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Contents

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1959

INDEX TO VOLUME X, 1959

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191. ON THE SPLITTING OF *GLOBIGERINA*

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ABSTRACT

Candeina and **Sphaeroidina** are analyzed as to the inner structure of their initial chambers. Together with **Globigerinatella** they make up a group which forms a planktonic series of species derived from **Cassidulina** ancestors. The genus **Globigerinella** cannot be maintained since **G. aspera** forms a continuous development series from trochoidal forms through typical **G. aspera** towards the **Biglobigerinella** group. Such a gradational development series cannot be divided into three different genera. In **Globigerinoides** the same process of the division of the aperture into several smaller apertures is followed. There seems no real reason to separate **Globigerinoides** from **Globigerina. Catapsydrax** is shown to be a reproductive stage of other globigerines from the **Globigerina venezuelana** group. **Globigerinita** also is a reproductive stage in the development of globigerines with the structure of the **Globigerina bulloides** group. **Globigerinoita** is the reproductive stage of the **Globigerina rubra** group. **Orbulina** and **Candorbulina** are also reproductive stages of other globigerines, especially those belonging to forms in the **triloba** group. All these genera have no taxonomic value in a natural system of the Foraminifera and thus must be abandoned.

DISCUSSION

Since planktonic Foraminifera have been recognized as important guide fossils, many authors have been busy with the study of them. They all had the Rules of Zoological Nomenclature in hand and with these rules they have made genera and species ad libitum. It is a pity that these rules give many instructions as to the description of new species and genera but none whatever as to the restrictions which zoologists know, I should say by intuition, must be taken into consideration when making new genera and species.

It has been a considerable task for Loeblich and his collaborators (1957) to give an extensive description and analysis of many (or nearly all) known planktonic Foraminifera. From their account we now have the following genera of the Globigerinidae alone: (I include here several genera which Bolli, Loeblich and Tappan (1957) put into their family Hantkeninidae, since I believe *Hantkenina,* after close study of the type species, to be a true globigerinid genus. Since I believe that *Orbulina* cannot have generic status, I do not use the family name, Orbulinidae.)

Globigerinelloides Cushman and Ten Dam, 1948
Planomalina Loeblich and Tappan, 1946
Hastigerinoides Brönnimann, 1952
Biglobigerinella Lalicker, 1948
Schackoina Thalmann, 1932
Hantkenina Cushman, 1924
Cribrohantkenina Thalmann, 1942
Hastigerina Thomson, 1876
Clavigerinella Bolli, Loeblich and Tappan, 1957
Cassigerinella Pokorny, 1955
Globigerina d'Orbigny, 1826
Globoquadrina Finlay, 1947
Hastigerinella Cushman, 1927
Globigerinoides Cushman, 1927
Sphaeroidinella Cushman, 1927
Pulleniatina Cushman, 1927
Globigerapsis Bolli, Loeblich and Tappan, 1957
Porticulasphaera Bolli, Loeblich and Tappan, 1957
Candeina d'Orbigny, 1839
Orbulina d'Orbigny, 1839
Catapsydrax Bolli, Loeblich and Tappan, 1957
Globigerinita Brönnimann, 1951
Globigerinoita Brönnimann, 1952
Globigerinatheka Brönnimann, 1952
Globigerinatella Cushman and Stainforth, 1945
Rugoglobigerina Brönnimann, 1952
Globigerinella Cushman, 1927

Rugoglobigerina is referred by Bolli, *et al.* (1957) to the family Globotruncanidae Brotzen, 1942, but the reason is not clear to the writer so it is included here in the Globigerinidae. This group includes so far twenty-seven genera. We will now attempt to analyze some of these genera, especially in respect to their taxonomy.

When we analyze the tests of many groups of Globigerinidae we find that they all, even the more primitively built species, show a radiate wall, that is, a wall in which each chamber is built as a sphaerocrystal. Moreover, the test never has a polished surface, at least in the type species of the whole group, *Globigerina bulloides,* from the northern Adriatic Sea (Rimini). This characteristic of the test is connected with the forming of hardened pseudopods for planktonic life; the base of each pseudopod is found to be in a more or less developed protuberance on the outer surface of the test. Another typical feature is the formation of globular chambers, which also must be connected with planktonic life. This formation of globular chambers has given rise to an increasing trend from the original form of test construction towards a globular test. It is striking that along with this tendency to form more globular tests an increase of pore diameter is found. Thus, typical trochoidal tests with four or more chambers in a whorl have finer pores than those forms with a more globular test. This phenomenon is quite understandable when we bear in mind that pores have to do with metabolism and that in a flattened trochoidal test the total surface is greater than it is in a more globular one with the same total volume. Thus, the size of the pores in the test wall is an important guide to the evolutionary state of the organism.

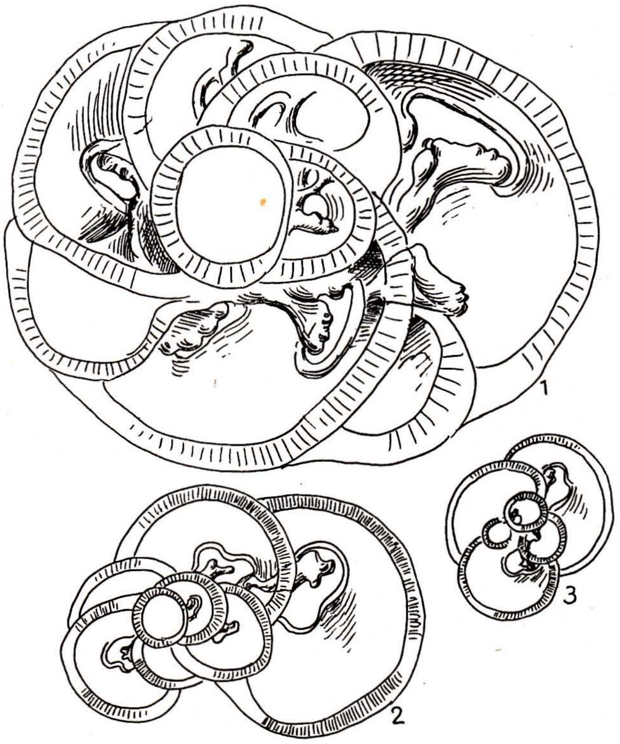
Sections reveal that in species with a thick test the early chambers have much thinner walls; but the study of the places where the chambers attach to each other reveals that these thin chamber walls cannot be explained by resorbing processes so that they must have always been thin. Dorsally, the outer side of the walls of the initial part may have been thickened secondarily, as can be detected easily in section. When studying plankton samples, we often find only specimens with very thin tests and in such cases they are mostly very small in size. This has led to the suggestion that these planktonic forms were the first planktonic stages of forms with thicker tests; whether or not these forms with thicker tests are planktonic cannot be solved here. It must be emphasized that up to the present we know very little about the life cycle of the Globigerinidae; there may be species which in one generation (when generations occur in these planktonic forms) are more primitively built than in another. Moreover, as is the case in so many other Foraminifera, some generations may build accessory chambers when producing flagellospores; this would be very opportune for planktonic organisms. It is obvious that these accessory chambers cannot be of taxonomic value except for their shape in the different species which form such chambers. Moreover, it may be that only one chamber, peculiarly formed, is used for gathering the spores; or it may be that the whole test is used for this purpose in which case all openings must be closed. Further, it may be that the spore chamber especially forms openings large enough to release the spores.

Such accessory chambers, formed for reproductive purposes, are common in certain groups of Foraminifera. In the Polymorphinidae they are widely known as the "fistulose chambers"; while each normal chamber forms only fine radiate canals at its oral end, the fistulose chambers form much larger openings. In connection with these openings, in fistulose individuals, we find that the walls of all earlier chambers have been pierced by secondary rounded openings which enable the spores to escape into the outer world.

In the *Cymbaloporetta* group the so-called float chamber likewise has a reproductive function so that in one species we find specimens with or without that chamber, those with the float chamber having quite a different appearance.

Specimens of many Peneroplidae (*Amphisorus, Marginopora, Archaias*) at the end of their development may also form large chambers, often irregularly built, in connection with the formation of plasmodiospores.

Bearing all these facts in mind, we may now analyze some of the genera of the globigerines. We readily may assume that very different groups of Foraminifera have given rise to planktonic forms. Surely this has been the case in the *Cassidulina* group. More flattened forms, such as *Cassidulina laevigata* d'Orbigny, are not planktonic; but there are indications that at least some of the forms related to *C. scabra* Brady are, or were, planktonic (thin walls, inflated chambers, globular test). Typical of the whole group of the Cas-



TEXT FIGURES 1-3

Fig. 1, *Cassidulina islandica* Nörvang. Recent. Transverse section, × 160. Contrary to most species of *Cassidulina,* this species has a more hyaline wall and the pores are more scattered. The simple toothplates, running from the border of one foramen towards the next one, are clearly seen. Fig. 2, *Sphaeroidina austriaca* d'Orbigny. Tortonian, Nussdorf, Austria. Transverse section, central part, × 160. The reduced toothplates can be seen distinctly; later chambers lack these toothplates except for an inner (sutural) lip which is the only remaining part. Fig. 3, *Candeina nitida* d'Orbigny. Recent, Caribbean Sea. Transverse section through the initial part, × 160. The strongly reduced toothplates are distinctly found, resembling in shape and position those of *Sphaeroidina* and, thus, forming the last stage in a reduction series from *Cassidulina* through *Sphaeroidina* to *Candeina.* The figure shows that the denial of Bolli, *et al.* (1957, p. 35) of the presence of reduced toothplates in the initial chambers of *Candeina* is not substantiated. The above three forms belong together and have no connection with *Globigerina.* They form another line from a benthonic to planktonic life.

sidulinidae is the biserial arrangement of the chambers; this arrangement together with the simple toothplate reminds us of Cretaceous Bolivininae, such as *Bolivina incrassata* Reuss. In such forms of *Bolivina* the walls show very fine and densely placed pores, are opaque in transmitted light, and the forms possess a primitive toothplate. The coiling and twisting of such a form leads without any difficulty to *Cassidulina.* In *Virgulina* and *Cassidulinoides* the chambers are higher but the twisted biserial arrangement remains; *Cassidulinoides* is nothing but a more globular *Virgulina; Ehrenbergina* shows the biserial arrangement throughout; *Virgulinella* and *Sphaeroidina* begin to show the planktonic features (thin walls, globular or inflated chambers, additional apertures) and the highest specialization in that direction is found in *Pullenoides* and *Candeina.* All these forms show the very fine, densely placed pores, the polished walls, opaque in transmitted light, and, in the first-formed chambers, the remnants of a primitive toothplate (which is denied by Bolli, *et al.* [1957, p. 35] for *Candeina*). These remnants cannot be detected by dissecting the test; one has to make gradational sections, traversing the initial chambers, as have been figured by Hofker (1956a, pl. 11, figs. 21-23; pl. 12, figs. 15-17). These toothplates must not be confused with the thickened lips over the aperture mentioned by Bolli, *et al.* (*loc. cit.*) (*see* text figs. 1-3).

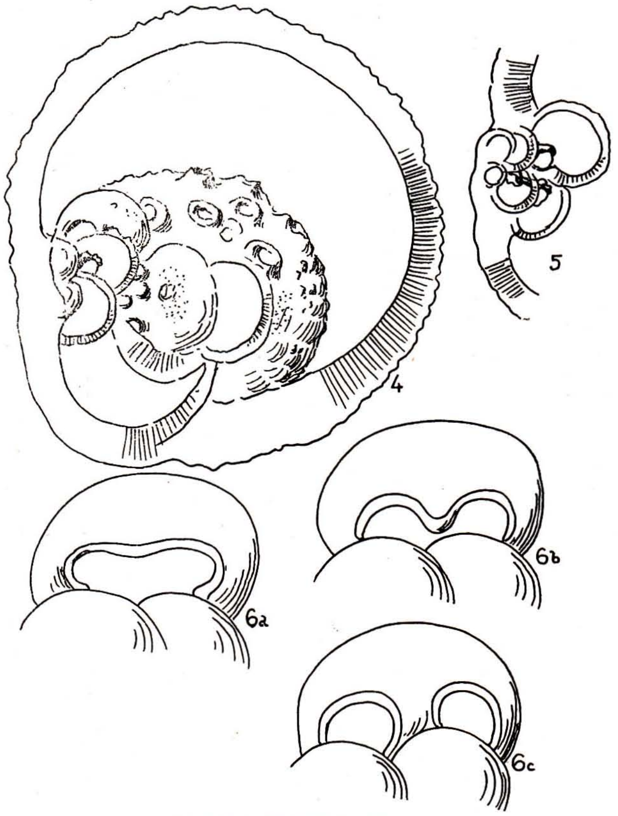
Thus, in a natural taxonomy *Candeina* cannot be included in the Globigerinidae. This is emphasized by the fact that a close examination of the genus reveals that the trochoid initial portion distinctly shows an alternation of chamber placement, each alternating chamber dropping slightly below the ones before and after it, as in *Cassidulina.*

The following genera also have tests with polished walls: *Schackoina, Pulleniatina, Sphaeroidinella,* and *Globigerinatella.*

While in all real globigerines the pores are simple protopores, in *Pulleniatina* they are deuteropores consisting of bundles of protopores radiating from the inner side of the wall (Hofker, 1956a, p. 203); the author believes it to belong to quite a different group of Foraminifera though the only species forming the genus (*sic!*) does not give us any clue to its origin.

The inner structure of *Schackoina* is not known; as far as the author knows most known specimens are casts. The walls show very fine protopores and the relation of the chambers does not suggest any connection with the globigerines and thus not with *"Hantkenina"* either.

Sphaeroidinella must be closely allied to *Pulleniatina;* in both genera the apertures show the structure of a complex aperture consisting of two distinct parts.



TEXT FIGURES 4-6

Figs. 4, 5, *Globigerinatella insueta* Cushman and Stainforth. Oligocene, unit 28, Ecuador. × 160. Fig. 4, partly sectioned test. The initial chambers are not yet reached; one of the chambers following the initial ones shows the reduced toothplate; the other chambers gradually develop sutural secondary openings and finally areal openings situated on short necks. Fig. 5, the same test showing the initial chambers. Next to the proloculus the toothplates are seen clearly; they do not differ from those in *Candeina* and *Sphaeroidina;* in one of the chambers the toothplate can be seen running from the border of the foramen towards that of the next chamber. Fig. 6, schematic figures taken from real specimens of *"Globigerinoides."* In 6a the broadening of the foramen is seen; in 6b the median lip is formed; in 6c the separate parts of the foramen have developed.

