collins) = *Globorotalia dehiscens* CHAPMAN, PARR and COLLINS, 1934, Linn. Soc. London, Jour. Zool., Vol. 38, no. 262, p. 569, pl. 11, figs. 36a-c.

Globoquadrina dehiscens advena Bermudez = *Globoquadrina quadraria advena* BERMUDEZ, 1949, Cushman Lab. Foram. Research, Special Pub. 25, p. 287, pl. 22, figs. 36-38.

Globoquadrina larmuei AKERS, 1955, Jour. Paleontology, vol. 29, no. 4, p. 661, pl. 65, figs. 4a-c.

Globorotalia acostaensis BLOW, of Jenkins, 1960, Micropaleontology, Vol. 6, no. 4, p. 358, pl. 4, figs. 1a-c.

Globorotalia archeomenardii BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 119, pl. 28, figs. 11a-c.

Globorotalia fohsi barisanensis LE ROY, Bolli, Contr. Cushman Found. Foram. Research, Vol. 1, pts. 3-4, p. 88, pl. 15, figs. 6a-c, 1950 = *Globorotalia barisanensis* LE ROY, 1939, Natuurk. Tijdschr. Nederl.-Indie, Vol. 99, pt. 6, p. 265, pl. 1, figs. 8-10.

Globorotalia fohsi fohsi Cushman and Ellisor = *Globorotalia fohsi* CUSHMAN and ELLISOR, 1939, Contr. Cushman Lab. Foram. Research, Vol. 15, p. 12, pl. 2, fig. 6.

Globorotalia kugleri BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 118, pl. 28, figs. 5a-c.

Globorotalia mayeri CUSHMAN and ELLISOR, 1939, Contr. Cushman Lab. Foram. Research, Vol. 15, pt. 1, p. 11, pl. 2, figs. 4a-4c.

Globorotalia obesa BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 119, pl. 29, figs. 2a-3.

Globorotalia opima continuosa Blow, of JENKINS, 1960, Micropaleontology, Vol. 6, no. 4, p. 366, pl. 5, figs. 4a-5c.

Globorotalia opima nana BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 118, pl. 28, figs. 3a-c.

Globorotalia opima opima BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 117, pl. 28, figs. 1a-2.

Globorotalia praemenardii CUSHMAN and STAINFORTH, 1945, Cushman Lab. Foram. Research, Special Pub. 14, p. 70, pl. 13, figs. 14a-c.

Globorotalia siakensis (Le Roy), LE ROY, 1939, Natuurk. Tijdschr. Nederl.-Indie, vol. 99, pt. 6, p. 262, pl. 4, figs. 20-22 (*fide* Ellis And Messina, 1940 et seq.). Berggren, W. A., 1963, Micropaleontology, vol. 9, no. 4, pp. 467-474, believes that *Globorotalia siakensis* is a synonym of *Globorotalia mayeri*.

Globorotaloides suteri BOLLI, 1957, U. S. Natl. Mus. Bull. 215, p. 117, pl. 27, figs. 9a-13b.

Hastigerina aequilateralis (Brady) = *Globigerina aequilateralis* BRADY, 1879, Quart. Jour. Micr. Sci., new ser., Vol. 19, 1-285. = *Globigerinella aequilateralis* (Brady) Bermudez, Cushman Lab. Foram. Research, Special Publ. 25, p. 280, pl. 21, fig. 51, 1949.

Orbulina suturalis BRÖNNIMANN, 1951, Contr. Cushman Found. Foram. Research, Vol. 2, pt. 4, p. 135, text fig. 2, figs. 1-15; text fig. 3, figs. 3-8, 11, 13-16, 18, 20-22; text fig. 4, figs. 2-4, 7-12, 15, 16, 19-22.

Orbulina universa D'ORBIGNY, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, Foraminifères, p. 3, pl. 1, fig. 1.—BLOW, Micropaleontology, vol. 2, no. 1, p. 66, text fig. 2, nos. 8-9, 1956.

REFERENCES

AKERS, W. H., 1955, Some planktonic foraminifera of the American Gulf Coast and suggested correlation with Caribbean Tertiary: Jour. Paleontology, Vol. 29, pp. 646-664.

BANDY, O. L., 1963, Cenozoic planktonic foraminiferal zonation and basinal development in Philippines: Amer. Assoc. Petr. Geol., vol. 47, pp. 1733-1746.

BANNER, F. T. and BLOW, W. H., 1960, Some primary types of species belonging to the superfamily Globigerinaceae: Contr. Cushman Found. Foram. Research, vol. 11, pp. 1-41.

BECKMANN, J. P., 1953, Die Foraminiferen der Oceanic Formation (Eocaen-Oligocaen) von Barbados, KL. Antillen: Ecl. Geol. Helv., vol. 46, pp. 301-412.

BERGGREN, W. A., 1963, Review and discussion on Eames et al. Fundamentals of mid-Tertiary stratigraphical correlation: Micropaleontology, vol. 9, pp. 467-473.

BLANCKENHORN, M., 1901, Neues zur Geologie und Paläontologie Aegyptens. III: Das Miozän. Z. deut. geol. Ges., Vol. 53, pp. 52-132.

BLOW, W. H., 1956, Origin and evolution of the foraminiferal genus *Orbulina* d'Orbigny: Micropaleontology, Vol. 2, pp. 57-70.

BLOW, W. H., 1957, Trans-Atlantic correlation of Miocene sediments: Micropaleontology, vol. 3, pp. 77-79.

BLOW, W. H., 1959, Age, correlation and biostratigraphy of the Upper Tocuyo (San Lorenzo) and Pozon formations, eastern Falcon, Venezuela: Bull. Amer. Paleontology, vol. 39, no. 178.

BOLLI, H. M., 1950, The direction of coiling in the evolution of some Globorotaliidae: Contr. Cushman Found. Foram. Research, vol. 1, pp. 82-89.

BOLLI, H. M., 1951, Notes on the direction of coiling of Rotalid foraminifera: Contr. Cushman Found. Foram. Research, vol. 2, pp. 139-143.

BOLLI, H. M., 1957, Planktonic foraminifera from the Oligocene-Miocene Cipero and Lengua formations of Trinidad, B.W.I.: Bull. U. S. Natl. Mus. 215, pp. 97-123.

CITA, M. B., and SILVA, I. P., 1960, Pelagic foraminifera from the type Langhian: Internatl. Geol. Congr. Repts. XXI Sess. Norden, pt. XXII, pp. 39-50.

COLE, W. S., TODD, R. and JOHNSON, C. G., 1960, Conflicting age determinations suggested by foraminifera on Yap, Caroline Islands: Bull. Amer. Paleontology, vol. 41, no. 186, pp. 77-112.

COLOM, G., 1858, The age of beds with *Miogypsina mediterranea* Brönnimann on the island of Majorca: Micropaleontology, vol. 4, pp. 347-362.

DI NAPOLI ALLIATA, E., 1952, Foraminiferi Pelagici e Facies in Italia: Atti VII Conv. Metano e Petrolio, vol. 1, Taormina, pp. 1-34.

DROOGER, C. W., 1956-b, Transatlantic correlation of Oligo-Miocene by means of foraminifera: Micropaleontology, vol. 2, pp. 183-192.

DURAND-DELGA, M. and MAGNE, J., 1958, Données stratigraphiques et micropaléontologique sur le Nummulitique de l'Est des cordillères bétique (Espagne): Rev. Micropaléontologie, vol. 1, no. 3, pp. 155-175.

EAMES, F. E., BANNER, F. T., BLOW, W. H., and CLARKE, W. J., 1962, Fundamentals of Mid-Tertiary stratigraphical correlation, 163 pp., Cambridge Univ. Press.

EAMES, F. T., and CLARKE, W. J., 1957, The ages of some Miocene and Oligocene foraminifera: Micropaleontology, vol. 3, p. 80.

GLAESSNER, M. F., 1959, Tertiary stratigraphic correlation in the Indo-Pacific region and Australia: J. Geol. Soc. India, vol. 1, pp. 51-67, Table 1.

HAGN, H., 1958, Mikropaläontologische Untersuchungen an Gesteinen der Insel Kephallinia (Adriatisch-Jonisce Zone Griechenlands): Ann. Géol. Pays Helléniques, vol. 9, pp. 89-114. Athens.

HUME, W. F., MADGWICK, T. G., MOON, F. W. and SADEK, H., 1920b, Preliminary geological report on Gebel Tanka area: Petrol. Research Bull. 4, Government Press, Cairo. 16 pp.

JENKINS, G. D., 1960, Planktonic foraminifera from the lakes entrance oil shaft, Victoria, Australia: Micropaleontology, vol. 6, pp. 345-373.