Globigerinatella is known by a single species (*sic!*), *G. insueta* Cushman and Stainforth. The author has already given an analysis of this species (Hofker, 1954a, pp. 151, 152) pointing out the polished surface of the test, the densely placed, very fine pores, and the reduced toothplates (whose presence is denied by Bolli, *et al.* [1957, pp. 38, 39]) which are identical to those of *Candeina.* Moreover, the coiling of the initial portion of the test is like that of *Cassidulina.* Therefore, this species belongs in the Cassidulinidae group and not to the Globigerinidae (*see* text figs. 4, 5).

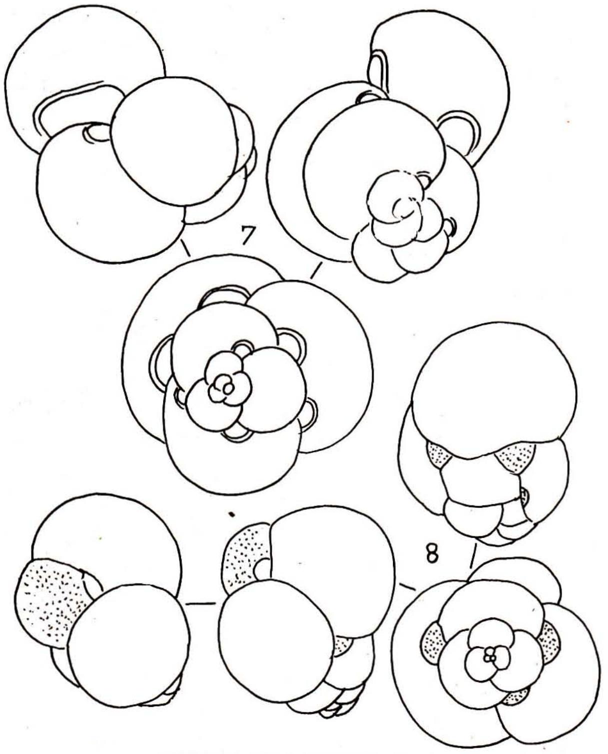
When we review the difficulties of Foraminifera in becoming planktonic forms, we find that in several groups the formation of secondary apertures is evident; we see this in *Pullenoides, Virgulinella, Stichocassidu-*

lina, Candeina, and *Globigerinatella.* This phenomenon may be due to the fact that it is the only way for animals with fine pores to expose Zoochlorellae to the light by transporting them with the streaming protoplasm; a single aperture may be too narrow an opening to expose and withdraw them readily. Moreover, there is the tendency to form globular tests and trochoidal or planispiral tests cannot give rise to a globular development by adding chambers from a single aperture. Again, it has already been suggested that the building of globular tests may endanger metabolism by means of pores alone and thus additional openings may be the only possible remedy.

The author has shown that a planispiral species like *Globigerina* (*Globigerinella*) *aspera* (Ehrenberg) begins its evolutionary life as a trochoidal form and gradually becomes more and more planispiral. In addition, the type of *Globigerinella* distinctly shows trochoidally arranged initial chambers. For this reason it is not clear to him how to justify the generic name *Globigerinella* in a natural system. We can only say that within the genus *Globigerina* more planispirally arranged species also occur. But it is clear that in the case where a species of *Globigerina* has given rise to a form with a more planispiral arrangement of chambers that the next stage of development towards the planktonic life will be the formation of a more globular test. This goal has been reached by Recent *Globigerina aequilateralis* by broadening the chambers together with the broadening of the apertures (Hofker, 1956a, pl. 24, figs. 10-12). But this also can be done by broadening the aperture, forming a lip in the middle of it, thus giving rise to two apertures, and then forming chambers from these two apertures. This procedure has been followed by *Globigerina biforaminata* Hofker, in the end giving rise to true *Biglobigerinella* Lalicker. Where, then, lies the boundary in the evolution of this form; where must we draw the line between *Globigerinella* and *Biglobigerinella*? We find in reality that, at the moment when *Globigerina aspera* reaches the planispiral stage, it begins to form the double aperture; when this double aperture gradationally is established it begins to form, at the very end of its development series, the two chambers of *Biglobigerinella.* Thus, we have to split a single developmental series of one single biological unit into—not three different species—but into three different genera. The absurdity of such taxonomy will be obvious to all biologists. The only solution is to drop these three genera and give them only subspecific rank, giving in the third name our knowledge as to the development of the stage. Thus the author (Hofker, 1956a, 1957) proposed *Globigerina aspera* forma *trochoidea* for the trochoid form in the Cenomanian-Santonian, *G. aspera* forma *subplana* for the upper Santonian form, *G. aspera* forma *plana* for the Maestrichtian form. A division into three different genera is quite impossible.

The same kind of thing is found in the use of the genus *Hastigerinella.* The author (Hofker, 1956a, pl. 34, figs. 1-7) has made a detailed study of a form of *Globigerina digitata* Brady, the more common development of the very rare aberrant form figured by Rhumbler (1911, p. 202, pl. 37, fig. 9) as *Hastigerina digitata.* This form was believed by Rhumbler himself (personal communication) to be in reality a variant (aberrant form) of Brady's species and is, as the author knows, linked by all kinds of intermediate forms with that studied in 1956. It shows the normal features of true *Globigerina* except for the last chambers which protrude at the margin. It may be that such chambers, as in *Hastigerina,* belong to the floating system of the species or they may be reproductive chambers, but there is no reason at all for separating this form (the only species of the genus) into a different genus. The second name, *digitata,* adequately fulfills the purpose of distinguishing the species from all other globigerines. It even may be that the species is nothing but a more planktonic stage of another species. One could as logically form a new genus for the more exaggerated forms of *Globigerina sacculifera* Brady!

Now that we know the real status of biforaminate forms of *Globigerina aspera* (*Biglobigerinella*) we can analyze the status of biforaminate forms in another group of *Globigerina,* viz. *Globigerinoides.* For here also we are dealing in reality with a biforaminate group. When studying large sets of a single species of so-called *Globigerinoides,* even of the type species *G. rubra* d'Orbigny, we find that young tests, especially, do not show the so-called secondary sutural openings. We observe in young tests and in section in the initial chambers one single aperture which opens into the umbilical region; this aperture in later chambers begins to form a lip in the central portion which finally reaches the wall of a former chamber, thus giving rise to two separate apertural openings. Since, however, the arrangement of the chambers in the later coils of these tests becomes twisted, the opening nearer to the umbilical cavity remains open there, whereas the other part of the aperture may be closed by the adjacent wall or may, perhaps, remain open at its spiral suture either totally or in part. But why create a separate genus for such forms? We can show that the forms from the middle Oligocene, which in the end lead to typical *Globigerina rubra,* have a simple aperture and consequently no secondary openings; then, at the end of the Oligocene, this phenomenon of apertural broadening and formation of a central lip occurs and gradually the sutural openings are seen. It is certain that in several other evolutionary series of species



TEXT FIGURES 7, 8

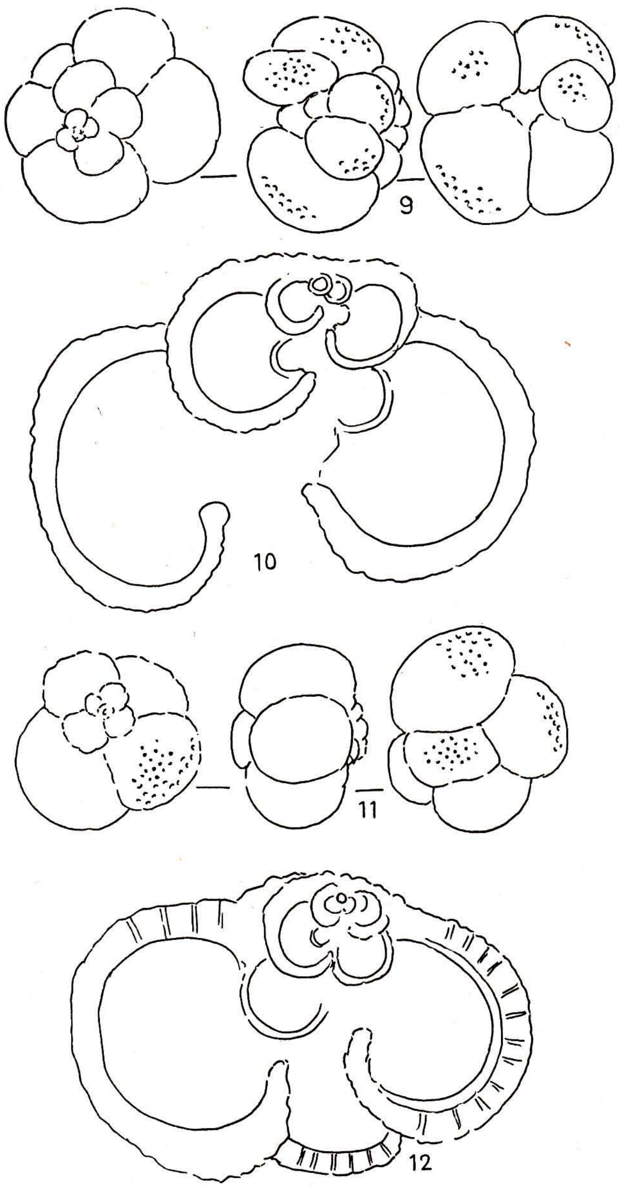
Fig. 7, *"Globigerinoides" rubra* (d'Orbigny). Recent, off Frederiksted, Virgin Ids., Caribbean, depth 500 fms., × 27. Normal specimen from three sides. Fig. 8, *Globigerina rubra* (d'Orbigny). Same locality and sample, × 27. In this individual, seen also from three sides, a closing porous plate having fine pores is formed over the umbilical cavity, formed over the umbilical cavity having fine pores, whereas the pores of the chamber walls are much coarser. Moreover, all so-called secondary sutural openings are closed likewise by porous plates of similar structure. It is typical that specimens with closed openings always have a smaller proloculus than the individuals with wide open apertures. Both specimens figured here (figs. 7, 8) show the rose color of the walls. That of fig. 8, obviously preparing sporulation and, therefore, closing its large openings, must be placed in Brönnimann's *Globigerinoita,* which genus thus has no real taxonomic basis.

quite a similar development took place, giving rise in different parts of the Tertiary to such secondary sutural openings. In gathering these into a single genus, the genus would not only become a polyphyletic one (and a polyphyletic genus is not a valid one), but also quite different stages of such a development would be enclosed in quite different genera! Such a procedure cannot lead to a natural system and must be abandoned as soon as possible. When we wish to show the occurrence of secondary openings (due to planktonic life) in a development, we can easily express it in a name: *Globigerina rubra primitiva* without openings; *Globigerina rubra foraminata* for the form with sutural openings. But the creation of a genus for these developmental stages which show sutural openings must lead to absurdity (*see* text figs. 6, 7).

The closing of apertural or toothplate openings by porous plates is a widespread phenomenon among Foraminifera. When this closing occurs in all specimens of a species, and also in all specimens of closely allied species, it may give rise to a generic characteristic and thus the creation of a genus is correct. In this way the genus *Reinholdella,* which includes all those conorboid species with closed protopores, is a correct genus; the closing of toothplate openings in *Pseudobulimina* has been fully analyzed by the author (1951) as well as that in *Robertinoides* (1956a) where both protoforamina and toothplate foramina are closed by porous plates. In all the genera allied to *Asterigerina* the protoforamen (or complicated foramen) is closed by a porous plate in the older chambers thus giving rise to the so-called supplementary chamberlets. But in all these cases all the individuals of a species have these plates, thus giving rise to a distinct generic feature.

In some forms of the Globigerinidae also, closing plates are found; they all show pores. When a larger umbilical hollow is found a closing plate may cover the whole cavity, since the closing of a single foramen would be useless. In the case of multiple openings, older openings may be closed when they are situated at the dorsal sutures. However, in all these cases these closing plates are not found in all individuals of a species but only in some of them, often only in some adult specimens while others of the same species in the same sample lack them. This seems to have been overlooked by authors, resulting in a completely absurd taxonomy. We will now try to prove this thesis.

Catapsydrax.—The type species is *Globigerina dissimilis* Cushman and Bermudez. It is found in the upper Eocene and lower Oligocene all over the world. When we analyze a sample in which many specimens of this species with covering central ventral plates are found, we find that they always occur with many more specimens of *Globigerina venezuelana* Hedberg. But the reverse is not always true; there are zones where *G. venezuelana* is abundant where *G. dissimilis* is not found. When we dissect specimens of the latter we find that the only difference between the two species is the closing plate. Usually this plate shows somewhat smaller pores than the surrounding ventral sides of the chambers. This is easily understood since the covering plate has no secondary thickening of the wall whereas the older chambers do, thus getting wider pores at the surface since these pores widen towards the surface. Now we know that in many species of Foraminifera certain modes of reproduction are reached during a given period of the evolutionary series of the species. Hofker (1957) discovered several of these changing modes of reproduction during geologic time. Therefore, we come to the conclusion that the type species of *Catapsydrax* is no more than a reproduc-



TEXT FIGURES 9-12

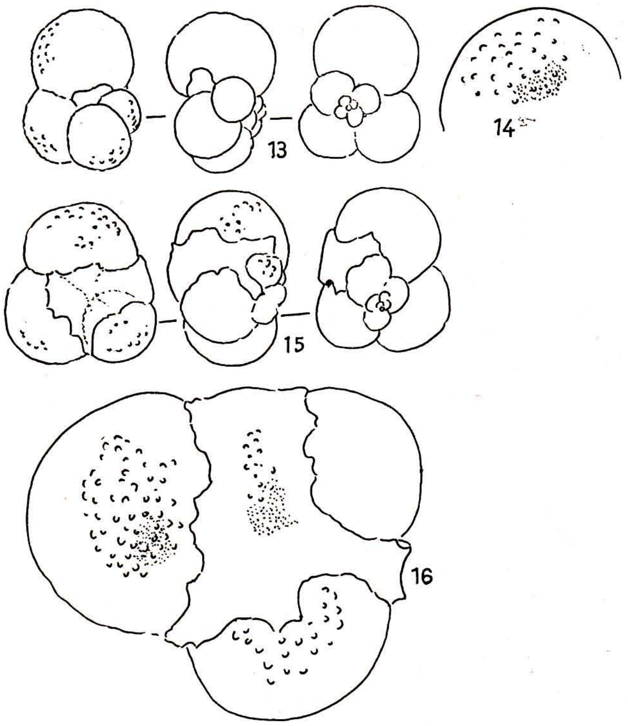
Figs. 9, 10, *Globigerina venezuelana* Hedberg. Oligocene, Cipero Marl, Trinidad. Fig. 9, specimen from three sides, showing the small last-formed chamber typical of the species, × 57. Fig. 10, transverse section through the individual shown in fig. 9, showing the proloculus and the large septal foramina connected with the umbilical openings, × 160.