LEROY, L. W., 1948, The foraminifer *Orbulina universa* d'Orbigny, a suggested Middle Tertiary time indicator: Jour. Paleontology, vol. 22, no. 4, pp. 500-508.

MACFADYEN, W. A., 1930, Miocene foraminifera from the Clysmic area of Egypt and Sinai: Geol. Survey Egypt.

MOON, F. W., and SADEK, H., 1923, Preliminary geological report on Wadi Gharandal Area: Petroleum research Bull. No. 12, Government Press. Cairo.

SADEK, H., 1959, The Miocene in the Gulf of Suez Region: Ministry of Industry, Geological Survey and research department.

SAID, R., 1962, The Geology of Egypt, Elsevier Publishing Co., Amsterdam & New York, 377 pp.

SAID, R., 1962a, Das Miozän in der westlichen Wüste Ägyptens: Geol. Jb. 80, S. 349-366, 2 Taf., 2 Abb., 3 tab. Hannover.

SAID, R., and BASIOUNI, M. A., 1958, Miocene Foraminifera of Gulf of Suez Region, Egypt: Amer. Assoc. Petr. Geol., vol. 42, pp. 1958-1977.

SOUAYA, F. J., 1963, On foraminifera of Gebel Gharra (Cairo-Suez road) and some other Miocene samples: Jour. Paleontology, vol. 37, no. 2, pp. 433-458.

STAINFORTH, R. M., 1949, Foraminifera of the upper Tertiary of Egypt: Jour. Paleontology, vol. 23, pp. 419-422.

STAINFORTH, R. M., 1960, Current status of transatlantic Oligo-Miocene correlation by means of planktonic foraminifera: Rev. Micropaléontologie, vol. 2, no. 4, pp. 219-230.

TODD, R., CLOUD, P. E., LOW, L. D. and SCHMIDT, R. G., 1954, Probable occurrence of Oligocene on Saipan: Amer. J. Sci., vol. 252, pp. 673-682.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVIII, PART 1, JANUARY, 1967

328. A TAXONOMIC REINTERPRETATION AND EMENDATION OF THE GENUS *TECHNITELLA* NORMAN, 1878

DREW HAMAN
Geology Department, University College of Wales, Aberystwyth, Wales, U. K.

ABSTRACT

The genus **Technitella** is reinterpreted, the former species proved to be taxonomically invalid, and the genus redescribed and emended.

INTRODUCTION

During research into the foraminifera from Tremadoc Bay, North Wales, a number of specimens attributed to the genus *Technitella* were obtained from the bottom sediments, these specimens being of both free and fixed types. Further examination of representatives of this genus in the British Museum of Natural History, London, showed a feature not previously noted and therefore a reinterpretation and subsequent emendation of this genus was thought to be desirable.

DISCUSSION

In 1878 Norman suggested that a possible relationship existed between *Haliphysema* and *Technitella,* but that the latter genus could be distinguished by its free and unattached character. All workers to the present day have followed Norman's ideas in stating that the test is free, unattached and monothalmous, and that it has a simple circular aperture at one end and a concentration of spicules at the other.

These free, unattached, monothalmous forms have been obtained from Tremadoc Bay, (Plate 6, figures 1-5, 7), but in addition, a monothalmous fixed form (Plate 6, figure 6) and a colonial fixed form were obtained (Plate 6, figure 8), all having wall structure identical to that of the type.

The species that have been erected to date vary only in such features as external morphological appearance, the degree of test inflation, the relative length and breadth of the test (excluding *T. thompsoni*). As a result of the examination of the Tremadoc Bay specimens, these morphological features are believed to be simply a factor of age and corresponding development of the colony. When for some reason the colony dies or is destroyed, it breaks up, owing to the fragile pseudotectinous nature of the test wall, and varied specimens assignable to the species as originally defined are released into the sedimentary milieu. Since destruction or death can occur in the colony at any time, the various components of the colony can be of different sizes and degrees of inflation, depending on the stage of colonial development reached before this takes place. These components, when discovered by previous authors, have been elevated to species level instead of being recognised as parts of a larger organism. As these "fragments" have been considered to be an entity in themselves, authors have been forced to recognise oral, aboral, superior, and inferior ends of the test and an aperture as well. Previously the aperture has always been taken as being the circular or slit-like opening at one end of the test, sometimes produced on a neck. From the new evidence it is shown that this aperture is, in fact, the attachment area; it is believed that the true aperture is at the opposite end of the test, where masking by spicules occurs. The aperture has been shown to be variable. Thus, it may be a simple opening surrounded by spicules, or it may have grains or platy material incorporated into the test wall surrounding it, or it may take the form of numerous perforations among the spicules at the apertural end of the test. The spicules projecting beyond the test could possibly then be regarded as a filter/defensive adaptation of the apertural region. The masking by spicules makes any definite statement about the aperture hazardous, but in Slide H20 102-106 in the British Museum there is one specimen with a definite aperture in this region, a minute circular opening (not a break in the test wall) slightly masked by spicules at the end opposite the supposed aperture. The "neck" and "lips" mentioned by previous authors are believed to be attachment modifications similar to the attachment disc of *Haliphysema*. The dactyloid fringes referred to by Höglund (1947) could be part of this disc.

TAXONOMY

Genus **Technitella** Norman 1878
emend. Haman 1966

Description.—Test attached, simple, monothalmous, or colonial, polythalmous, consisting of a single elongate, oval, fusiform chamber, or of a branching tubular colony. Attachment area may have a disc-like structure developed or may be simple. Aperture at the end of the test opposite the attachment area, small, simple, slit-like to circular, with or without grains or plates incorporated into the test wall around it, or takes the form of a number of small perforations set between the spicules in this region. Wall thin, composed of acicular sponge spicules set in a pseudotectinous membrane and longitudinally parallel to the test or at an angle to it, projecting from it in the apertural direction. Spicule concentration generally present in the apertural region, spicules projecting beyond the limit of the test. Small amount of cement present.

Remarks.—Under the International Rules of Nomenclature, Norman's type species, *T. legumen,* must stand as valid, but it is again necessary to emend the type description. Since the type species should be either the monothalmous attached form or the colonial attached form, it is proposed that both these forms be included in the type species as genoholotypes with the designation "forma" used for convenience but without valid taxonomic standing.

Technitella legumen Norman 1878
emend. Haman 1966
"forma" colonial
Plate 6, figure 8

Description.—Test attached, colonial, composed of four to five elongate tubes arising either from one another or from different parts on the anchoring material. Attachment area large, disc-like. Aperture indeterminate, formed by the open ends of the tubes that are broken. Test wall thin, matte, pseudotectinous, with acicular sponge spicules set in it randomly.

Dimensions.—Length of branches up to 0.75 mm.; diameter of branches (maximum) 0.25 mm.

"forma" solitary
Plate 6, figure 6

Description.—Test attached, simple monothalmous, tubular, longer than broad, breadth equal throughout except in the upper third of the test where it becomes bluntly pointed, slightly curved. Apertural opening indistinct, situated at the masked superior end. Test wall thin, pseudotectinous, covered with acicular sponge spicules wholly or partly imbedded in the wall, 70-75% directed superiorly where there is a distinct concentration of them extending beyond the limit of the test; remainder of the spicules randomly scattered over the wall and projecting at varying angles from it.

Dimensions.—Length of body up to 1.85 mm.; diameter of body (maximum) 0.55 mm.

The problem now remains of where the species *T. thompsoni* occurs in the new scheme. It is believed that this form should not have been assigned to the genus originally, as it does not show any of the typical features of this genus. Heron-Allen and Earland discussed the test material in their remarks on the species and also noted Wright's comment that this form was probably not a foraminifer. The authors proved the rhizopodal nature of the test and, possibly because of the high degree of selectivity in test material, placed it in the genus *Technitella.* It is believed that this form belongs to the family Astrorhizidae but that its exact position is open to conjecture.