Fig. 11, *Globigerina venezuelana* Hedberg, now in the form known as *Globigerina dissimilis* Cushman and Bermudez. Same sample. This form is the type species of *Catapsydrax* Bolli, Loeblich and Tappan, × 57.

Fig. 12, *Globigerina venezuelana* forma *dissimilis*. Transverse section showing all the structures of *G. venezuelana,* except for a much smaller proloculus and the chamber closing the umbilical hollow. Even the more detailed structure of the walls, pore index 4-2.5, is identical. Obviously this form is merely the sporulating *G. venezuelana.* Thus, the genus *Catapsydrax* has no taxonomic value. × 160.

tionary development stage of *Globigerina venezuelana.* Another form mentioned by Bolli (1957, p. 116), *Catapsydrax stainforthi* Bolli, Loeblich and Tappan, from the Cipero Marl of Trinidad, also could be analyzed by the author. In the samples containing this species a quite similar species was found shaped like small specimens of *Globigerina venezuelana* or of *G. juvenilis* Bolli, which showed all the characteristics of *Catapsydrax stainforthi* except for the closing plate. Here again these forms are more common than the ones with the closing plates. Thus, even in another "species" of *Catapsydrax* we find exactly the same data as were found in the type species. We must conclude that *Catapsydrax* has no value as a genus, but has been created on the basis of certain reproduction stages of other normal globigerines (*see* text figs. 9-12).

Globigerinita.—The type species, *Globigerinita naparimaensis* Brönnimann, is common in many deep-sea



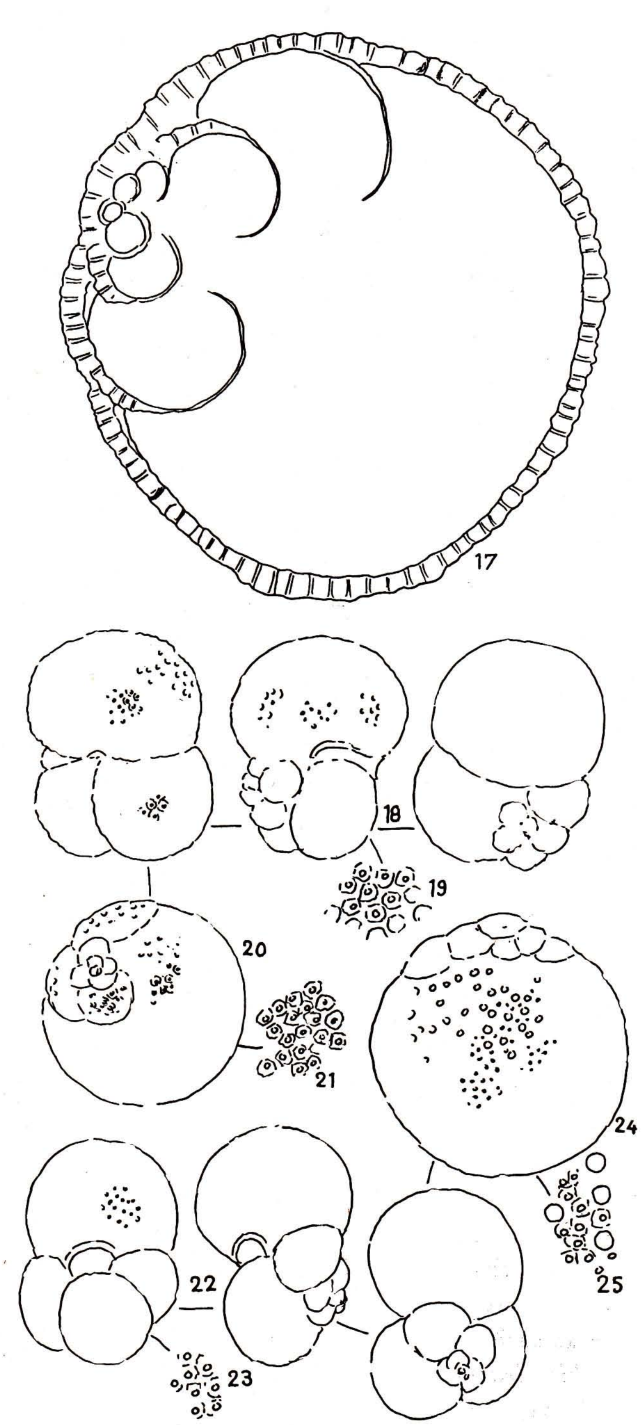
TEXT FIGURES 13-16

Figs. 13, 14, *Globigerina* cf. *G. bulloides* d'Orbigny. From 1200 m., south of Sumatra, sample Telegraaf No. 47. Fig. 13, from three sides, × 57. Fig. 14, last-formed chamber enlarged further, × 160. Pore index 40-0.1, with fine pustules between, typical of *G. bulloides.*

Figs. 15, 16, *"Globigerinita" naparimaenis* Brönnimann. Same sample. Fig. 15, from three different sides, × 57. Fig. 16, × 160. A similar specimen was the type species for Brönnimann's *Globigerinita* with its irregular closing plate with small openings at the border. We find that not only are specimens like those figured in figs. 13 and 15 very common in one sample, but also that both show the typical features of *G. bulloides* and quite the same wall structure (in *"Globigerinita"* also the pore index is 40-0.1 with fine pustules). The only difference between the two forms is the covering plate and the fact that the individuals with this plate show a smaller proloculus. Obviously *Globigerinita* is the sporulation stage of *Globigerina* cf. *G. bulloides,* and as such has no taxonomic meaning.

samples, especially in the Pacific Ocean. The author found it in sample Telegraaf 47 where it was extremely common (*see* Hofker, 1951.) Together with many specimens having a closing ventral plate, a multitude of specimens was found having all the typical characteristics of the species (very fine pores, pore index 40-0.1; fine knobs between the pores; a large foramen opening at the ventral umbilicus, etc.) but lacking the covering plate. These specimens without the plate certainly belong to the same species, but they were not in that stage of reproduction which made the covering plate necessary. The difference between this plate and that of so-called *Catapsydrax* is that in this species the covering plate extends over the neighboring sutural openings and has many irrregular foramina. This difference can be explained easily by the fact that in *Globigerina venezuelana* the pores are rather coarse whereas in this species they are very fine. The species itself seems to belong to the *Globigerina bulloides* group, which also shows fine pores. The fine pores in the plate make it necessary to have small openings to permit the passage of the spores (*see* text figs. 13-16).

Globigerinoita.—From the Miocene to Recent we find many forms which belong to the so-called "*Globigerinoides*" *rubra* group. They show, as already stated, openings along the dorsal spiral suture, just where the septal sutures reach the spiral one; this place is obvious since it coincides with the more dorsal position of one of the two apertures formed by the double aperture. Among many normal specimens of *Globigerina* (*Globigerinoides*) *rubra* from off Frederiksted (Santa Cruz, West Indies) the author detected several not differing at all from the normal specimens (pore index 4.5-1.5; short spines between the pores; rose coloring of the test) which showed a bullate chamber covering the so-called supplementary openings. These



TEXT FIGURES 17-25

Fig. 17, *Candorbulina* sp. Oligocene of Ecuador, Unit 26. Transverse section, × 160. Contrary to the groups in which covering plates are found, here the plate is much larger, forming a globular test having a wall which contains not only the smaller pores but larger rounded openings for the issue of the spores. In this group of forms the former walls of chambers are partly resorbed, as can be distinctly seen in our figure.

Figs. 18, 19, *Globigerina* (*Globigerinoides*) *triloba* Reuss. Oligocene of Ecuador, Unit 23. Fig. 18, from three sides, × 57. Fig. 19, same specimen, structure of wall, × 160. The pore index is 4-2. The species is very common in the sample.

Figs. 20, 21, *Candorbulina*-form of *Globigerina triloba* Reuss. Same sample as figs. 18, 19. This *Candorbulina* does not show larger openings in the globular last-formed chambers. Fig. 20, × 57. Fig. 21, same specimen as fig. 20, structure of wall, × 160. The pore index is 4-2.

Figs. 22, 23, *Globigerina ampliapertura* Bolli, Upper Oligocene of Ecuador, Unit 39. It is very common in the sample. Fig. 22, from three sides, × 57. Fig. 23, same specimen as that shown in fig. 22, wall structure, × 160; pore index 3-2.

Figs. 24, 25, *Candorbulina*-form of *Globigerina ampliapertura*. Upper Oligocene of Ecuador, Unit 39. Figs. 24, × 57. This form shows a multitude of larger round openings in the globular chamber, all near the dorsal side; between these openings the normal pores are found. Fig. 25, same specimen as in fig. 24, wall structure, × 160. When we omit the larger openings used for the issue of spores, the pore index is 3-2, similar to that of the normal form.

It is typical that in all specimens of *Candorbulina* and *Orbulina* studied the proloculus is smaller than that in the average of the species to which it seems to belong, also found in the same sample. In all cases it was found that the normal *Globigerina*-form was of the type of *G. bulloides*.

plates all have very fine pores and, therefore, the larger umbilical covering plate shows some small rounded openings. This description fully agrees with that given by Brönnimann (1952) for his genus. So now we know that the type species of the genus, *Globigerinoita morugaensis* Brönnimann, is merely *Globigerina* (*Globigerinoides*) *rubra* in its reproductive stage (*see* text fig. 8).

When analyzing many forms of *Orbulina* and *Candorbulina* (*Candorbulina* and *Biorbulina* are considered by Bolli, *et al.* (1957, p. 35) as synonyms of *Orbulina*) the author found that in all cases observed, Recent as well as fossil, these globular forms always occur with globigerines having the same test features, especially of the structure of the outer wall (pore indices and pustulation), except that in many forms larger rounded openings are found which may have a function in sporulation or with the exposure of Zoochlorellae to the light. Whether these globular forms, in which a globigerine stage can be detected having typically resorbed inner walls (*see* text fig. 17), develop as a floating device or as a reproductive stage of the species is not yet certain. The resorption of the inner walls may point to sporulation since in many forms whose reproductive cycle is known the inner walls are resorbed for this purpose, so that a single cavity is formed. Geologists will observe that orbulinid forms appear for the first time in the Oligocene but we must recapitulate that also the forms with thick walls and the *venezuelana* type appear for the first time in that period. The author (Hofker, 1954b, pp. 38, 39) has given a short note on the occurrence of species of *Globigerina* together with orbulinid forms. Not only are different species of Orbulina found in the different geological horizons but also in the Recent; it may be that all these species are reproductive stages of as many different species of *Globigerina* (*see* text figs. 18-25).

CONCLUSIONS

Candeina, Pulleniatina, Sphaeroidinella and *Globigerinatella* belong to groups differing greatly from the Globigerinidae.

Globigerinella cannot be separated as a genus from *Globigerina.*

Biglobigerinella is a *Globigerinella* which tries to become more globular; it cannot be separated from *Globigerina.*

Hastigerinella should not be separated from *Globigerina.*

Globigerinoides for the same reason as in *Biglobigerinella* cannot be separated from *Globigerina.*

Catapsydrax is merely a group of reproductive stages of other species of *Globigerina;* it has no generic value whatever.

Globigerinita is the reproductive stage of globigerines having fine pores; the genus has no taxonomic value.

Globigerinoita is the reproductive stage of the *Globigerina rubra* group; it has no taxonomic value.

Orbulina and its allies are reproductive stages of other globigerines; as a genus it has no value.

The other new genera proposed by Bolli, *et al.* (1957) should be restudied in respect to their internal structure and to the species with which they occur. This is also true of other genera: *Globoquadrina* Finlay as emended by Bolli, *et al.* (1957, p. 31) also includes all the forms related to *Globigerina cretacea* d'Orbigny. It would be necessary to study the development of these Tertiary species and to see whether or not they are phylogenetically related to that Cretaceous form. Moreover, the author has shown (1956 b) that *Rugoglobigerina* is merely a somewhat developed *Globigerina cretacea* having very well-developed tena which, however, do not fuse into a single plate covering the umbilical cavity; sections reveal that the tena of the adjacent chambers cover each other closely. Since in this way the opening for the extrusion of protoplasm was nearly closed, some wider openings had to remain, hence the so-called secondary openings at these tena. There is no reason whatever to place these forms, at least the type species *Globigerina rugosa* Plummer, in the Globotruncanidae as has been done by Gandolfi (1955) and Bolli, *et al.* (1957).

Globigerapsis Bolli, Loeblich and Tappan should be restudied, since only the outer characteristics are given.

Porticulasphaera Bolli, Loeblich and Tappan certainly belongs to the *Candeina* group; it may be the ancestor of true *Candeina nitida* but only a study of the initial chambers can solve this question. Since only one species has been referred to this genus its value as such is questionable.

Globigerinatheka Brönnimann is certainly some reproductive stage of another form; the study of samples in which it occurs will reveal other specimens without the cover plates.

So, the general conclusion is that there exists only a singue genus of planktonic globigerine species: *Globigerina.* There are some other forms, such as *Hantkenina* (of which *Cribrohantkenina* may be the reproductive stage having a cribrate covering plate) which may be separated from the main group; a study of the more detailed structure, however, showed that it must be very closely allied to the more planispiral types of *Globigerina.*

Splitting the genus *Globigerina* into many genera, which certainly have no generic meaning, confuses our knowledge of this important group of Foraminifera. This splitting, as proposed by Bolli, *et al.* (1957), will lead not only to confusion but also to the danger that later investigators will forget the possibility of the occurrence of reproductive stages in *Globigerina,* and, in addition, the relationships in this group. The author believes that the only way to get to the bottom of the problem of the taxonomy of the globigerines is by the study of the internal structures, of pore dimensions, and the apertural characteristics; the latter have not been considered by Bolli, *et al.* (1957) since they, together with several other authors, in many instances have been misled by accessorial structures which have to do with the life cycle of these planktonic forms.

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192. *ASTEROCYCLINA* FROM A PACIFIC SEAMOUNT*

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ABSTRACT

Specimens of **Asterocyclina** found in "boulders" dredged from the side of a seamount near the Tuamotu Islands, French Oceania, are described and illustrated. One suite of specimens is assigned to **Asterocyclina penuria** Cole, known previously from New Caledonia, Soemba, Saipan Island, Guam Island and the Eniwetok drill holes in the upper Eocene, Tertiary **b.** Associated specimens of **Asterocyclina** are described as a new species. No other larger Foraminifera were recovered from these sediments.

INTRODUCTION

Recently, M. N. Bramlette of Scripps Institution of Oceanography at La Jolla, California, sent me fragments of three separate "boulders" which were obtained on the Scripps Institution of Oceanography Downwind Expedition of 1958 from the Baird dredge haul No. 4 at latitude 16° 47′ south, longitude 146° 15′ west. He had recognized that these fragments contained larger Foraminifera which belonged to a genus which is restricted to the Eocene.

These fragments were obtained at a depth of 980 meters (3,215 feet) on the side of a seamount which occurs on the southwest flank of the rise on which the Tuamotu Archipelago, French Oceania, is situated. The top of this seamount is 380 fathoms (2,280 feet) below sea-level. Thus, the samples were obtained approximately 1,035 feet below the summit of the seamount.

The fragments were coated heavily with manganese oxide. Each had an approximate diameter of four inches and the surfaces had large shallow pits. Two of the fragments were composed of soft, porous limestone whereas the third fragment had zones of dense, white limestone embedded in soft, porous limestone. All the fragments on broken surfaces showed abundant accidental sections as well as external views of larger Foraminifera.

The two fragments which were composed of the soft limestone were soaked in water for a few hours after which it was possible to disintegrate them completely. The other fragment was sawed into several pieces so that the surfaces thus produced could be studied by reflected light.

Several hundred matrix-free specimens were obtained from the two fragments which were disintegrated. The polished surfaces of the third fragment demonstrated that it contained an equally prolific fauna. Although it had been expected that several genera of larger Foraminifera would be present, all of the specimens represented only the genus *Asterocyclina.*

The matrix-free specimens were perfectly preserved externally and internally. As the internal cavities of the specimens were air-filled, it was difficult to section them without destroying the internal structures. Therefore, the specimens had to be impregnated during grinding to fill the cavities, and thus, strengthen the chamber walls.

Although the specimens were extremely diversified externally, it was possible to divide them into groups. Representative specimens of each group were sectioned and studied. Finally, on the basis of internal structure two species were recognized, one of which seemingly is the same as *Asterocyclina penuria* Cole. The other species so far as could be ascertained is new.

A. penuria had been reported previously from New Caledonia (Deprat, 1905, p. 507), Soemba (Caudri, 1934, p. 97), Saipan Island (Cole, 1957, p. 350), the

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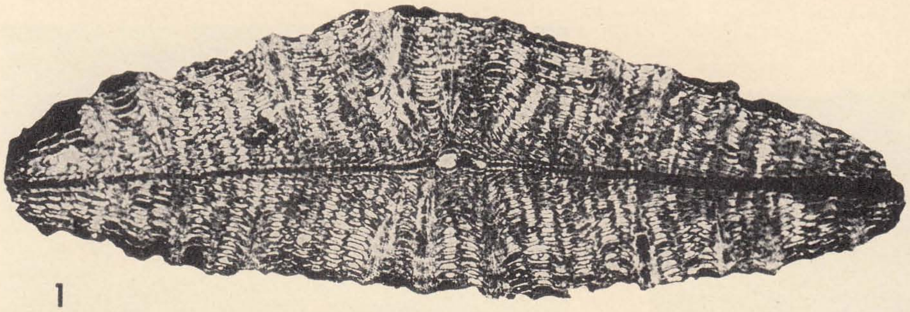
* The cost of the printed plates was supplied by the William F. E. Gurley Foundation for paleontology of Cornell University.

EXPLANATION OF PLATE 1

FIGS.		PAGE
1-4, 6-11.	*Asterocyclina penuria* Cole	12
1-4.	Vertical sections; 1, 3, 4, × 20; 2, × 40; 1, section from a specimen similar to fig 8; 2, section of a small specimen; 3, enlargement of part of the specimen illustrated as fig. 1, pl. 3 and made from a specimen similar to fig. 7; 4, enlargement of part of the specimen illustrated as fig. 2, pl. 3 and made from a specimen similar to fig. 9.	
6-11.	External views, × 8, to illustrate variable shape, number of rays and papillae.	
5.	*Asterocyclina elongaticamera* Cole, n. sp.	11
	Part of the equatorial section, × 230, illustrated as fig. 12, pl. 3 to show the embryonic and periembryonic chambers.	

All the specimens are from the locality described in the text.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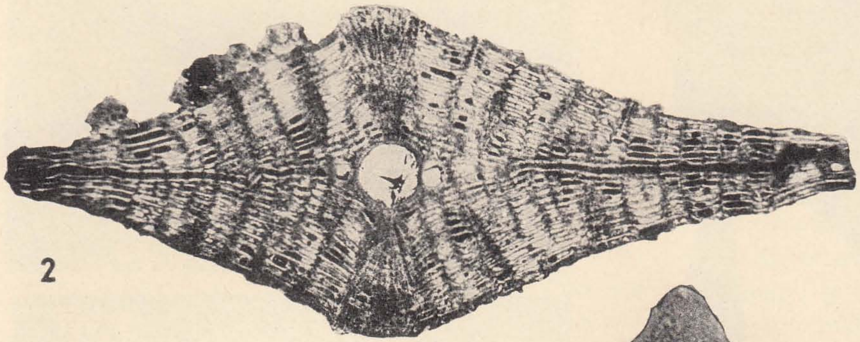
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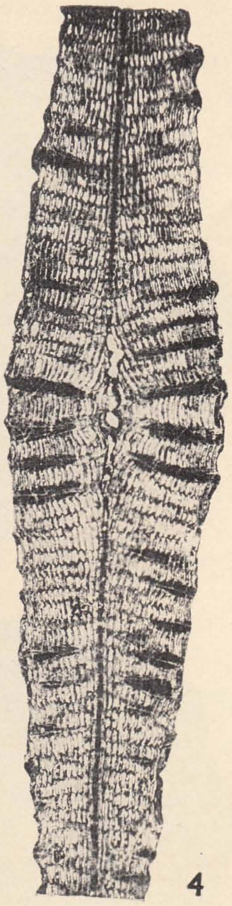
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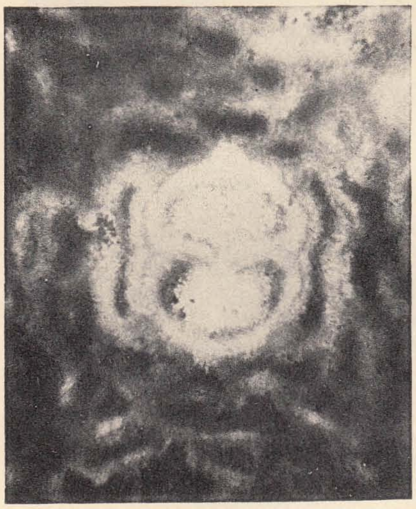
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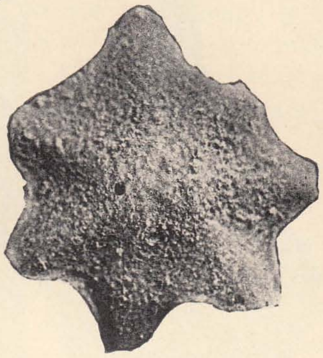
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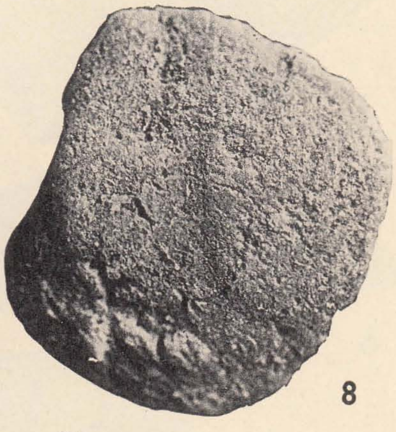
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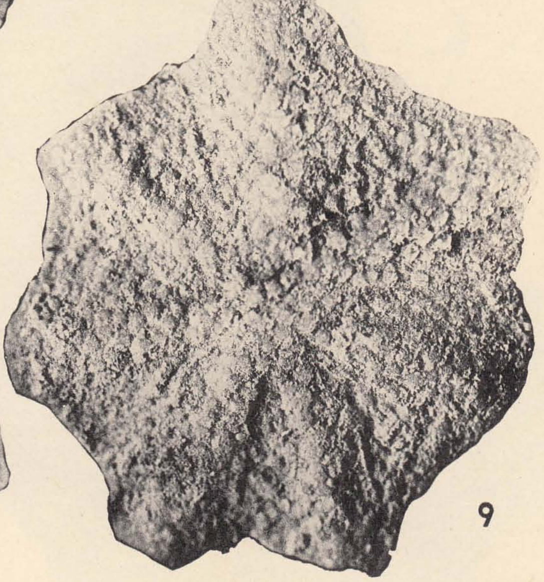
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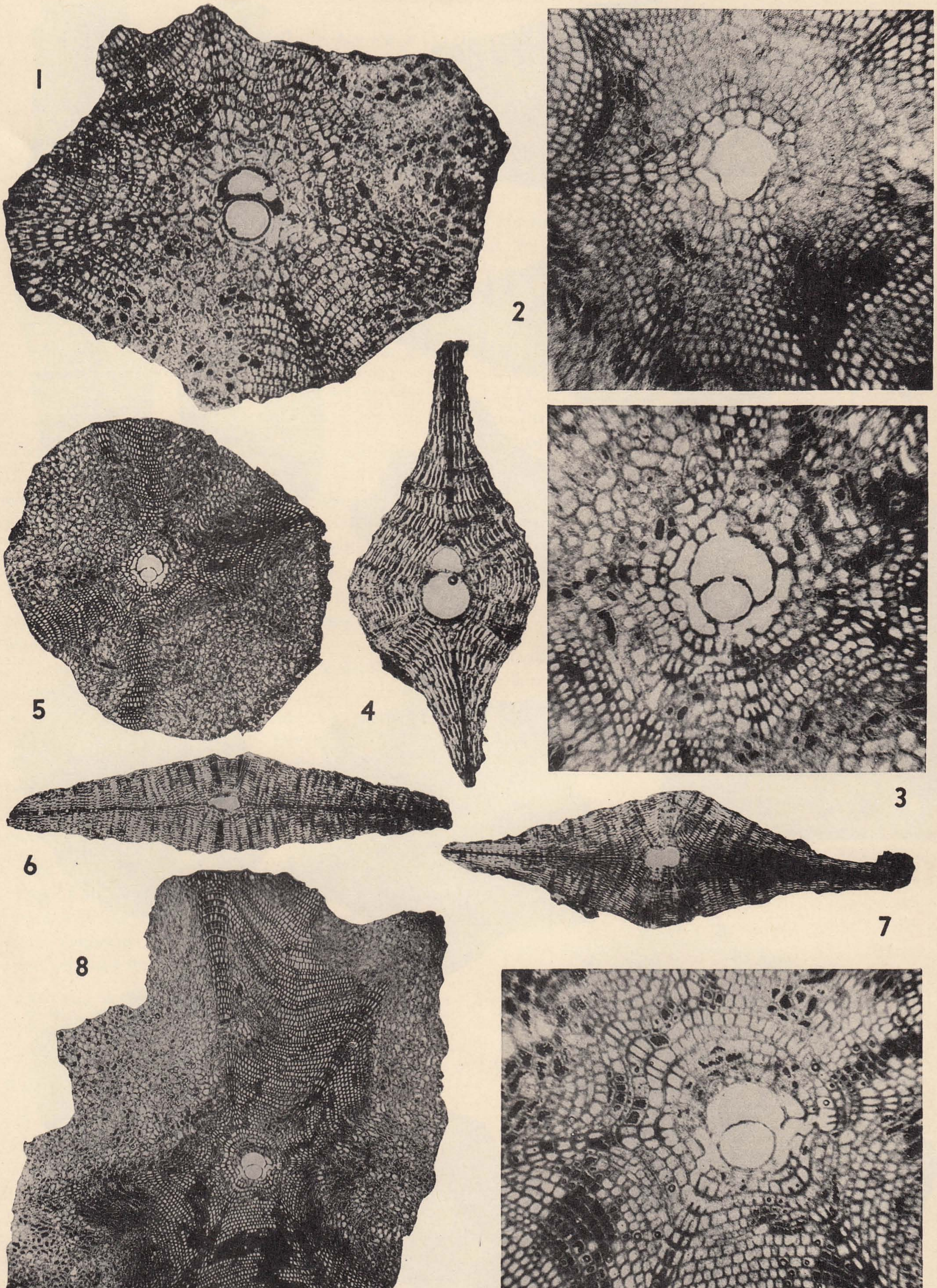
Cole: *Asterocyclina* from a Pacific Seamount



Cole: *Asterocyclina* from a Pacific Seamount

Eniwetok drill holes (Cole, 1958, p. 778) and Guam Island (Cole, unpublished mss.). At all these localities this species is associated with other genera and species of larger Foraminifera which characterize the upper Eocene, Tertiary *b*, of the Indo-Pacific region. Therefore, these samples are assigned to this age.

Insofar as could be determined this is the first record of upper Eocene determined on the basis of larger Foraminifera from samples dredged at such depths in the Pacific. However, Hamilton (1953) has determined by smaller Foraminifera the occurrence of Upper Cretaceous, upper Paleocene and lower-middle Eocene sediments on other mid-Pacific seamounts.

Although Wiseman (1936, p. 441) reported the presence of an "orbitoid foraminiferan" in a sample dredged from a depth of 744 fathoms near Providence Reef in the Indian Ocean, he did not identify the specimen. The illustration which he gave is a drawing which suggests that the specimen may be a *Miogypsinoides* similar to *M. dehaartii* van der Vlerk. If this interpretation is correct, the age of the material would be Tertiary *e*.