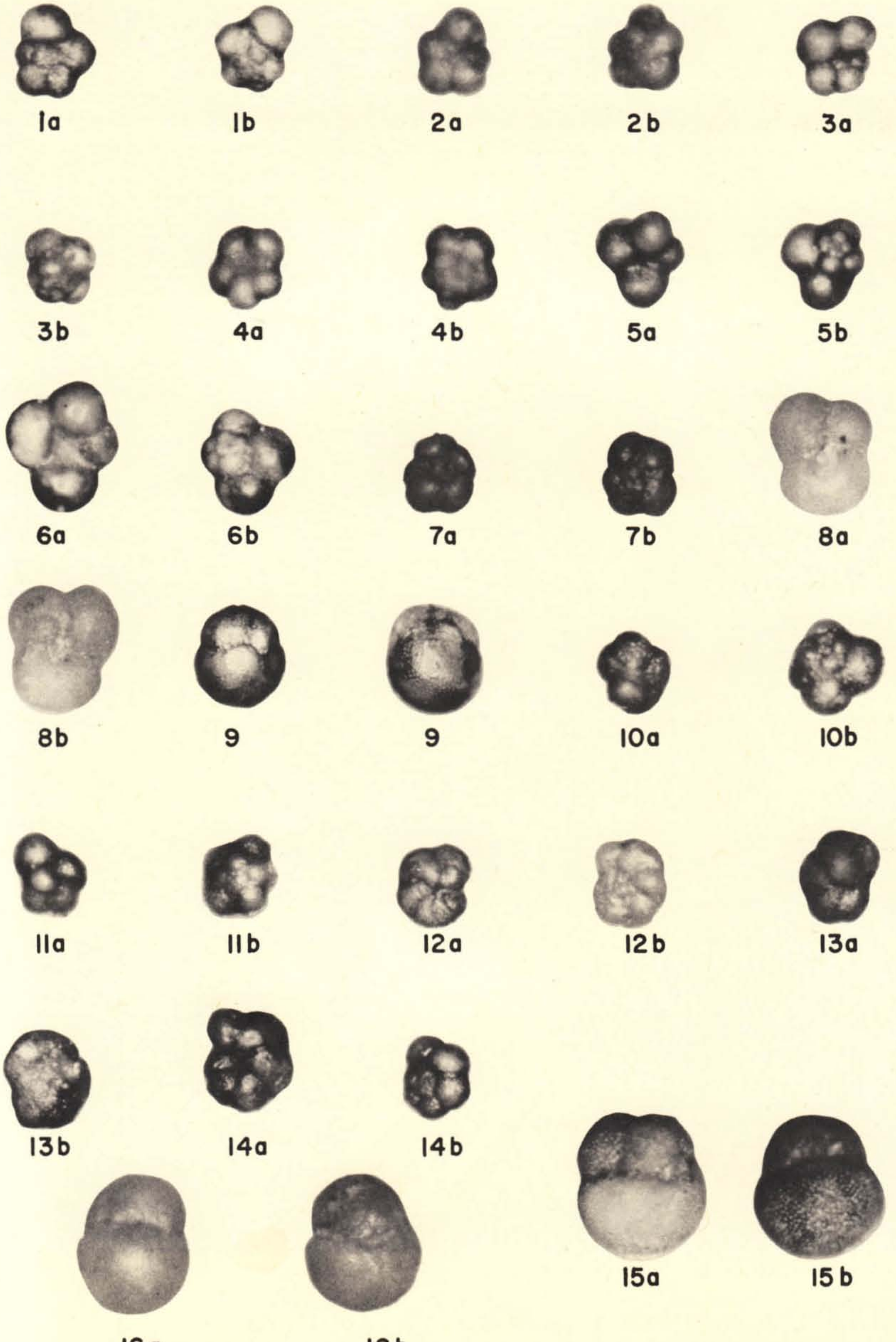
CONCLUSIONS

All previous theories concerning the mode of life of the genus *Technitella* have been, in the light of new evidence, shown to be incorrect, the genus being an attached form, not unattached as previously assumed. The generic description has been emended, as has the description of the type species, all other former "species" of the genus being now taxonomically invalid.

EXPLANATION OF PLATE 5

In all figures *a* is the ventral and *b* the dorsal view except when otherwise indicated. The dorsal and the ventral views are for two specimens of the same depth. All specimens are from the Abu Rudeis well No. 2.

FIGS.		PAGE
1.	*Globigerina ciperoensis* Bolli; × 30; from depth 6985′.	23
2.	*Globigerina ciperoensis angulisuturalis* Bolli; × 40; from depth 7305′.	23
3.	*Globigerina ciperoensis angustiumbilicata* Bolli; × 40; from depth 6985′.	23
4.	*Globigerina concinna* Reuss; × 40; from depth 7405′.	23
5.	*Globigerina praebulloides occlusa* Blow and Banner; × 40; from depth 5605′.	24
6.	*Globigerina praebulloides praebulloides* Blow; × 30; from depth 8285′.	24
7.	*Globoquadrina altispira globosa* Bolli; × 18; from depth 7955′.	24
8.	*Globigerinoides subquadrata* Bronnimann; × 30; from depth 7075′.	24
9.	*Orbulina suturalis* Bronnimann; × 30; from depth 4610′.	25
10.	*Globigerinita dissimilis* (Cushman and Bermudez); × 40; from depth 7305′.	24
11.	*Globigerinita stainforthi* (Bolli, Loeblich and Tappan); × 40; from depth 7305′.	24
12.	*Globorotalia fohsi barisanensis* LeRoy; × 40; from depth 5555′.	24
13.	*Globorotalia fohsi fohsi* Cushman and Ellisor; × 40; from depth 4905′.	25
14.	*Globorotalia kugleri* Bolli; × 30; from depth 7725′.	25
15.	*Globigerinoides bispherica* Todd; × 30; from depth 5730′.	24
16.	*Globigerinoides transitoria* Blow; × 30; from depth 6315′.	24



Said and El-Heiny: Moicene Planktonic Foraminifera of Egypt

Haman: Reinterpretation of Technitella

ACKNOWLEDGMENTS

Thanks are due to Dr. C. G. Adams and Dr. R. Hedley, who allowed the author access to British Museum collections, and to Dr. J. R. Haynes for critically reading the manuscript.

REFERENCES

ADAMS, T. D. and FRAMPTON, J., 1965, A note on some Recent Foraminifera from Northwest Iceland: Contr. Cush. Found. Foram. Res., Vol. 16, Pt. 2, 55-59.

ANDERSON, G. J., 1963, Distribution patterns of Recent Foraminifera of the Bering Sea: Micropaleo., Vol. 9, No. 3, 305-317.

BARKER, R. W., 1960, Taxonomic notes on the species figured by H. B. Brady in his Report on the Foraminifera dredged by H.M.S. Challenger during the years 1873-1876: Soc. Econ. Pal. and Min., Sp. Pub. No. 9, Tulsa.

BRADY, H. B., 1884, Report on the Foraminifera dredged by H.M.S. Challenger during the years 1873-1876: Chall. Rep. Zool., Vol. 9.

BRUCE, J. R., COLMAN, J. S. and JONES, N. S., 1963, Marine Fauna of the Isle of Man: Liv. Univ. Press, Mem. No. 36, 35.

CHAPMAN, F., 1902, The foraminifera. An introduction to the study of the Protozoa: Longmans, London.

CHAPMAN, F., and PARR, W. J., 1937, Foraminifera: Australasian Antarctic Exped., Sci Repts., 1911-1914, Ser. C, Vol. 1, Pt. 2.

COLOM, G., 1958, The age of the beds with *Miogypsina mediterranea* Brönnimann on the island of Majorca: Micropaleo., Vol. 4, No. 4.

CUSHMAN, J. A., 1910, A monograph of the Foraminifera of the North Pacific Ocean, Pt. 1: U. S. Nat. Mus. Bull. 71.

CUSHMAN, J. A., 1918, The Foraminifera of the Atlantic Ocean. Pt. 1: U. S. Nat. Mus. Bull. 104.

CUSHMAN, J. A., 1921, Foraminifera of the Phillipine islands and adjacent seas: U. S. Nat. Mus. Bull. 100, Vol. 4.

CUSHMAN, J. A., 1925, An introduction to the Morphology and Classification of the Foraminifera: Smith. Miscell. Coll., Pub. 2824, Vol. 77, No. 4.

CUSHMAN, J. A., 1927, An outline of a reclassification of the Foraminifera: Contr. Cush. Lab. Foram. Res., Vol. 3, Pt. 1.

CUSHMAN, J. A., 1929, The Foraminifera of the Atlantic Ocean: U. S. Nat. Mus. Bull 104, Pt. 6.

CUSHMAN, J. A., 1947, New species and varieties of Foraminifera from off the South Eastern coast of the United States: Contr. Cush. Lab. Foram. Res., Vol. 23, Pt. 4.

CUSHMAN, J. A., 1948, Arctic Foraminifera: Contr. Cush. Lab. Foram. Res., Sp. Pub. No. 23.

CUSHMAN, J. A., 1959, Foraminifera, their classification and economic use. Harvard Univ. Press.

EARLAND, A., 1934, Foraminifera Pt. III: Discovery Repts. Vol. X, (1935).

FLINT, J. M., 1897, A descriptive catalogue of specimens dredged by the U. S. Fish Commission Steamer Albatross. Foraminifera: U. S. Nat. Mus., Ann. Rept., Pt. 1.

FOLIN, L. DE, 1881, Exploration de l'aviso a vapeur "Le Travailleur" dans le golfe de Gascogne en juillet 1880: Soc. Hist. Nat. Bull., Toulouse. Annee 15.