In the Eniwetok drill hole F-1 *Asterocyclina penuria* occurred in five cores taken between 3,963 and 4,553 feet below sea-level. Elsewhere, it was found in samples taken from outcrops above sea-level.

It is generally agreed that larger Foraminifera of the kind represented by *Asterocyclina* lived at comparatively shallow depths. Recently, Cole (1958, p. 751) has estimated that similar sediments to those under discussion would accumulate at depths between 25-40 fathoms.

The specimens are deposited temporarily in the Cole collection and eventually will be transferred to the U. S. National Museum.

DESCRIPTION OF SPECIES

Family DISCOCYCLINIDAE

Genus **Asterocyclina** Gümbel, 1870

Asterocyclina elongaticamera Cole, n. sp.

Plate 1, figure 5; plate 3, figures 5-14

The test is small with diameters from about 1.7 to 2.0 mm. and a thickness at the center of 0.7 to 0.95 mm. The central area is umbonate with a group of 4 to 7 strongly projecting papillae which have diameters of 100 to 150 μ. The umbonate area is surrounded by a flange across which are 5 to 7 rays which merge into the central area on their proximal ends and which form bluntly rounded projections on their distal ends. The rays and interray areas are covered by small, slightly elevated papillae with diameters of about 40 μ. Measurements of the specimens which illustrate the external appearance, figures 9-11, plate 3, are given in Table 1.

TABLE 1

Measurements and surface features of entire specimens of *Asterocyclina elongaticamera*

Specimen	Pl. 3, fig. 9	Pl. 3, fig. 10	Pl. 3, fig. 11
Maximum diameter .. mm.	2.05	1.85	1.9
Diameter of umbo .... mm.	1.0	0.9	0.8
Number of large umbonal pillars	7	7	4
Number of rays	6	5	7
Prominence of rays	Moderate	Low	Strong

The embryonic chambers are small, bilocular and nearly equal. There are 2 large, prominent periembryonic chambers, one on each side of the embryonic chambers located at each end of the dividing wall between the embryonic chambers. These are shown by figure 5, plate 1 and figure 14, plate 3. In this last figure the dividing wall between the embryonic chambers is not shown clearly although its position is indicated by the median contraction between the two embryonic chambers. Measurements of the embryonic chambers and other details of the equatorial sections are given in Table 2.

TABLE 2

Measurements of equatorial sections of *Asterocyclina elongaticamera*

Specimen		Pl. 3 fig. 12	Pl. 3, fig. 13
Diameter	mm.	1.85	1.75
Embryonic chambers:			
Diameters of initial chamber	μ	25 x 40	25 x 40
Diameters of second chamber	μ	25 x 40	25 x 40
Distance across both chambers ..	μ	60	60
Thickness of outer wall	μ	10	10
Equatorial chambers:			
Radial diameter	μ	20 - 30	20 - 30
Tangential diameter	μ	15	15

Measurements of vertical sections are given in Table 3.

EXPLANATION OF PLATE 2

Figs.		Page
1-9.	*Asterocyclina penuria* Cole	12

1. Equatorial section, × 40, of a specimen similar to fig 4.
2, 3, 9. Parts of equatorial sections, × 40, to illustrate the embryonic and periembryonic chambers; 3, part of fig. 5; 9, part of fig. 8.
4, 6, 7. Vertical sections; 4, × 40; 6, × 12.5; 7, × 20.
5, 8. Equatorial sections, × 12.5

TABLE 3
Measurements of vertical sections of
Asterocyclina elongaticamera

Specimen		Pl. 3, fig. 8	Pl. 3, fig. 6	Pl. 3, fig. 7
Diameter	mm.	1.95	1.6	1.8
Thickness	mm.	0.8	0.95	0.7
Diameter of umbo	mm.	0.8	0.9	0.9
Thickness of flange near umbo	mm.	0.5	0.4	0.25
Width of flange	mm.	0.7	0.55	0.8
Embryonic chambers:				
Length	μ	60	70	40
Height	μ	30	30	30
Equatorial layer*:				
Height at center	μ	25	30	30
Height at periphery	μ	50	30	80
Lateral chambers:				
Number		15	15	15
Length	μ	200	170	150-200
Height	μ	10-20	20	10-20
Thickness of floors and roofs	μ	10	10	10
Surface diameter of pillars	μ	70-100	110	70-100

* Includes thickness of floor and roof.

The lateral chambers are more or less arranged in regular tiers where they occur between pillars, but elsewhere they tend to overlap. The chamber walls and floors are thin and normally concave. The chamber cavities are moderately high and open.

Well oriented vertical sections have 4 prominent umbonal pillars which radiate inward toward the embryonic chambers. Smaller pillars are scattered irregularly throughout the remainder of the sections.

Discussion.—Although the embryonic chambers are similar to those of *A. centripilaris* Cole (1958, p. 775), the vertical sections are entirely different. There is only one centrally located pillar on each side of the embryonic apparatus in *A. centripilaris* and the floors and roofs of the lateral chambers are straight.

Asterocyclina penuria Cole

Plate 1, figures 1-4, 6-11; plate 2, figures 1-9;
plate 3, figures 1-4

1957. *Asterocyclina penuria* Cole, U. S. Geol. Survey Prof. Paper 280-I, p. 350, 351, pl. 116, figs. 1-10.

1958. *Asterocyclina penuria* Cole. Cole, *idem,* 260-V, p. 778-780, pl. 246, figs. 1-11; pl. 247, figs. 1-15; pl. 248, figs. 8, 12-17.

The test has a diameter from 1.5 to over 8.0 mm. and a thickness at the center of 0.7 to 1.4 mm. Small specimens typically have a small umbo surrounded by a thin flange. These specimens either do not have rays or the rays are weakly developed and the outline of the test is circular. Certain larger specimens (fig. 8, pl. 1) also are without rays or have poorly developed rays. Most of the larger specimens have a small, low umbo which may be distinct (fig. 10, pl. 1) or which may be indistinct (figs. 6, 7, 9, 11, pl. 1). These specimens have numerous rays which usually project as bluntly rounded prolongations beyond the interray areas. Some specimens have the surface entirely covered by coarse papillae (fig. 9, pl. 1) whereas others (fig. 11, pl. 1) have umbonal papillae and a few scattered papillae along the axis of the rays. The interray areas are without papillae.

Measurements of equatorial sections are given in Table 4.

The embryonic chambers are large, bilocular with the second chamber slightly embracing the initial chamber. These chambers are surrounded completely by a distinct ring of periembryonic chambers. This ring is composed of two distinct kinds of chambers as the initial embryonic chamber is bordered by two, narrow, elongate periembryonic chambers (figs. 2, 3, 9, pl. 2), whereas the second embryonic chamber is bounded by numerous, nearly square periembryonic chambers.

Measurements of vertical sections are given for convenience in Tables 5 and 6, the first of which represents the smaller specimens and the second the larger specimens.

The lateral chambers are arranged in regular tiers. The floors and roofs of these chambers are straight and the chambers are low, but open. The development of pillars is extremely variable. Some sections (fig. 2, pl. 1) have only one central pillar, whereas other sec-

TABLE 4
Measurements of equatorial sections of *Asterocyclina penuria*

Specimen		Pl. 2, fig. 1	Pl. 2, figs. 8, 9	Pl. 2, figs. 3, 5	Pl. 2, fig. 2
Diameter	mm.	1.9	7.55	3.9	6.2
Embryonic chambers:					
Diameters of initial chamber	μ	140 x 160	150 x 190	150 x 180	—
Diameters of second chamber	μ	100 x 250	120 x 280	140 x 290	—
Distance across both chambers	μ	260	290	310	260
Thickness of outer wall	μ	20	10	20	10

TABLE 5

Measurements of vertical sections of small specimens of *Asterocyclina penuria*

Specimen		Pl. 2, fig. 4	Not illustrated	Pl. 1, fig. 2	Pl. 3, fig. 3	Pl. 2, fig. 7	Pl. 3, fig. 4
Diameter	mm.	1.65	1.9	2.1	2.6	3.5	3.65
Thickness	mm.	0.7	1.1	0.85	1.35	1.1	1.0
Diameter of umbo	mm.	0.85	1.1	1.2	1.8	1.8	1.7
Embryonic chambers:							
Length	μ	250	240	210	—	230	90
Height	μ	160	120	150	—	130	150
Equatorial layer*:							
Height at center	μ	50	30	40	40	40	40
Height at periphery	μ	30	40	40	60	40	80
Lateral chambers:							
Number		11	23	15	27	20	22
Length	μ	80	60-100	90-110	70-140	150	50-80
Height	μ	10	10	10	10-20	5	5
Thickness of floors and roofs	μ	10	8	5	10	10	10
Surface diameter of pillars	μ	100-140	70-120	200	100-160	150-200	50-150

* Includes thickness of floor and roof.

TABLE 6

Measurements of vertical sections of large specimens of *Asterocyclina penuria*

Specimen		Pl. 3, fig. 2	Pl. 2, fig. 6	Pl. 3, fig. 1	Pl. 1, fig. 1
Diameter	mm.	6.4	5.25	6.4	4.53
Thickness	mm.	1.15	1.2	1.1	1.4
Diameter of umbo	mm.	1.6	1.9	1.8	1.2
Embryonic chambers:					
Length	μ	230	270	230	200
Height	μ	90	120	130	90
Equatorial layer*:					
Height at center	μ	50	60	50	50
Height at periphery	μ	70	90	140	140
Lateral chambers:					
Number		17	16	15	15
Length	μ	80-150	50-100	100-160	100-150
Height	μ	10-20	10	10	15-30
Thickness of floors and roofs	μ	10	10	10-20	10-20
Surface diameter of pillars	μ	50-120	50-150	50-100	140-190

* Includes thickness of floor and roof.

tions (fig. 3, pl. 1) have numerous, irregularly scattered pillars.

Discussion.—*A. penuria* was a new name given by Cole (1957, p. 350) to specimens from New Caledonia identified by Deprat (1905, p. 507) as *Orthophragmina pentagonalis* since this specific name had been used by Schafhäutl (1863) for a different European species. *A. penuria* occurs in New Caledonia, Soemba, Saipan Island, Guam Island, and in the drill holes on Eniwetok Atoll in the upper Eocene, Tertiary *b*.

Cole (1957, p. 351; 1958, p. 779) has demonstrated that this species showed considerable variation in size. This same variation in size is shown by specimens in the present collection. The small specimens from Saipan (Cole, 1957, pl. 116, fig. 2) and the Eniwetok drill holes (Cole, 1958, pl. 247, figs. 2, 4) should be compared with the specimen (fig. 4, pl. 2) in the present collection. All these specimens are seemingly identical.

However, larger specimens show certain differences, particularly in vertical section. Most of the Saipan, Guam and Eniwetok specimens have strongly inflated umbos, whereas those in the present collection have low umbos which merge into the flange.

Internally, however, the structures of all of the larger specimens are strikingly similar. The equatorial sections (figs. 1-3, 5, 8, 9, pl. 2) should be compared with those of Deprat (1905, pl. 18, fig. 24) and Cole (1957, pl. 116, figs. 6-9; 1958, pl. 246, figs. 1-8). All of the specimens, moreover, have low, open rectangular cavities in the lateral chambers which are arranged in regular tiers. The development of pillars is irregular.

Thus, the differences in the larger specimens in the present collection from those specimens previously assigned to this species are in the form of the specimens and the degree of inflation of the umbonal area. Such differences as these are thought to be environmentally controlled. Therefore, these specimens are believed to be well within the specific limits of this species.

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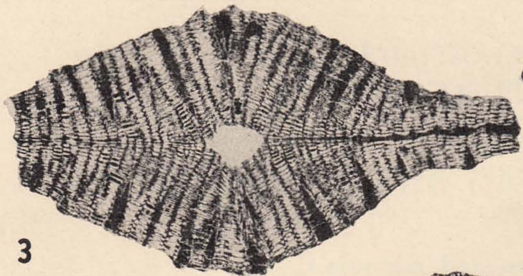
EXPLANATION OF PLATE 3