FOLIN, L. DE, 1888, Considérations physiologiques sur les rhizopodes réticulaires: Naturaliste, Paris. Vol. 2, Ser. 2.

GALLOWAY, J. J., 1933, A manual of foraminifera. Bloomington Ind. Press.

GLAESSNER, M. F., 1963, Principles of Micropaleontology. Hafner.

GOËS, A. K., 1894, A synopsis of the Arctic and Scandinavian Recent marine foraminifera: Kongl. Sv. Vet. Akad. Handl. Bd. 25, No. 9, N.F.

HERON-ALLEN, E., and EARLAND, A., 1912, On some new Astrorhizidae and their shell structure: Journ. Roy. Micro. Soc.

HERON-ALLEN, E., and EARLAND, A., 1932, Foraminifera Pt. 1: Discovery Repts., Vol. IV.

HÖGLUND, H., 1947, Foraminifera in the Gullmar Fjord and Skagerak: Zool. Bidrag. Fran. Uppsala, Band 26.

LACROIX, E., 1929, Les Astrorhizides du littoral méditerranéen entre Saint Raphael et Monaco: Bull. Inst. Ocean. Monaco. No. 545.

LOEBLICH, A. R., and TAPPAN, H., 1964, Treatise on Invertebrate Paleontology. Part C, Protista 2(1): Geol. Soc. Amer.

MARIE, P., 1938, Sur la faune de Foraminifères de l'estuare de la France: Bull. Lab. Marit. Dinard, Fasc. 20.

EXPLANATION OF PLATE 6

FIGS.		PAGE
1-5, 7.	*Technitella* fragments, approx. × 32.	27
6.	*Technitella legumen* "forma" solitary, approx. × 32.	28
8.	*Technitella legumen* "forma" colonial, approx. × 32.	28

NORMAN, A. M., 1878, On the genus *Haliphysema* with description of several forms apparently allied to it: Ann. Mag. Nat. Hist., Ser. 5, Vol. 1.

NORMAN, A. M., 1878, On the architectural achievements of little masons, Annelidan(?), and Rhizopodan in the abyss of the Atlantic. Ann. Mag. Nat. Hist., Ser. 5, Vol. 1.

NØRVANG, A., 1941, Notes on some foraminifera from off Bergen: Bergens Mus. Arbok. Nat. Nr. 11.

NØRVANG, A., 1945, The Zoology of Iceland, Pt. 2, Vol. 2, Foraminifera.

PARR, W. J., 1950, Foraminifera: B.A.N.Z. Antarctic Res. Exped. Repts., Ser. B, Vol. 5, Pt. 6.

PEARCEY, F. G., 1890, Notes on the foraminifera of the Faroe Channel and Wyville Thomson Ridge with a description of a new species of *Hyperammina*: Trans. Nat. Hist. Soc. Glasgow, n.s., Vol. 2.

PEARCEY, F. G., 1914, Foraminifera of the Scottish National Antarctic Expedition: Trans. Roy. Soc. Edin., Vol. XLIX, Pt. IV, No. 19.

POKORNÝ, V., 1963, Principles of Zoological Micropalaeontology: Vol. 1. Pergammon Press.

RHUMBLER, L., 1913, Die Foraminiferen: Plankton-Exped. Humboldt Stift., Bd. III, L.c., Teil 2.

STAINFORTH, R. M., 1949, Foraminifera in the Upper Tertiary of Egypt: Journ. Pal., Vol. 23, No. 4.

WIESNER, H., 1931, Die Foraminiferen der deutschen Sudpolar Expedition 1901-1903: Deutsche Sudpolar Exped. Band XX, Zool. Bd. 12.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME XVIII, PART 1, JANUARY, 1967

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the Foraminifera that have come to hand.

ANDAL, PACITA P. A report on the discovery of fusulinids in the Philippines.—The Philippine Geologist, v. 20, No. 1, March 1966, p. 14-22, pls. 1, 2, text fig. 1 (map).—First record of late Paleozoic rocks.

ARNI, PAUL. Contribution to the history of growth of the *Chordoperculinoides* shell.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 339-346, pls. 1, 2, text figs. 1, 2 (diagrams).—Detailed discussion based on *C. bermudezi* (Palmer) from the Paleocene of Libya.

ASANO, KIYOSHI, and TAKAYANAGI, YOKICHI. Stratigraphic significance of the planktonic Foraminifera from Japan.—Sci. Repts. Tohoku Univ., 2nd Ser. (Geol.), v. 37, No. 1, 1965, p. 1-14, text figs. 1, 2 (paleogeographic maps), tables 1-5 (range chart, correl. tables).—Local planktonic zonation between Cretaceous and Miocene.

BANDY, ORVILLE L., and CHIERICI, MARIA A. Depth-temperature evaluation of selected bathyal Foraminifera common to California, U.S.A., and the Mediterranean Sea.—Internat. Geol. Congress, 22nd, New Delhi, 1964, Vol. of Abstracts, p. 111-112.

BARTENSTEIN, HELMUT, BETTENSTAEDT, FRANZ, and BOLLI, HANS M. Die Foraminiferen der Unterkreide von Trinidad, W. I. Zweiter Teil: Maridale-Formation (Typlokalität).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 129-177, pls. 1-4, text fig. 1 (loc. map).—Illustrated systematic catalog of 84 species (1 new and 7 indeterminate) from 2 localities; age within the range upper Aptian to middle lower Albian.

BARTLETT, G. A. Foraminifera distribution in Tracadie Bay, Prince Edward Island.—Geol. Survey of Canada, Paper 66-20, 1966, p. i-vi, 1-54, text figs. 1-14 (index map, loc. map, distrib. maps, graphs), check list.—Based on 10 stations within a shallow brackish lagoon having circulation restricted by a baymouth bar. Twenty-three species are involved and the central bay has the richest fauna—chiefly an association of *Elphidium* and *Ammonia beccarii*. *A. beccarii* may be a local relict.

BERMUDEZ, PEDRO J. Consideraciones sobre los sedimentos del Mioceno Medio al Reciente de las costas central y oriental de Venezuela. Primera Parte.—Venezuela Ministerio de Minas e Hidrocarburos, Bol. Geol., v. 7, No. 14, Aug. 1966, p. 333-411, fotos 1-9 (outcrop photos), graficos 1, 2 (range charts), correl. table, map, range charts.—Study based on 13 localities, including 2 deep wells. Generalized ranges between Recent and middle Miocene are shown for 567 species and subspecies of benthonic and 71 of planktonic Foraminifera. Specific ranges of species are shown in 3000 and 4100 feet of section in 2 Cubagua wells.

BERMUDEZ, PEDRO J., and FUENMAYOR, ANGEL N. Consideraciones sobre los sedimentos del Mioceno Medio al Reciente de las costas central y oriental de Venezuela. Segunda Parte. Los Foraminiferos bentonicos.—Venezuela Ministerio de Minas e Hidrocarburos, Bol. Geol., v. 7, No. 14, Aug. 1966, p. 413-611, pls. 1-4.—Alphabetical catalog of 556 species and subspecies (24 new) and illustrations of 43 of them. *Hopkinsinella* gen. nov. (genotype *Uvigerina auberiana* d'Orbigny var. *glabra* Millett) is erected.

BIZON, J.-J., and BIZON, G. *Globorotalia miozea saphoae,* nouveau nom pour *Globorotalia saphoae*.—Revue de Micropaléontologie, v. 9, No. 1, June 1966, p. 55.—The Grecian form belongs to the *miozea* lineage as known from New Zealand.

BLOW, W. H., and BANNER, F. T. Discussion: Zonation of Cretaceous to Pliocene marine sediments based on planktonic Foraminifera—a comment.—Bol. Informativo Asoc. Venez. Geol., Min. Petrol., v. 9, No. 2, Feb. 1966, p. 55.

The morphology, taxonomy and biostratigraphy of *Globorotalia barisanensis* LeRoy, *Globorotalia fohsi* Cushman and Ellisor, and related taxa.—Micropaleontology, v. 12, No. 3, July 1966, p. 286-302, pls. 1, 2, text-figs. 1-4 (correl. chart, graph, range diagrams, drawings).—Restudy of types of *G. barisanensis, G. fohsi, G. fohsi robusta,* and *G. lobata* results in renaming the sequence of planktonic zones. Three new species are described in *Globorotalia* to occupy vacant positions in the *G. fohsi* lineage—i.e., from a wholly rounded periphery to a progressively more carinate one.

BOLLI, HANS M. The planktonic Foraminifera in well Bodjonegoro-1 of Java.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 449-465, pl. 1, text fig. 1 (zonal range chart), table 1 (range chart).—Thirteen planktonic zones are recognized in the more than 2000 meters of Pliocene and Miocene section. Fifty-six species and subspecies (2 new) are listed and their ranges in the well shown. A few are illustrated and coiling directions are shown for some others.

BOLTOVSKOY, ESTEBAN. Methods for sorting of Foraminifera from plankton samples.—Jour. Paleontology, v. 40, No. 5, Sept. 1966, p. 1244-1246, table 1.—Simple filtration is faster and more convenient than other methods.

BOSELLINI, A., and BROGLIO LORIGA, C. Presenza di uno strato a Foraminiferi nel Raibliano (Carnico superiore) del Gruppo di Sella, Dolomiti occidentali.—Studi Trentini Sci. Nat., n. ser., sez. A, v. 43, fasc. 1, 1966, p. 149-156, text figs. 1-4 (columnar section, outcrop photo, photomicrographs).—Specimens of irregularly coiled tubular chambers (*Glomospira*? and *Glomospirella*?) in association with *Permodiscus*.

BRAZHNIKOVA, N. E., and ROSTOVTHEVA, L. F. Foraminifery *in* The Fauna of the lowest part of Tournaisian (zone $C_1{}^t a$) in the Donetz Basin (in Russian).—Acad. Sci. Ukrainian SSR, Instit. Geol. Sci., Kiev, 1966, p. 9-42, pls. 1-18.—Illustrated systematic catalog of about 40 species, subspecies, varieties, and forma (1 subspecies and 2 forma new).

BUGROVA, E. M. Occurrence of the foraminiferal genus *Lockhartia* in the Palaeocene of the USSR (in Russian).—Akad. Nauk SSSR, Paleont. Zhurnal, 1966, No. 2, p. 122-125, 1 text fig.—One new species, *L. luppovi*.

CAMACHO, HORACIO H. Invertebrados Fosiles.—EUDEBA (Editorial Universitaria de Buenos Aires), 1966, 707 p., 121 text figs., 8 tables.—In this Spanish textbook, the 6th chapter (p. 83-139, 15 text figs.) treats Foraminifera.

CARALP, MICHELLE, VALETON, SIMONE, and VIGNEAUX, MICHEL. The pelagic Foraminifera of the younger Tertiary of southern Aquitaine.—Bol. Informativo, Asoc. Venez. Geol., Min. Petrol., v. 9, No. 3, March 1966, p. 61-64, range chart.—A "free translation" by R. M. Stainforth of "Les Foraminifères pélagiques du Tertiaire terminal sud-aquitain" (C. R. Acad. Sci. Paris, t. 261, p. 3431-3434, Oct. 27, 1965) in which support is given to the Bolli (1957) Trinidad chronology.

CHANG, LI-SHO. A biostratigraphic study of the Tertiary in the Hengchun Peninsula, Taiwan, based on smaller Foraminifera (III: southern part).—Proc. Geol. Soc. China, No. 9, April 1966, p. 55-62, pls. 1-4, text fig. 1 (map).—Illustrations of about 65 species and subspecies from the Miocene and correlation by planktonics.

CHRISTODOULOU, G., and MARANGOUDAKIS, N. A *Globotruncana* fauna from Kiveri-Argos area, Greece.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 303-308, pl. 1, text figs. 1-4 (map, foram drawings).—Four species and 1 subspecies of *Globotruncana*, none new, indicate upper Campanian.

CICHA, IVAN. Einige Allgemeine Probleme der Phylogenese der Foraminiferen im Miozän der Westkarpaten.—Geol. Sbornik, v. 17, No. 1, Bratislava, June 1966, p. 131-144, text figs. 1-8 (graphs, range charts, drawings).—Phylogenetic sequences of *Bolivina* and *Cyclammina*.

CIFELLI, R., and SACHS, K. N., JR. Abundance relationships of planktonic Foraminifera and Radiolaria.—Deep-Sea Research, v. 13, Aug. 1966, p. 751-753, text fig. 1 (graph).—Study based on plankton tows from a traverse in the western North Atlantic between 41° and 13° N. The trend shows a shift from strong dominance of Foraminifera in the north to strong dominance of Radiolaria in the south. Actual numbers ranged from 39,000 to 600 per 1000 cubic meters. Standing crops are roughly comparable in both groups, and coexistence seems to be generally favorable.

CIRY, RAYMOND. Contribution à l'étude des Méandropsinidés: *Larrazetia chartacea* (Des Moulins).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 259-267, pls. 1-3, text fig. 1 (schematic drawing).—From the lower Maestrichtian of France.

CITA, MARIA BIANCA. Le genre *Stensiöina* dans le Crétacé supérieur italien.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 247-257, pl. 1, text figs. 1-7 (foram drawings), tables 1, 2.—Illustrations of 3 species and 2 subspecies from 4 Italian localities.

CIVRIEUX, J. M. SELLIER DE, and DESSAUVAGIE, T. F. J. Reclassification de quelques Nodosariidae, particulièrement du Permien au Lias.—Publ. Instit. Études et Recherches Min. de Turquie, No. 124, 1965, 178 p., 25 pls., 27 text figs. (graph, diagrams, map, columnar section, range chart, outline drawings from thin-sections).—A careful monograph based on sectioned material from the Upper Permian of Turkey, the Triassic of Austria, and the Liassic of France. A standard system for diagnosis, description, and nomenclature of specimens studied in oriented thin section is proposed. In the systematic part, 49 species (25 new and 4 indeterminate) are classified in 26 genera (12 new and 1 given a new name). Many nodosariid genera are discussed in detail and new generic diagnoses are given for 11 of them.

COLOM, G., and RANGHEARD, Y. Les couches a Protoglobigérines de l'Oxfordien Supérieur de l'ile d'Ibiza et leurs équivalents a Majorque et dans le domaine Subbétique.—Revue de Micropaléontologie, v. 9, No. 1, June 1966, p. 29-36, pls. 1, 2, text figs. 1, 2 (drawings, map).

CONTINI, D., and PARIWATVORN, P. Etude comparée de la microfaune du Lias supérieur d'Aselfingen (Jura du Randen) et de Pouilley-les-Vignes (Jura Franc-Comtois).—Ann. Sci. Univ. Besançon, ser. 2, Geol., fasc. 18, 1964, p. 35-44, text figs. 1-8 (columnar sections, tables of distrib. and abund.).—An example of the use of smaller Foraminifera to complement ammonites in correlation between macrofauna-poor outcrops.

CRESCENTI, U. Sulla biostratigrafia del Miocene affiorante al confine Marchigiano-Abruzzese.—Geologica Romana, v. 5, 1966, p. 1-54, pls. 1, 2, text figs. 1-9 (columnar sections, drawings), tables 1-4 (correl. charts, range charts).—Five local biostratigraphic units are defined by planktonics and correlation is shown with planktonic zonations of Bolli, Blow, Jenkins, and Bandy. Ranges of 34 planktonic species between Aquitanian and Messinian are indicated. Forty-five species (2 new) are described and most of them illustrated.

DEL SERE, MICAELA. "Lagenidea" del Lias dell' Albenza (Bergamo).—Riv. Ital. Paleont. Stratig., v. 72, No. 1, March 1966, p. 147-188, pls. 12-15, text figs. 1, 2 (map, columnar section), tables 1-4.—Thirty-four species (none new, 9 indeterminate.

DIECI, G. Età luteziana delle "argile di Rio Giordano" (Appennino settentrionale modenese): documentazione micropaleontologica.—Boll. Soc. Paleont. Ital., v. 4, No. 1, 1965, p. 9-27, pls. 1, 2, range chart.—Includes illustrations of 14 species of planktonic Foraminifera, none new. Total fauna (67 species) is listed.

DONDI, LUCIANO, and PAPETTI, ITALO. Studio paleoecologico e stratigrafico sul passaggio Pliocene-Quaternario nella bassa Valle del Santerno (Emilia).—Riv. Ital. Paleont. Stratig., v. 72, No. 1, March 1966, p. 231-244, text figs. 1, 2 (map, graphs).—Boundary between upper Pliocene and Calabrian (lower Pleistocene) is at level of great increase in some cold water species (*Globigerina pachyderma, Hyalinea balthica,* and *Bolivinita quadrilatera*).

EISENACK, ALFRED. Symbionten in fossilen Protisten.—Paläont. Zeitschr., Stuttgart, Band 40, Nr. 1/2, May 1966, p. 103-107, pl. 8.—Minute globular bodies observed within Silurian Foraminifera interpreted as symbiotic algae.

EJEL, FOUAD, and NOUET, GILBERT. Présence de *Cuvillierina vallensis* (Ruiz de Gaona) dans la région de Damas (Syrie).—Revue de Micropaléontologie, v. 9, No. 1, June 1966, p. 19-22, pl. 1.—In the lower Eocene.