FIGS.		PAGE
1-4.	*Asterocyclina penuria* Cole	12
1-4.	Vertical sections; 1, 2, × 12.5; 3, 4, × 20.	
5-14.	*Asterocyclina elongaticamera* Cole, n. sp.	11
5-8.	Vertical sections, × 40; 5, section which is not centered and shows only two pillars; 6, holotype with 4 strong pillars between which are elongate lateral chambers; 7, 8, sections to illustrate variation.	
9-11.	External views, × 8.	
12-14.	Equatorial sections; 12, 13, × 40; 14, × 230; 14, represents the central part of fig. 13, enlarged, to show embryonic and periembryonic chambers; for a similar view of fig. 12, see fig. 5, pl. 1.	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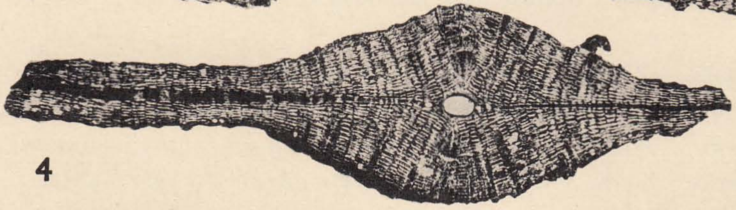
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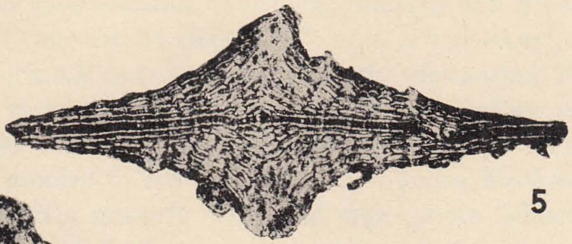
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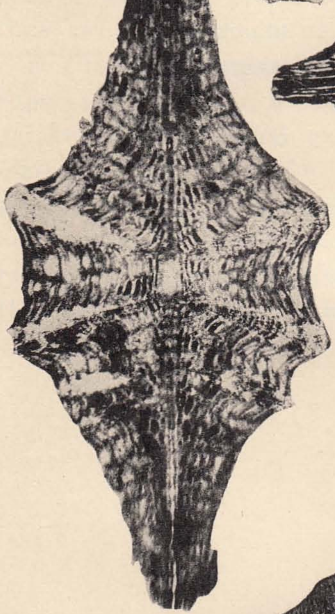
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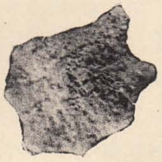
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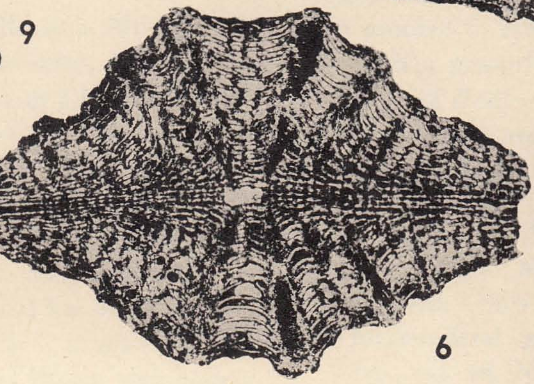
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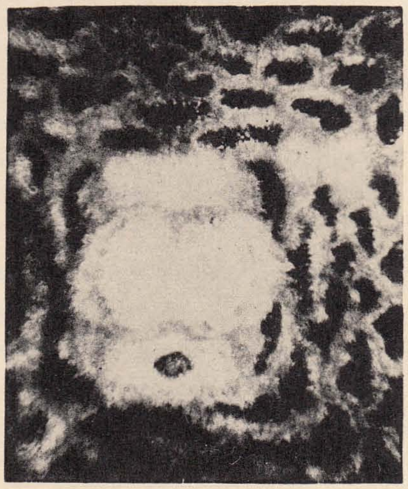
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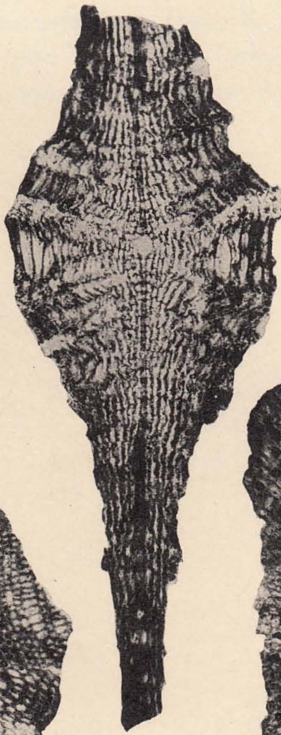
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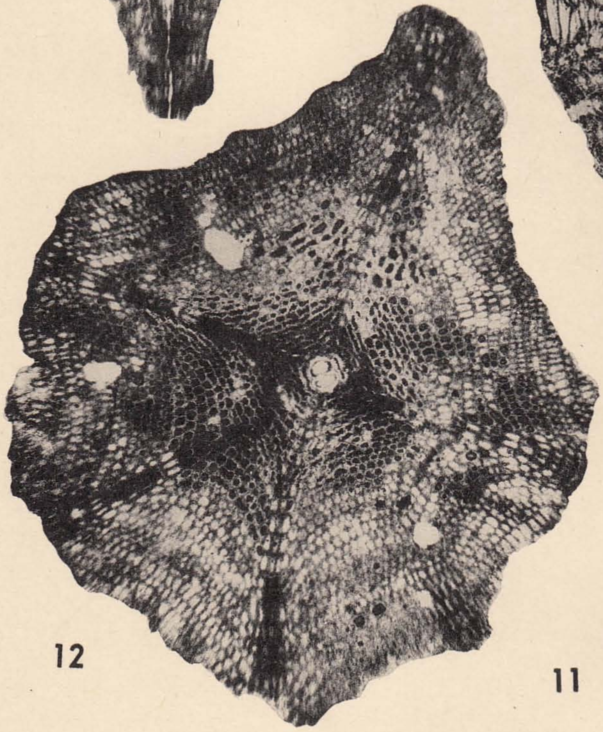
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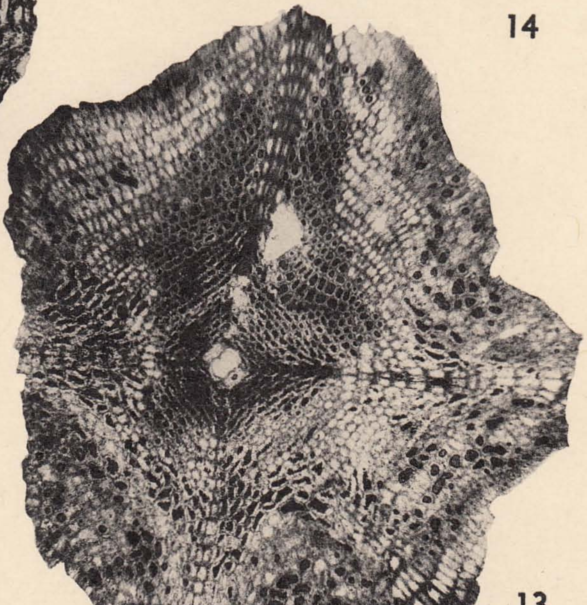
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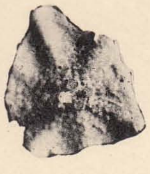
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Cole: *Asterocyclina* from a Pacific Seamount

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 1, JANUARY, 1959

193. STATUS OF THE GENERA *HEDBERGINA* AND *HEDBERGELLA*

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In a recent issue of this journal, Ruth Todd (1958), in her very useful literature review, listed a paper by Brönnimann and Brown (1958). In her annotation covering their article she states: *"Hedbergella* (type species *Anomalina lorneiana* var. *trocoidea* Gandolfi), a new name for *Hedbergina."* Because Miss Todd's review is so widely read and esteemed, and because Brönnimann and Brown's paper is in a less widely circulated journal, I feel a comment on the status of these two genera should be made.

Due to the unfortunate wording of the title of their paper ("*Hedbergella,* a new name for a Cretaceous planktonic foraminiferal genus") and also a similar sentence ending (page 15) ". . . and for which we now propose the new name *Hedbergella.*", it would readily be supposed that Brönnimann and Brown were indeed replacing the genus *Hedbergina* with *Hedbergella.* However, this could not be done. *Hedbergina* was validly named, with an originally designated type species in good standing, which Brönnimann and Brown (p. 15) specifically recognize, ". . . *G. seminolensis* . . . was originally, though inadvertently, designated the type species of *Hedbergina;* and for this reason the designation is binding and must be followed." They then proceed to erect, in fact, a new genus, *Hedbergella,* with a properly designated type species different from that of *Hedbergina.* Both genera are thus nomenclatorially valid, and one is not intended as a replacement of the other.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 1, JANUARY, 1959

194. *GYMNESINA GLOMEROSA*, N. GEN., N. SP. (FAM. OPHTHALMIDIIDAE) FROM THE MEDITERRANEAN

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ABSTRACT

A new genus of the Ophthalmidiidae with an agglutinated test is described from the Mediterranean Sea.

INTRODUCTION

While studying sediments from the Mediterranean coasts of southern Spain (Alboran Sea), northern Morocco (from Ceuta to Melilla) and the Balearic Islands I have come rather frequently upon an odd foraminifer. At first I believed the specimens to belong to some species of the genus *Reophax* that made up its test from coarse agglutinated foreign material, as this is the first impression they give. But on breaking up a number of individuals for examination, I discovered that the initial chambers were arranged in a spiral plane. This structure, and other details described below, showed that this was a new genus and species unrelated to *Reophax.*

It is not strange that this foraminifer should have remained unnoticed hitherto, since at first sight its test could be mistaken for a simple grouping of coarse sand grains accidentally stuck together, so small and inconspicuous is the test among the material that it agglutinates. It is also very fragile, and dredged material easily disintegrates, when washed, into unequal fragments, each carrying a small portion of white wall and recognizable only to a practiced eye.

This new genus represents an isolated, somewhat aberrant form morphologically, within the systematics of the Family Ophthalmidiidae, to which it belongs. Comparison with other genera that seem to be most closely related to it is made at the end of this note. The characters of the new genus and species can be defined as follows.

Family OPHTHALMIDIIDAE

Genus **Gymnesina** Colom, new genus

Genotype.—Gymnesina glomerosa Colom, n. sp.

Derivation of name.—From *Gymnesiai,* the name given by the Greeks to the islands of Majorca and Minorca.

Test calcareous, white, not porcellanous, very irregular in shape, with very thin brittle walls. Only the early stage has a clearly defined shape, being planispiral with 4 or 5 chambers varying in size in different specimens (Pl. 4, figs. 4, 7). This arrangement reveals the systematic filiation of the genus. Under high magnification the initial, spiral stage is seen to consist of a globular central proloculus followed by 4 or 5, rarely 6, chambers arranged in a flattened coil and roughly triangular in shape; the inner apex of each chamber is generally prolonged in a point tapering towards the preceding chamber and forming in this way the means of communication between the chambers. This initial spiral stage is quite flattened on the side of adhesion to the support on which it fastens itself and is provided with a tenuous membrane of organic nature. Its dorsal side, on the other hand, when free is always a little bulging.

However, in an organism so plastic and so easily adaptable to any object within its reach, the shape and arrangement of these first 4 or 5 spiral chambers can vary considerably, and specimens with large or with small coiled chambers can be found (Pl. 4, figs. 4, 7), sometimes clearly triangular and again arched; in the latter case, it is unusual not to find some triangular chamber among the arched ones (Pl. 4, figs. 1-3). Starting from the fifth chamber the test develops quite irregularly and consists of a flattened white tube —more or less wide, sometimes narrow—variously disposed among the sand grains that it agglutinates and tending to end in branches. From what I have been able to observe so far, each branch has a terminal aperture; one or two apertures are frequent, three are rare.

Gymnesina glomerosa Colom, n. sp.

Plate 4, figures 1-8; Plate 5, figures 1-10

Holotype.—Pl. 4, fig. 3. Specimen from sample no. 194, depth 100 meters, from the S.E. coast of Majorca, collected by the Instituto Español de Oceanografia. Maximum diameter of coil, with its 5 initial chambers, 0.80 mm.

Up to the present I have observed only one species

EXPLANATION OF PLATE 4

FIGS.		PAGE
1-8.	*Gymnesina glomerosa* Colom, n. gen., n. sp.	16

1-3, arrangement of initial chambers, × 45. gement of initial chambers.
4-8, × 25; 4, 7, specimens showing the arran

Plate 4

Colom: *Gymnesina glomerosa*, n. gen., n. sp.

Colom: *Gymnesina glomerosa,* n. gen., n. sp.

whose general characters correspond to the generic description. It is very variable in shape and size, as these factors are determined by the foreign material which it collects. It is not surprising, therefore, that specimens will differ somewhat in appearance according to the bathymetric and ecological media in which they have developed. When the sea bottom is coarsely detrital, large specimens, up to 3 or 5 mm. in length or in diameter, with coarse angular sand granules or reworked organic remains irregularly joined together are obtained (Pl. 5, fig. 6). The white wall of the test is then almost entirely hidden, only small portions of it being visible among the agglutinated material. The arrangement of the detrital elements gives individuals of two general shapes: either more or less rectilinear or else vaguely rounded, like pellets of sand, 3 to 5 mm. in diameter. Other specimens select only a few coarse sand grains (Pl. 5, figs. 2-3) and then the walls of the foraminifer become more apparent. In other cases the sand grains are not compactly agglutinated, that is, not formed into a dense mass, but are very lightly joined together as in the specimen shown in Pl. 5, figs. 4 and 5 (both sides). Here the initial stage of spiral chambers (Pl. 5, fig. 5) followed by a long narrower tube that unites the few sand grains and ends on the opposite side in a long, fine, tapering, uncovered neck with a terminal aperture (Pl. 5, fig. 4) can be seen. In other cases this organism attaches itself to a thick mollusk or echinoid fragment and in extending over it incorporates detrital elements that usually are small in size (Pl. 5, fig. 8). The species presents many variations within these general lines, and always on a basis of reworked detrital elements, which change the aspect of the foraminifer according to the composition of the sea bottom (detrital sands, zoogenous sands, etc.). Consequently it is possible to obtain specimens of smaller size also (Pl. 5, figs. 9, 10) from sandy beds at greater depths where the detrital elements are notably finer.

Comparisons and relationships.—The characters of the early stage of chambers of the new genus *Gymnesina* show its undoubted filiation with the Ophthalmidiidae. Its irregular spiral, followed by a long irregularly disposed tube, places it in this group. Among the genera of the same family that seem to be most closely related to *Gymnesina* is *Rhizonubecula* Le Calvez, 1935, a form that lives in the *Posidonia* beds of the Bay of Banyuls (France) at shallow depths; its early stage of spiral chambers shows an arrangement very similar to *Gymnesina,* although its later portion develops into a series of long segmented tubes. But Le Calvez' is a ramose, incrusting form (*R. adherens*), with fine, thin walls.

The genus *Meandroloculina,* genotype *M. bogatschovi* Bogdanowicz, 1935, from the Miocene of Russia offers a similar initial structure, but the coil following its proloculus is short and the succeeding chambers are arranged in a zigzag; it is the later, uniserial chambers that most resemble the final spiral chambers of *Gymnesina. Meandroloculina* does not have agglutinated walls, however, and an agglutinative structure with coarse materials, such as *Gymnesina* presents, is not known in other genera of the family Ophthalmidiidae.

Ecology.—The new species lives only on detrital bottoms, at depths of from 40 to 50 meters to about 200 meters; it is rare outside these limits. On the Balearic coasts it is usually found localized along the southeastern part of the island of Majorca where there exists a wide coastal platform at a depth of 100 to 200 meters connected with a platform situated southwest of the island of Minorca in identical bathymetric conditions. In this, as in other similar zones of the Moroccan and Alboran Sea coasts, detrital deposits composed essentially of "conchuela" (great quantities of triturated mollusk and echinoid remains) occupy vast areas and it is in them that the species occurs with greatest frequency and can become even common. But its favorite habitat within these areas is always on the finely arenaceous sediment, at depths of about 100 meters.

Such arenaceous biotopes contain a large assemblage of benthonic Foraminifera with arenaceous tests, among which species of *Textularia* — *T. pseudotrochus, T. pseudorugosa, T. sagittula, T. gramen, T. candeiana,* and so on — are remarkable for their abundance, as are also other Foraminifera of various different families: *Gypsina globulus, Elphidium crispum, Miniacina miniacea, Cibicides lobatulus, Eponides repandus, Adelosina laevigata, Quinqueloculina disparilis, Q. undulata, Q. cornuta, Q. seminulum,* to cite only the most frequent.