FARINACCI, ANNA. I Foraminiferi di un livello marnoso nei calcari diasprigni del Malm (Monti Martani, Umbria).—Geologica Romana, v. 4, 1965, p. 229-258, text figs. 1-47 (drawings).—Illustrated catalog of 44 species (6 new and 2 indeterminate) and 2 subspecies (1 new).

FIERRO, GIULIANO. Contributo allo studio delle microfaune del Mare Jonio.—Atti Soc. Ital. Sci. Nat. e Museo Civico Storia Nat. Milano, v. 103, fasc. 4, Dec. 15, 1964, p. 381-389, table 1.—Quantitative analysis of a sample from 500 meters, a cold-water population.

FIERRO, GIULIANO, and CERETTI, PAOLO. I Foraminiferi planctonici in alcuni campioni di fondo del Mare Tirreno.—Atti Accad. Ligure Sci. Lett., v. 22, 1965, p. 1-19, pls. 1, 2, text figs. 1-3 (map, graphs), tables 1-3.—Quantitative analysis of 22 species from 8 bottom samples. Species are grouped as to warm, temperate, and cold.

FUGANTI, A., MORTEANI, G., and UNGARO, S. Studio sedimentologico e micropaleontologico dei sedimenti terziari di Castel Tesino (Trento) con riferimento al tettonismo del "cristallino di Cima d'Asta."—Studi Trentini Sci. Nat., n. ser., sez. A, v. 42, fasc. 2, 1965, p. 274-300, pl. 1 (biostratigraphic chart), 18 figs. on 8 pls. —Eocene to lower Miocene Foraminifera.

GLAESSNER, MARTIN F. Notes on Foraminifera of the Genus *Hedbergella.*—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 179-184, pl. 1.—*Globigerina infracretacea* a primitive species in *Hedbergella.*

GOLEV, B. T., and SOVCHIK, YA. V. First find of an Oligocene species of *Nummulites intermedius* d'Archiac on the southern side of the Ukrainian Carpathians (translation).—Doklady Acad. Sci. U.S.S.R. Earth Sci. Sec., v. 165, Nov.-Dec. 1965, p. 91-92, text fig. 1.

GORDON, W. A. Variation and its significance in classification of some English Middle and Upper Jurassic nodosariid foraminifera.—Micropaleontology, v. 12, No. 3, July 1966, p. 325-333, pls. 1, 2, text-figs. 1-11 (drawings, histogram, scatter diagram).—Variations of a single species from a single sample exhibit morphology of several genera. Transgression of species across generic boundaries is attributed to the fact that nodosariid classification was developed on the basis of material from a time when the family had declined in numbers and diversity from their peak in Jurassic and Early Cretaceous. Modification of classification ought to be made by grouping species into larger units rather than by defining new genera. Five species from the Corallian Beds, Oxfordian, are discussed and their variation illustrated.

GRÖNHAGEN, DORIS, and LUTERBACHER, HANSPETER. Beobachtungen an den Foraminiferen-Gattungen *Pseudotextulariella* und *Textulariella* sowie verwandten Formen.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 235-246, text figs. 1-7 (drawings and schematic drawings of specimens).—Internal structures are illustrated. *"Cuneolina"* is regarded as a flattened *Textulariella*. Textulariellidae nov. fam. includes genera having trochospiral early coil and alveolar structure.

GROSSHEIDE, KSENIJA. Das Profil der Mergelgrube von Astrup und Die Foraminiferen des Doberges bei Bünde und von Astrup (Textulariidae bis Buliminidae).—Beih. geol. Jahrb., Hannover, Band 60, 1965, p. 43-119, pls. 3-12, 18, text figs. 11-14 (maps, columnar sections, outline drawings).—Occurrence and abundance in about 80 upper Oligocene samples are indicated for 90 species and subspecies (1 species new).

HAYASAKA, ICHIRO, and KATO, MAKOTO. On *Pseudoschwagerina miharanoensis* Akagi, *in* An Upper Palaeozoic Fauna from Miharanoro, Hiroshima Prefecture, Japan.—Jour. Fac. Sci., Hokkaido Univ., ser. 4, Geol. & Min., v. 13, No. 3, July 1966, p. 265-271, pls. 31, 32.

VAN HINTE, J. E. *Orbitoides hottingeri* n. sp. from northern Spain.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 69, No. 3, 1966, p. 388-402, pls. 1, 2, text figs. 1-10 (drawings, graphs), tables 1, 2.—A primitive species from the Santonian.

HOOPER, KENNETH. A note on an anomalous miliolid.—Micropaleontology, v. 12, No. 3, July 1966, p. 371, text figs. 1-6 (photos of specimen).—A Recent aberrant specimen similar to *Miliolinella chukchiensis* but having an aperture at both top and bottom.

HOTTINGER, LUC. Foraminifères rotaliformes et Orbitoïdes du Sénonien inférieur pyrénéen.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 277-301, pls. 1-6, text figs. 1-11 (paleogeographic map, geol. section, foram drawings). —Seven species (3 new) and a new genus: *Orbitokathina* n. gen. (type species *O. vonderschmitti* n. sp.).

HUANG, TUNYOW. Planktonic Foraminifera from the Somachi Formation, Kikai-jima, Kagoshima Prefecture, Japan.—Trans. Proc. Paleont. Soc. Japan, n. ser., No. 62, June 30, 1966, p. 217-233, pls. 27, 28, text figs. 1-3 (map, stratigraphic column, graph), table 1.—A predominantly planktonic population (with minor amounts of deep-water benthonics) from one of the islets of the Ryukyu Islands, interpreted as an open-sea deposit of early Pliocene age.

JONES, J. I. The distribution and variation of living pelagic Foraminifera in the Caribbean.—Trans. Third Caribbean Geol. Conf. held at Kingston, Jamaica, 2nd-11th April 1962, 1966, p. 178-183, text figs. 1-3 (map, graphs), tables 1, 2.—Quantitative analysis of standing crops at the surface and at various depths. *Globigerinoides sacculifer* and *G. ruber* are dominant.

KAHLER, FRANZ and GUSTAVA. Fusulinida (Foraminiferida), Teil 2.—Fossilium Catalogus. 1: Animalia, Pars 112, s'Gravenhage, Aug. 15, 1966, 538 p.

Über die Doppelschalen der Fusuliniden.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 33-38.

KANMERA, KAMETOSHI, and MIKAMI, TAKAHIKO. Succession and sedimentary features of the Lower Permian Sakamotozawa Formation.—Mem. Fac. Sci., Kyushu Univ., ser. D, Geol., v. 16, No. 3, Nov. 20, 1965, p. 265-274, text figs. (range chart, geol. map).—Ranges indicated for 24 fusulinids.

Fusuline Zonation of the Lower Permian Sakamotozawa Series.—Mem. Fac. Sci., Kyushu Univ., ser. D, Geol., v. 16, No. 3, Nov. 20, 1965, p. 275-320, pls. 44-53, text fig. 1 (map), table 1 (check list).—Twenty-six species, 6 indeterminate and 1 new.

KENNETT, J. P. Faunal succession in two upper Miocene-lower Pliocene sections, Marlborough, New Zealand.—Trans. Roy. Soc. New Zealand, Geol., v. 3, No. 15, Jan. 19, 1966, p. 197-213, text figs. 1-5 (maps, columnar sections), tables 1-3 (range chart, depth charts).—Correlation between the 2 sections—one a deep-water facies and the other a shallow-water facies—interpreted from evolutionary stage of Foraminifera in the deeper section and from mollusks in the shallower.

Stratigraphy and fauna of the type section and neighbouring sections of the Kapitean Stage, Greymouth, N.Z.—Trans. Roy. Soc. New Zealand, Geol., v. 4, No. 1, May 18, 1966, p. 1-77, pls. 1-16, text figs. 1-7 (maps, columnar sections, correl. diagram), tables 1-6.—Over 100 species (10 new) of late Miocene and Pliocene age.

KHOREVA, I. M. O Foraminiferakh iz Pinakul'-skikh Otlozhenij Chukotki.—Akad. Nauk SSSR, Biull. Komissii po Izucheniju Chetvertichnogo Perioda, No. 31, 1966, p. 104-116, pls. 1, 2, text figs. 1, 2 (graphs).—Quantitative record of 12 Quaternary Foraminifera in 2 bore holes.

KOCHANSKY-DEVIDÉ, VANDA. Über das geologische Alter der Gattung *Reichelina* und die Reichelinen Jugoslawiens.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 39-45, pl. 1.—*Reichelina slovenica* n. sp. from the Permian.

KRISTAN-TOLLMANN, EDITH. Zum Bau und zur Taxonomie der triadischen Foraminiferengattung *Duostomina*.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 47-63, pl. 1, text figs. 1-10 (schematic drawings and photos of clay models to show structure).