EXPLANATION OF PLATE 5

FIGS.		PAGE
1-10.	*Gymnesina glomerosa* Colom, n. gen., n. sp. × 18 2, 3, same specimen from both sides; 4, 5, same specimen from both sides; 9, 10, specimen with agglutinated elements of smaller size.	16

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 1, JANUARY, 1959

195. *NUTTALLINELLA*, NEW NAME FOR *NUTTALLINA* BELFORD, 1958 (NON *NUTTALLINA* DALL, 1871)

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Dr. Hans E. Thalmann has informed the writer that *Nuttallina* Belford, 1958, with type species *Nuttallina coronula* Belford, is preoccupied by *Nuttallina* Dall, 1871 for a molluscan genus. The following new name is therefore proposed:

Nuttallinella, new name, for *Nuttallina* Belford, 1958, Contrib. Cushman Found. Foram. Research, vol. IX, pt. 4, p. 93, non *Nuttallina* Dall, 1871, Amer. Jour. Conchology, vol. VII, p. 135.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 1, JANUARY, 1959

RECENT LITERATURE ON THE FORAMINIFERA

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

ALEXANDROWICZ, STEFAN. Outline of microfaunistic stratigraphy of the Silesian-Cracovian Miocene (in Polish with English summary).—Poland Instyt. Geol. (Warsaw), tom 2, no. 1, 1958, p. 54-81, tables 1, 2.—Fourteen microfaunal associations of smaller Foraminifera observed in bore-holes may be useful in regional correlation.

ANDERSEN, HAROLD V. Foraminiferal faunules from the mudlumps. Abstract.—Trans. Gulf Coast Assoc. Geol. Soc., v. 7, Nov. 6-8, 1957, p. 152.—Evidence of vertical displacement of clay in mudlumps.

ANNOSCIA, ENRICO, and MANTOVANI, M. PIA. Fossili Maestrichtiani nel Flysch della Valle del Sinni.—Boll. Soc. Geol. Ital., v. 76, 1957, 10 p., text figs. 1-7 (map, photomicrographs).—Correction of age determination from middle Eocene to Maestrichtian is based on **Globotruncana** and orbitoids observed in thin section.

BASHKIROV, L. V. Orbitoidy I Ikh Znachenie Dlja Stratigrafii Paleogena.—Moskov. obshch. ispyt. prirody, Otdel geol., Biul., tom 33, vyp. 2, 1958, p. 113-115, 1 range chart.—Ranges of 23 orbitoid species.

BEHM, HANS J., and GREKULINSKI, EDMUND F. The ecology of Foraminifera of Main and Richmond Creeks, Staten Island, New York.—Proc. Staten Island Instit. Arts and Sci., v. 20, no. 2, Spring 1958, p. 52-66, map, 1 pl.—Ten arenaceous species in a marsh facies and 4 others (all but **Rotalia beccarii** arenaceous) in an estuary facies live commensally with algae.

BIEDA, EUGENIA. Index Foraminifers and the age of the Mielnik Chalk (Eastern Poland) (in Polish with English summary).—Poland Instyt. Geol. (Warsaw) Biul. 121, tom 3, 1958, p. 17-89, pl. 20 (range chart), text figs. 1-27.—Age determined as upper Campanian-lower Maestrichtian. Twenty-two species (1 new), 4 subspecies, and 1 variety described and illustrated.

BIESIOT, PETER GERARD, JR. Miocene Foraminifera from the Uloa sandstone.—Trans. Proc. Geol. Soc. South Africa, v. 60, 1957, p. 61-80, pls. 4-6, text fig. 1 (map).—Fifty-three species and varieties, 8 new and 11 indeterminate, described or recorded and illustrated from rocks of probably Burdigalian age in Zululand.

BLAICHER, JADWIGA. The microfauna of the Magura series of the Grybow region (middle Carpathians) (in Polish with English summary).—Poland Instyt. Geol. (Warsaw), tom 2, no. 2, 1958, p. 385-399, tables 1, 2.—Ranges of species between Turonian and upper Eocene.

BÜRGL, HANS. Biostratigrafía de la Sabana de Bogotá y sus Alrededores.—Bol. Geol., Colombia Instit. Geol. Nac., v. V, no. 2, May-Aug. 1957, p. 113-185, pls. 1-20.—Lists of Foraminifera from the Upper Cretaceous.

BYKOVA, E. V. On a found of chitinoid Foraminifera in Ordovician deposits of North Kazakhstan (in Russian).—Doklady Akad. Nauk SSSR, tom 120, no. 4, 1958, p. 879-881, pl., figs. 1-4.—Alexandrellidae new family.

CHARRIER, GIOVANNI. Fauna Pliocenica di San Gaudenzio (Lessona presso Biella). Nota II: Foraminiferi; Molluschi Pteropodi.—Boll. Serv. Geol. Italia, v. 79, fasc. 1-2, 1958, p. 355-368, pl. 1, text fig 1.—**Elphidium crispum** in upper Pliocene.

CRESPIN, IRENE. Foraminifera from rock samples from the Fiji Islands.—Australia Bur. Min. Resources, Records 1958/31 (mimeographed), p. 1-4.—Lists of smaller and larger Foraminifera with age determinations of 5 samples.

DALEON, BENJAMIN A. A brief summary of some Foraminifera in Philippine stratigraphy.—The Philippine Geologist, v. 12, no. 3, June 1958, p. 82-84, map, range chart.—Ranges between Cretaceous and upper Pliocene indicated for 13 genera of larger Foraminifera and 21 species of smaller Foraminifera.

DAVIS, E. Les Foraminifères Néogènes d'Élide (Péloponèse).—Ann. Géol. Pays Helléniques, ser. 1, tome 8, 1957, p. 263-268, pl. 50.—Thirty-eight species from the Pliocene (Astian).

DIKOVA, PENKA. Contribution a la connaissance de quelques espèces de la famille Nonionidae du Tertiaire de la Bulgarie du Nord-Est (in Bulgarian with French résumé).—Ann. Direction Gén. Recherches Géol. Min., ser. A, v. 6, 1954 (1956), p. 153-177, pls. 1-4, table (distrib. and range).—Seventeen species (1 indeterminate) and 3 varieties.

DROOGER, C. W. Das Alter der Miogypsinen-Gesteine von Kaphallinia.—Ann. Géol. Pays Helléniques, v. 9, 1958, p. 115-118.—Notes on coexistence of miogypsinids and planktonics. Companion to paper by Herbert Hagn.

DUNBAR, CARL O. On the validity of **Schwagerina** and **Pseudoschwagerina**.—Jour. Paleo., v. 32, no. 5, Sept. 1958, p. 1019-1021.—Review of literature, opinions, and evidence bearing on the case.

DUSZYNSKA, STANISLAWA. Carboniferous Foraminifers from Marginal Beds in Upper Silesia (in Polish with English summary).—Poland Instyt. Geol. (Warsaw) Biul. 121, tom 3, 1958, p. 5-16, text figs. 1-5.—Three agglutinated species, none new.

GHORAB, M. A., and ISMAIL, M. M. A microfacies study of the Eocene and Pliocene east of Helwan.—Egyptian Jour. Geol., v. 1, no. 2, 1957, p. 105-124, pls. 1-7, chart 1.—Larger and smaller Foraminifera are listed from several local microfacies associations from upper Lutetian, Bartonian, and Astian.

HAGN, HERBERT. Mikropaläontologische untersuchungen an gesteinen der insel Kephallinia (Adriatisch-Jonische Zone Griechenlands).—Ann. Géol. Pays Helléniques, v. 9, 1958, p. 90-114, pl. 7.—Two outcrops considered equivalent to **Globigerinatella insueta** and **Globorotalia fohsi** zones of the Caribbean.

HENDRIX, W. E. Foraminiferal shell form, a key to sedimentary environment.—Jour. Paleo., v. 32, no. 4, July 1958, p. 649-659, pls. 87-89, text figs. 1-8 (map, graphs).—Statistical study of relationships between thickness of wall, section or outline of test, and ornamentation on the one hand, and grain size of sediment, presence or absence of lamination, and clay and organic carbon content on the other hand. Thin-walled, unornamented foraminifers are more numerous in laminated and fine-grained sediments.

IGO, HISAYOSHI. On a remarkable **Triticites** from the pebbles of the Sorayama conglomerate, Fukuji, southeastern part of the Hida Massif, central Japan.—Japanese Jour. Geol. Geogr., v. 28, no. 4, Dec. 25, 1957, p. 239-246, pl. 18.—Three species 2 new and 1 indeterminate, from the Late Carboniferous.

JOVTSCHEVA, PENKA. Sur la présence de quelques formes de Valvulinidae dans le crétacé et le tertiaire de la Bulgarie du Nord-Est (in Bulgarian with French summary).—Ann. Direction Gén. Recherches Géol. Min. (Sofia), ser. A, v. 7, 1956 (1957), p. 97-134, pls. 1-8, text fig. 1 (range chart), table.—Fifty-six species and 1 variety, none new, in 15 genera, are described and illustrated.

KHALILOV, D. M. O Pelagicheskoj Faune Foraminifer Paleogenovykh Otlozhenij Azerbajdzhana.—Akad. Nauk Azerbaidzhan. Trudy, tom 17, 1956, p. 234-255, pls. 1-5.—Twenty-six globigerinid species and varieties (17 species and 8 varieties new) in 3 genera, 1 new: **Globoconusa** (genotype **G. conusa** n. sp.).

KIRK, H. J. C. The geology and mineral resources of the Upper Rajang and adjacent areas, Sarawak.—Borneo Geol. Survey Dept. Mem. 8, 1957, p. 1-181, pls. 1-53 (photographs), text figs. 1-29, tables 1-30, 4 colored geol. maps.—Smaller and larger Foraminifera listed from Upper Cretaceous to Miocene rocks.

KRAEVA, J. J. Predstavniki Rodini Asterigerinidae Z Paleogenovikh Vihdkladihv Prichornomors'koji Zapadini.—Geol. Zhurnal, Akad. Nauk Ukrain. RSR, tom 18, vyp. 3, 1958, p. 71-77, pl. 1.—Five species of **Asterigerina**, 2 new.

LANTERNO, EDOUARD. Contribution a la connaissance de l'Éocène des environs de Varèse, de Côme et de Bergame.—Arch. Sci. Soc. Phys. Hist. Nat. Genève, v. 11, fasc. 2, April-June 1958, p. 167-193, text figs. 1-9.—Larger and smaller Foraminifera listed and illustrated.

LeROY, L. W., and SCHIELTZ, N. C. Niobrara-Pierre boundary along Front Range, Colorado.—Bull. Amer. Assoc. Petr. Geol., v. 42, no. 10, Oct. 1958, p. 2444-2464, text figs. 1-12.—A few species of Foraminifera, mostly arenaceous, are illustrated from the Smoky Hill member of the Niobrara formation and the Sharon Springs member of the Pierre formation.

LIPPARINI, TINO. Foraminiferi Cretacei della struttura di Monteveglio (Appennino Bolognese).—Boll. Serv. Geol. Italia, v. 79, fasc. 1-2, 1958, p. 327-348, pls. 1, 2 (map, outline drawings), text fig. 1 (photo).—Eight species and 2 new varieties described and illustrated from middle Cenomanian to lower Turonian beds.

LOEBLICH, ALFRED R., JR. Danian stage of Paleocene in California.—Bull. Amer. Assoc. Petr. Geol., v. 42, no. 9, Sept. 1958, p. 2260-2261.—Planktonic Foraminifera indicate correlation of Cheneyan stage with Danian.

LUCZKOWSKA, EWA. The Miocene microfauna of the Carpathian Foredeep (in Polish with English summary).—Poland Instyt. Geol. (Warsaw), tom 2, no. 1, 1958, p. 105-125, pls. 1-7.—Photographs of 14 assemblages of smaller Foraminifera.

MALZAHN, ERICH. Neue Fossilfunde und vertikale Verbreitung der niederrheinischen Zechsteinfauna in den Bohrungen Kamp 4 und Friedrich Heinrich 57 bei Kamp-Lintfort.—Geol. Jahrb., Band 73, May 1957, p. 91-125, pls. 10-13, text fig. 1, table 1.—Permian small Foraminifera listed and an assemblage illustrated.

MIKLUKHO-MAKLAJ, A. D. O Gomeomorfii Fuzulinid.—Vses. paleont. obshch. Ezhegodnik, tom 16, 1955-1956, 1957, p. 48-57, pls. 1, 2, table.—Thin sections illustrated.

MYERS, DONALD A. Stratigraphic distribution of some fusulinids from the Thrifty formation, Upper Pennsylvanian, Central Texas.—Jour. Paleo., v. 32, no. 4, July 1958, p. 677-681, pls. 92, 93, text fig. 1 (sections).—Evolutionary trends in **Triticites plummeri,** as it occurs in 3 limestone members of the Thrifty formation, may be useful for stratigraphic correlation.

NEMKOV, G. I. Unknown genera of big Foraminifera, discovered in paleogenic deposits of the South of the USSR, and their importance for the stratigraphy (in Russian).—Doklady Akad. Nauk SSSR, tom 120, no. 5, 1958, p. 1099-1102, text figs. 1-9.—Concerning mostly camerinid genera.

NEMKOV, G. I., and KHLOPONIN, K. L. A discovery of Paleocene **Nummulites** in the eastern Carpathians (translated from Russian).—Proc. Acad. Sci. USSR, Geol. Sci. Sect., v. 114, no. 6, 1957, in English translation 1958, p. 479-481, 1 text fig.—**Nummulites solitarius** de la Harpe.

NOTA, DIRK JOHANNES GREGORIUS. Sediments of the Western Guiana shelf (Reports of the Orinoco Shelf Expedition volume II).—Thesis Univ. Utrecht, Meded. Landbouw. Wageningen/Nederland 58 (2), 1958, p. 1-98, photos 1-12, appendices I-IV (bottom profiles, maps), text figs. 1-39 (maps, diagrams).—Preliminary study of Foraminifera indicates presence of 4 assemblages from near shore to outer shelf.