LE CALVEZ, YOLANDE. Contribution à l'étude des Foraminifères de l'Oligocène inférieur (Sannoisien) dans le Bassin de Paris.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 401-419, pls. 1-3, text fig. 1 (strat. table).—Twenty-seven species, 2 new.

LEHMANN, ROGER. Description des Globotruncanidés et Hétérohelicidés d'une faune maestrichtienne du Prérif (Maroc).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 309-317, pls. 1, 2.—Sixteen species, none new.

LIENERT, OTTO GEORG. Stratigraphie der Drusbergschichten und des Schrattenkalks im Säntisgebirge unter besonderer Berücksichtigung der Orbitoliniden.—Zürich Univ., Geol. Instit., n. Folge, nr. 56, 1965, 141 p., 3 pls. (map, geol. sections), 4 pls. (photomicrographs), 4 text figs. (columnar sections, diagram, graph), tables 1-3.

LÓPEZ BALUJA, LUISA M., and IBARRA MARTÍN, MARÍA E. Estudio de dos Foraminiferos planctonicos del Mioceno de Cuba.—Instit. Cubano Recursos Minerales, Publ. Especial No. 1, 1964, p. 1-21, pls. 1-3, map, columnar section, correl. table.—Possibility of morphologic connection between *Globigerinita naparimaensis* and *Globigerinatella insueta*.

MACFADYEN, W. A. Foraminifera from the Upper Cretaceous of James Ross Island.—British Antarctic Survey, Bull. No. 8, May 1966, p. 75-87, text figs. 1 (map), 2 (drawings).—Seventeen species from the lower to middle Campanian.

MAGNÉ, JEAN. Contribution à l'étude micropaléontologique du Dogger de Muret-le-Château (Causse du Comtal, Aveyron).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 65-71, pls. 1, 2, text fig. 1 (columnar section).—*Orbitopsella*? in thin sections from the Bathonian.

MAMEDOV, T. A. Otkrytie Nummulitov v Paleothenovykh Otlozhenijakh Azerbajdzhana.—Akad. Nauk Azerbajdzhan. SSR, Baku, Me'ruzeler Doklady, tom 21, No. 12, 1965, p. 23-27, 1 pl.—Three species of *Nummulites*, 1 new.

MANGIN, JEAN PHILIPPE. Les courbes de croissance chez les Operculines: notion d'espèce en paléontologie et méthode rapide de détermination.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 347-353, text figs. 1-5 (line drawings, table, graphs).—Spiral angle as means of determination of species.

MAYNC, W. Bemerkungen zur Foraminiferenfauna aus den Typusprofilen von Valangin und Hauterive, *in* Die Typus-Profile des Valanginien und Hauterivien.—Bull. Ver. Schweiz. Petrol.-Geol. u. -Ing., v. 31, No. 81, April 1965, p. 71-73.

MERIC, ENGIN. Etude Géologique et Paléontologique de la Région entre Kâhta et Nemrutdag (Sud-Est Anatolie).—Revue Fac. Sci. Univ. Istanbul, ser. B, tome 30, fasc. 1-2, 1965, p. 55-107, pls. 1-20 (1-6, landscapes; 7-16, Foraminifera; 17, 18, megafossils; 19, geol. map; 20, geol. sections), text figs. 1-5 (map, geol. sections, columnar sections, drawings).—Many species of larger and smaller Foraminifera listed from Maestrichtian, Ypresian, Lutetian, Burdigalian, and Tortonian. A few species are illustrated, mostly in *Loftusia, Nummulites, Somalina,* and *Orbitoides.*

MITSUSHIO, HIROMI. Bottom sediments off Tsuyazaki, northeast of Fukuoka City (English abstract of Japanese text).—Sci. Repts. Fac. Sci., Kyushu Univ., Geol., v. 8, No. 2, 1965, p. 101-135, 20 text figs. (maps, graphs), 6 tables.—Occurrence and abundance of benthonic and planktonic Foraminifera are tabulated.

MURRAY, J. W. The Foraminiferida of the Persian Gulf. 4. Khor al Bazam.—Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier Publ. Co., Amsterdam, v. 2, No. 2, June 1966, p. 153-169, text figs. 1-14 (drawings, distrib. maps, graphs).—Preliminary quantitative study based on 97 samples from a shallow high-salinity area of carbonate sedimentation in an elongate coastal lagoon behind a barrier of islands and reefs. Distribution of species groups (miliolids, peneroplids, and elphidiids) is described and mapped. Specimens appear to live on seaweed and not in the sediments. Black specimens are concentrated along the axis of the lagoon and tests damaged by boring algae occur in near-shore areas.

NEAGU, THEODOR. *Schackoina* from the Cenomanian of the eastern Carpathians.—Micropaleontology, v. 12, No. 3, July 1966, p. 365-

369, pls. 1, 2.—One species and 2 subspecies from a rich middle Cenomanian fauna which is listed.

NEAGU, T., and POPESCU, G. *Vidalina carpathica* n. sp. des dépôts Barremiens Carpatiques.—Revue de Micropaléontologie, v. 9, No. 1, June 1966, p. 40-42, pl. 1.

OLAUSSON, ERIC. Evidence of climatic changes in North Atlantic deep-sea cores, with remarks on isotopic paleotemperature analysis, *in* Progress in Oceanography, v. 3, M. Sears, Editor.—Pergamon Press, Oxford, 1965, p. 221-252, text figs. 1-10 (graphs).—Six time units (i.e., postglacial, Würm, Riss, and Mindel glaciations, and Eem and Holstein interglacials) are assigned to the warm and cool phases that have already been recognized by others' analyses of planktonic Foraminifera in cores of the 1948 *Albatross* cruise.

PAJIC, VERA. The Middle Carboniferous microfauna of western Serbia.—Vesnik Zavoda Geol. Geofiz. Istraz., Yugoslavia, ser. A, No. 21, 1963, translation 1965, p. 235-253, pls. 1-6.—Illustrations of many species in thin-section.

PANTIC, SMILJKA. Upper Permian microfossils from the Anisian conglomerates of Haj Nehaj—Montenegro.—Vesnik Zavoda Geol. Geofiz. Istraz., Yugoslavia, ser. A, No. 21, 1963, translation 1965, p. 175-213, pls. 1-10.—Twelve species of foraminifers, 1 *Lasiotrochus* new.

PAPETTI, ITALO, and TEDESCHI, DANTE. Nuovo genere di Foraminifero del Santoniano Superiore.—Geologica Romana, v. 4, 1965, p. 119-127, text figs. 1-8 (map, thin-section photomicrographs, diagrammatic reconstruction).—*Cuvillierinella salentina* gen. et sp. nov. differs from the Peneroplidae in its chambers having labyrinthic structure.

PAVLOVEC, R. Evolution of the species *Nummulites problematicus* Tellini and its vertical extension.—Bull. Sci., Yougoslavie, sec. A, tome 11, No. 1-2, Jan.-Feb. 1966, p. 4, evolution chart.—Developed in upper Eocene from *N. fabianii*.

Einige Bemerkungen zur Entwicklung der Nummulitinen.—Bull. Sci., Yougoslavie, sec. A, tome 11, No. 1-2, Jan. Feb. 1966, p. 4, 5.

PIERONI, PIER GIOVANNI. *Lepidocyclina* and *Miogypsina* from Opi, Sangro Valley (Central Apennines).—Geologica Romana, v. 4, 1965, p. 161-172, pls. 1-3, text figs. 1-10 (map, columnar section, drawings, histograms, stratigraphic chart), tables 1-4.—Stage of evolution of three species in the lower sediments indicates the transgression took place in the Chattian.

PITAKPAIVAN, KASET. Fusulines of the Rat Buri Limestone of Thailand.—Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., v. 17, No. 1, Nov. 20, 1965, p. 3-69, pls. 1-6, text figs. 1-11 (map, diagram, graphs), tables 1-35.—Twenty-five Permian species and subspecies (4 new and 6 indeterminate).

POZARYSKA, KRYSTYNA. The Cretaceous-Tertiary boundary in Poland and adjacent areas (in the light of Foraminifera).—Ann. Soc. Geol. Belgique, v. 89, 1965-66, Bull. no. 3, June 1966, p. 47-64, paleogeographic map, occur. and abund. table, check list, correl. chart.

PREMOLI SILVA, ISABELLA. La struttura della parete di alcuni Foraminiferi planctonici.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 219-233, pls. 1-3, text figs. 1-6 (drawings of specimens).—A double-layered wall—the inner layer shapes each individual chamber; the outer undulating layer covers previously formed chambers. Honeycomb structure is found in several genera, and a thick crust developed upon the honeycomb structure in *Globorotaloides variabilis* results in a wall similar to that of *Sphaeroidinella*.