NYIRO, R. M. Neue Formen der Familie Lagenidae aus den tortonischen Schichten von Szokolya (in Hungarian with German summary).—Földtani Közlöny, Bull. Hungarian Geol. Soc., köt. 88, füz. 2, April-June 1958, p. 243-244, pl. 24.—Three species, 1 (**Palmula appendicifera**) new.

OGNIBEN, L. Stratigrafia e microfaune del Terziario della zona di Caiazzo (Caserta).—Riv. Ital. Pal. Stratig., v. 64, no. 2, p. 89-142, tables 1-6, diagrams 1-3; no. 3, 1958, p. 199-286, pls. 8-15.—One hundred species, varieties, and subspecies (2 planktonic forms new) from the middle Miocene.

OZAKI, H. Stratigraphical and paleontological studies on the Neogene and Pleistocene formations of the Tyosi District.—Bull. Nat. Sci. Mus. Tokyo, v. 4, no.

1 (no. 42), March 1958, p. 1-182, pls. 1-24, text figs. 1-16, tables 1, 2, maps 1-3.—Foraminifera listed from 4 formations (Miocene, lower Pliocene, upper Pliocene, and Pleistocene) and some species illustrated (pl. 1) from the Miocene formation.

ÖZTEMUR, VECIHE. Note on the new **Haplophragmium** species found in southeastern Turkey.—Bull. Min. Research Explor. Instit. Turkey, no. 50, April 1958, p. 73, 74, pl. 1.—**Haplophragmium giganteum** from Maestrichtian marls in a well.

PAZDROWA, OLGA. **Ophthalmidium** of the Vesulian and Bathonian in the neighborhood of Czestochowa (in Polish with English summary).—Poland Instyt. Geol. (Warsaw) Biul. 121, tom 3, 1958, p. 91-162, pls. 1-7, text figs. 1-12 (graphs).—Quantitative analysis of specimens of **O. carinatum** Kubler and Zwingli permits recognition of 3 new subspecies of local stratigraphic importance. Regeneration of damaged individuals is discussed.

POGREBIJAK, V. O. Dejakih Novih Vidi Fuzulihnihd ihz Seredn'okam'janovugihl'nikh Vihdkladihv Pihvnihchnoji Okrajini Doneth'kogo Basejnu (in Russian).—Geol. Zhurnal, Akad. Nauk Ukrajin. RSR, tom 18, vyp. 2, 1958, p. 69-79, text figs. 1-10.—Nine species, all new. Two not named.

POLSKI, W., and WALLER, H. O. Recent occurrence of **Gumbelitria vivans** Cushman.—Compass of Sigma Gamma Epsilon (An honorary scientific fraternity magazine devoted to earth sciences), v. 35, no. 4, 1958, p. 226-229, text figs. 1, 2 (map, drawings).—Transparent, unfilled specimens found in 80 samples at depths of 62 to 656 feet along the Asiatic shelf.

RAU, WELDON W. Stratigraphy and foraminiferal zonation in some of the Tertiary rocks of southwestern Washington.—U. S. Geol. Survey Oil and Gas Invest. Chart OC 57 (2 sheets), 1958, figs. 1-5 (map, stratigraphic sections, correlation table, range chart).—From the Eocene to the "Oligo-Miocene" (Saucesian), 8 zones are based on smaller Foraminifera and are located in 13 sections. Ranges and geographic occurrence of 202 species and subspecies are indicated.

RAUSER-CHERNOUSOVA, D. M., and REITLINGER, E. A. Development of foraminiferae during Paleozoic and their stratigraphical importance (in Russian). —Izvest. Akad. Nauk SSSR, ser. Geol., no. 11, 1957, p. 103-124, text figs. 1-3, table.—Evolution diagrams for genera.

REISS, Z. Notes on Foraminifera from Israel. 7, Remarks on the age of the so-called 'Dalia-marls' in northern Israel. 8, The systematic position of **Sigalia** and **Bolivinoides.** 9, **Protopeneroplis striata** Weynschenk from the Jurassic of Israel.—Israel Geol. Survey Bull. 17, March 1958, p. 3-10, text figs. 1, 2.—Pelagic forms listed from Dalia marls indicate late Cenomanian to early Turonian age. Ornamentation, apertural features, and wall structure indicate **Sigalia** and **Bolivinoides** belong in different superfamilies. Geographic range of **Protopeneroplis striata** extended to Israel. Systematic position of the genus (not agglutinated and not a peneroplid), and its relation to **Robuloides** are in doubt. A question is raised as to the validity of **Ventrolammina.**

REY, M., and NOUET, G. Microfacies de la region Prerifaine et de la Moyenne Moulouya (Maroc Septentrional).—Internat. Sedimentary Petrographical Ser., v. 3, 1958, p. 1-41, pls. 1-97, 3 sections, 3 maps, 2 tables.—Book includes 194 thin section photographs showing large and small Foraminifera as well as other microfossils from Lias to Miocene.

SAID, RUSHDI, and BASIOUNI, M. A. Miocene Foraminifera of Gulf of Suez region, Egypt.—Bull. Amer. Assoc. Petr. Geol., v. 42, no. 8, August 1958, p. 1958-1977, pl. 1 (thin sections), text figs. 1-5 (maps, section, graphs).—Interpretation of Miocene paleoecology, paleogeography, and bottom topography is based on statistical study of small Foraminifera populations.

SAKAGAMI, SUMIO, and OMATA, TOSHIKAZU. Lower Permian fusulinids from Shiraiwa, northwestern part of Ome, Nishitama-gun, Tokyo-to, Japan.—Japanese Jour. Geol. Geogr., v. 28, no. 4, Dec. 25, 1957, p. 247-264, pls. 19, 20.—Nine species (4 new), 1 new subspecies, and 2 varieties are included in 5 genera, 1 new: **Kwantoella** (type species **K. fujimotoi** n. sp.).

SAWAI, KIYOSHI. Deposits of foraminiferal tests in the Kii Strait, Japan.—Mem. College Sci., Univ. Kyoto, ser. B, v. 24, no. 4, March 1958, p. 325-334, text fig. 1 (map), tables 1, 2.—Quantitative analysis involving 28 stations between 10 and 80 meters and 135 species.

SELLI, RAIMONDO. Sulla trasgressione del Miocene nell' Italia meridionale.—Giornale Geol., Ann. Mus. Geol. Bologna, ser. 2, v. 26, 1954/55 (1957), p. 1-72, pls. 1-9, tables 1, 2.—Smaller and larger Foraminifera used in dating transgressions from Aquitanian to Tortonian.

SHENG, J. C. Some Upper Carboniferous fusulinids from the vicinity of Beiyin Obo, Inner Mongolia.—Acta Palaeont. Sinica, v. 6, no. 1, 1958, p. 35-50, pls. 1, 2.—Seven species (4 new) and 1 variety.

SHENTON, EDWARD H. A study of the Foraminifera and sediments of Matagorda Bay, Texas.—Trans. Gulf Coast Assoc. Geol. Soc., v. 7, Nov. 6-8, 1957, p. 135-150, text figs. 1-9 (maps, graphs), tables 1-3.—Quantitative analysis of Foraminifera in 21 bottom samples. About 25 species, almost exclusively calcareous, were recognized. No apparent correlation between fauna and sediment types was observed.

SIGAL, JACQUES. La classification actuelle des familles de Foraminifères planctoniques du Crétacé.—C.R.S. Soc. Géol. France, no. 12, June 16, 1958, p. 262-265. —Discussion of family criteria.

SMITTER, YVOR H. The species relationships and stratigraphic distribution of southern African Upper Cretaceous **Epistomina.**—Palaeontologia Africana, v. 5, 1957 (June 1, 1958), p. 83-85, text fig. 20.—Characteristics and stratigraphic ranges of **E. caracolla, E. zuluensis,** and **E. pondensis** between Santonian and Montian.

SMOUT, A. H., and EAMES, F. E. The genus **Archaias** (Foraminifera) and its stratigraphical distribution. —Palaeontology (Pal. Assoc. London), v. 1, pt. 3, June 1958, p. 207-225, pls. 39-41.—Six valid species, 2 new, and 1 probably valid species. Eight invalid names synonymous with **A. angulatus.** Six species removed from **Archaias. Cyclorbiculina** Silvestri 1937 a valid genus distinguished from **Archaias** by presence of subepidermal partitions.

SOLANGE, FRANÇOIS, LEHMANN, JEAN-PAUL, and MAYNC, WOLF. Sur un niveau à Pseudocyclammines dans le Séquanien du Jura français.—C. R. S. Soc. Géol. France, no. 12, June 16, 1958, p. 252-255, 1 text fig. (section).

STYK, OLGA. Triassic microfauna in the neighborhood of Chrzanow and in the north-western part of the Mesozoic periphery of the Swiety Krzyz Mts. (in Polish with English summary).—Poland Instyt. Geol. (Warsaw) Biul. 121, tom 3, 1958, p. 163-176, pls. 21-23, text figs. 1-3, table 1.—A few Foraminifera mentioned and illustrated.

SZTEJN, JANINA. Micropalaeontological stratigraphy of the Lower Cretaceous in central Poland (in Polish, Russian, and English).—Poland Instyt. Geol. Prace (Warsaw), tom 22, 1957, p. 1-260, pls. 1-16, text figs. 1-26, tables 1, 2.—From the Infravalanginian to Hauterivian, 103 species, subspecies, and varieties of Foraminifera, 7 species and 3 subspecies new.

Key to recognizing foraminifers of the Lower Cretaceous from Middle Poland (in Polish).—Poland Instyt. Geol. (Warsaw) Biul. 138, 1958, p. 1-55, text figs. 1-120.—An illustrated species catalog including 116 species (1 new), 3 varieties, and 1 subspecies in 44 genera.

TAIROV, CH. A. O Dvukh Novykh Rodakh Iz Semejstv Verneuilinidae I Ammodiscidae, Prinadlezhashchikh K Faune Foraminifer.—Akad. Nauk Azerbaidzhan. Doklady, tom 12, no. 1, 1956, p. 113-116, text figs. 1-3.—Three new arenaceous species from the lower Aptian in 3 genera, 2 of which are new: **Verneuilinella** (genotype **V. azerbaidjanica** n. sp.) and **Arenoturrispirillina** (genotype **A. aptica** n. sp.).

THALMANN, HANS E. Bibliography and index to new genera, species, and varieties of Foraminifera for the year 1955.—Jour. Paleo., v. 32, no. 4, July 1958, p. 737-762.

TURNOVSKY, KURT. Eine neue Art von **Ammocibicides** aus dem Eozaen Nordanatoliens.—Bull. Geol. Soc. Turkey, v. 6, no. 2, Feb. 1958, p. 78, 79, text fig. 1.—**Ammocibicides anatolicus.**

Eine neue Art von **Globorotalia** Cushman aus dem Eozaen Anatoliens und ihre Zuordnung zu einer neuen Untergattung.—Bull. Geol. Soc. Turkey, v. 6, no. 2, Feb. 1958, p. 80-86, text fig. 1.—**Globorotalia (Astrorotalia) stellaria** nov. subgen. nov. sp.

TZANEVA, PARASKEVA. Contribution à l'étude microfossile de la famille des Buliminidae du crétacé et du tertiaire de la Bulgarie du Nord-Est (in Bulgarian with French summary).—Ann. Direction Gén. Recherches Géol. Min. (Sofia), ser. A, v. 7, 1956 (1957), p. 11-32, pls. 1-7.—Thirty-four species and 1 variety, none new, in 7 genera, are described and illustrated.

TZANKOV, V., STRACHIMIROV, B., DIMITROVA, N., and VRABLIANSKI, B. Contribution a l'étude de la géologie du bassin Tertiaire de Bela (in Bulgarian with French résumé).—Ann. Direction Gén. Recherches Géol. Min., ser. A, v. 6, 1954 (1956), p. 1-47, pls. 1-5, map, sections, tables.—Nineteen species and 1 variety of smaller Foraminifera, none new, from the Priabonian.

VALENSI, LIONEL. Micropaléontologie des silex du Grand Pressigny.—Bull. Soc. Géol. France, ser. 6, v. 7, 1957, p. 1083-1090, pl. 48b, text pls. 1, 2, text fig. 1.—A few Foraminifera in thin section.

VAPTZAROVA, JANKA. Formes fossiles des Verneuilinidae dans le crétacé et le tertiaire du Nord-Est de la Bulgarie (in Bulgarian with French summary).—Ann. Direction Gén. Recherches Géol. Min. (Sofia), ser. A, v. 7, 1956 (1957), p. 37-69, pls. 1-7.—Thirty-eight species (1 new) and 3 varieties in 7 genera are described and illustrated.

VAN VOORTHUYSEN, J. H. Holocene ecology of two profiles, based on Foraminifera, chapter 12 **in** The excavation at Velsen.—Verhandl. Kon. Nederl. Geol.-Mijnb. Genootschap, Geol. ser., deel 17, Dec. 1957, p. 190-192, distrib. and abund. graph.—Occurrence and abundance of 37 species of Foraminifera at short intervals within an 18-meter section reveal the changing sedimentary conditions through the Holocene.

WARREN, A. D. The Anahuac and Frio sediments in Louisiana.—Trans. Gulf Coast Assoc. Geol. Soc., v. 7, Nov. 6-8, 1957, p. 221-237, pls. I-IV (sections), text figs. 1-4 (correl. chart, logs), maps 1-3.—Benthonic index Foraminifera listed for stages and zones in the Oligocene and Miocene.

WITWICKA, EMILIA. Micropalaeontological stratigraphy of Upper Cretaceous of the Chelm borehole (Lublin Upland) (in Polish with English summary).—Poland Instyt. Geol. (Warsaw) Biul. 121, tom 3, 1958, p. 177-267, pls. 8-19, 24, 25.—Seven stages between Cenomanian and upper Maestrichtian are recognized in the borehole. Twenty-five species (1 new) and 6 subspecies described and illustrated.

WOODLAND, ROLAND BERT. Stratigraphic significance of Mississippian endothyroid Foraminifera in central Utah.—Jour. Paleo., v. 32, no. 5, Sept. 1958, p. 791-814, pls. 99-103, text figs. 1-5 (map, stratigraphic section, graph).—Recognition of 4 faunal zones. Correlation between Utah and Mississippi Valley on basis of comparative phylogeny. Notes on ecologic interpretations. Fourteen species, 8 new, are described and illustrated.

Ruth Todd