RAT, PIERRE. *Nubecularia reicheli* nov. sp., Foraminifère constructeur de fausses oolithes dans le Bajocien de Bourgogne.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 73-85, pl. 1, text figs. 1-5 (drawings of foram sections).

REISS, Z., and GVIRTZMAN, G. *Borelis* from Israel.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 437-447, pls. 1, 2, text figs. 1, 2 (map, strat. range chart).—A Tortonian species and subspecies and a Recent species.

REYMENT, R. A. Observations on the variability of *Sagrina circumspinosa* (de Klasz and Rérat) (Eocene: Foraminifera).—Nigerian Jour. Sci., v. 1, No. 1, March 1966, p. 65-70, pl. 1, text figs. 1-6 (drawings, graphs).—A middle Eocene marker in coastal Nigeria.

Morphologische Variation bei zwei fossilen Arten der Gattung *Cibicides* Montfort (Foraminifera, Prot.).—Paläont. Zeitschr., Stuttgart, Band 40, Nr. 1/2, May 1966, p. 65-69, text figs. 1-3 (drawings).—One from the Maestrichtian and one from the Paleocene, both new, show uncoiling stages.

Afrobolivina africana (Graham, de Klasz, Rérat). Quantitative Untersuchung der Variabilität einer paleozänen Foraminifere.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 319-337, pls. 1-3, text figs. 1-11 (histograms, graphs, diagram, map, line drawings), tables 1-4.—Illustrations and detailed description, including comparisons with the Maestrichtian species, *A. afra*.

RICHTER, GOTTHARD. Zür Ökologie der Foraminiferen. III. Verdriftung und Transport in der Gezeitenzone.—Natur und Museum (Frankfurt a.M.), Band 95, heft 2, Feb. 1, 1965, p. 51-62, text figs. 1-4, tables 1-3.—Along the North Sea coast, examples of living specimens being displaced from the tidal zone by tidal flow, by ice-movement, and within sediment.

SACHS, K. N., JR. Variability of certain Tertiary larger Foraminifera.—Trans. Third Caribbean Geol. Conf. held at Kingston, Jamaica, 2nd-11th April, 1962, 1966, p. 176-177.

SCHAUB, HANS. Über die Grossforaminiferen im Untereocaen von Campo (Ober-Aragonien).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 355-377, pls. 1-6, text figs. 1-9 (loc. map, correl. table, graphs, drawings of thin sections).—Thirteen species of *Nummulites* (2 new) and 5 of *Assilina*.

SCHOTT, WOLFGANG. Foraminiferenfauna und Stratigraphie der Tiefsee-Sedimente im Nordatlantischen Ozean.—Repts. Swedish Deep-Sea Exped., v. 7, Sediment cores from the North Atlantic Ocean, No. 8, 1966, p. 355-469, pls. 1-11 (biostratigraphic profiles, 1-4; occur. table, 5; core photographs, 6-8; photomicrographs of microfauna, 9-11), text figs. 1-55 (local. maps, percentage distrib. maps, maps showing currents, temp., kind and thickness of sediments, and bottom topography, charts showing stratigraphy and planktonic species, stratigraphic profile, graphs, correl. chart), tables 1-21.—Study based on 19 cores from off northwest Africa and across the Atlantic to the Caribbean. About 190 species are enumerated, none new, and typical assemblages illustrated from the present ocean floor, Wisconsin III, and Postglacial. Maps illustrating the quantitative distribution of 17 planktonic species based on the combined records of present cores and those studied by Ovey 1950, Phleger, 1952, 1953, and Schott 1935, permit the evaluation of species as cold, temperate, or warm indicators. Three cores, going back to the Holocene and young Pleistocene, are studied in detail and serve as standard profiles of warm and cold surface waters. Study of benthonics reveal interspersed horizons of allochthonous specimens in the longest core.

SEIBOLD, ILSE. Über den Verbleib älterer Sammlungen jurassischer Foraminiferen.—Paläont. Zeitschr., Stuttgart, Band 40, Nr. 1/2, May 1966, p. 151-154.—Enumeration of 13 still-extant collections and 6 lost and 7 unknown ones.

SEIGLIE, GEORGE A., and BERMUDEZ, PEDRO J. Tres géneros nuevos y una especie nueva de foraminíferos del terciario de las Antillas.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 431-435, pl. 1.—*Longiapertina* (type species *L. varistriata* sp. nov.) and *Asterigerinita* (type species *Globorotalia kochi* Pijpers, 1933) from middle Eocene of Cuba and *Reichelinella* (type species *Discorbis baitoensis* Bermudez, 1949) from the Miocene of Cuba and Dominican Republic.

SIGAL, JACQUES. Contribution à une monographie des Rosalines. 1. Le genre *Ticinella* Reichel, souche des Rotalipores.—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 185-217, pls. 1-6, text fig. 1 (range chart).—Nine species (3 new) and 3 new varieties.

SKINNER, JOHN W., and WILDE, GARNER L. Permian fusulinids from Pacific Northwest and Alaska.—Univ. Kansas Paleont. Contr., Paper 4, May 23, 1966, p. 1-64, pls. 1-49, text figs. 1-10 (maps, columnar sections).—Consists of 8 short papers covering areas in Nevada, Oregon, Washington, British Columbia, and Alaska, in which are described 59 species (47 new). The new genus *Alaskanella*, with *A. landoni* n. sp. as type species, is erected.

Permian fusulinids from Sicily.—Univ. Kansas Paleont. Contr., Paper 8, June 22, 1966, p. 1-16, pls. 1-20, text fig. 1 (map).—Fourteen species (10 new and 2 indeterminate). New subgenus *Sosioella* is proposed in the genus *Chusenella*, with type species *Chusenella sosioensis* Pasini, 1964.

SKVORTSOV, V. P. New Visean foraminifers of North Fergana (translation).—Internat. Geol. Review, v. 8, No. 7, July 1966, p. 803-810, pl. 1.—Ten new species.

SRINIVASAN, M. S. Descriptions of new species and notes on taxonomy of Foraminifera from the Upper Eocene and Lower Oligocene of New Zealand.—Trans. Roy Soc. New Zealand, Geol., v. 3, No. 17, May 18, 1966, p. 231-256, pls. 1-6, table 1.—Thirty-three species (23 new) and a new subspecies. Four new genera and a new subfamily are erected and reclassifications suggested for several other genera. *Latibolivina* (type species *Bolivina anastomosa* Finlay 1939), *Wadella* (type species *Carpenteria hamiltonensis* Glaessner and Wade, 1959), *Virguloides* (type species *V. wellmani* n. sp.), *Vellaena* (type species *V. zealandica* n. sp.), and Trifarininae n. subfam. of the Uvigerinidae.

STEINECK, P. LEWIS. *Gavelinella olssoni*, new name for the foraminiferal species *Cibicides compressus* Olsson, 1960.—Jour. Paleontology, v. 40, No. 5, Sept. 1966, p. 1248.

VILLAVICENCIO, MILAGROS L. Notes on the occurrence of a giant Nummulite(?) in the Philip-

pines.—The Philippine Geologist, v. 20, No. 1, March 1966, p. 23-28, pls. 1, 2, text fig. 1 (map).

VAN DER VLERK, I. M. *Miogypsinoides, Miogypsina, Lepidocyclina* et *Cycloclypeus* de Larat (Moluques).—Eclogae Geol. Helvetiae, v. 59, No. 1, 1966, p. 421-429, pls. 1, 2, text figs. 1, 2 (histograms).—From the type bed from which *Miogypsinoides dehaartii* was described, are illustrated transitional forms uniting that species with *Miogypsina borneënsis*. Biometrical analysis of specimens of *Lepidocyclina* from Larat indicates correlation with Aquitanian.

WANG KUO-LIEN. On *Colaniella* and its two allied new genera (English abstract of Chinese text).—Acta Palaeont. Sinica, v. 14, No. 2, May 1966, p. 206-232, pls. 1-5, 1 text fig.—Seven new species described, and two new genera: *Pseudocolaniella* and *Paracolaniella*.

WILLIAMS, THOMAS E. Permian Fusulinidae of the Franklin Mountains, New Mexico-Texas.—Jour. Paleontology, v. 40, No. 5, Sept. 1966, p. 1142-1156, pls. 147-150, text fig. 1 (columnar section), tables 1-5.—Five species, none new.

ZUCCHI, MARIA LUISA. Fauna a macro e microforaminiferi nelle marne arenacee eoceniche di Sardagna (Trento).—Studi Trentini Sci. Nat., n. ser., sez. A, v. 42, fasc. 2, 1965, p. 301-322, pls. 1, 2, text fig. 1 (columnar section, map).—Fifty-two species of smaller Foraminifera, and 9 of larger, none new.

RUTH TODD
U. S. Geological Survey
Washington, D. C.

ABU RUDEIS WELL

2

SURFACE ELEVATION = 10'.