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198. THE GENERA *EPONIDES, LACOSTEINA, NUTTALLIDES, PLANORBULINA,* AND *HALKYARDIA*

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ABSTRACT

Restudy of the type species of **Eponides** and **Alabamina** shows that the two genera are synonymous. **Lacosteina** belongs to the dentate Foraminifera. The coiled portion shows the features of **Conorboides**, being usually trochoid with the axis of coiling forming an angle with the triserial portion. Since the toothplates are also typical of **Conorboides**, **Lacosteina** probably represents a wild-growing form of that genus; the relationship between the two forms is similar to that between **Dyocibicides** and **Cibicides**. The type species of **Nuttallides** is nearly identical with Eocene **Asterigerina campanella** of Europe which differs only specifically from the type species of **Asterigerina**. **Nuttallides** is, therefore, a synonym of **Asterigerina**. The type species of **Planorbulina** shows the characteristics of **Cymbaloporetta** and the latter must be placed in the synonymy of the former. The family Cymbaloporettidae must be incorporated in the Planorbulinidae. The whole group is allied to **Discopulvinulina**. The type species of **Halkyardia** shows an umbilical structure which resembles that of **Ferayina**, but not that of **Cymbaloporetta**. It may be that **Cymbalopora**, **Halkyardia**, and **Ferayina** belong to one group of the Foraminifera, and it is certain that **Cymbaloporetta** with its allies belong to a quite different one.

EPONIDES MONTFORT, 1808

The type species of *Eponides* is *Nautilus repandus* Fichtel and Moll (1798, p. 35, pl. 3, figs. a-d). The species was well figured for the first time by Brady (1884, p. 684, pl. 104, fig. 18) as "*Pulvinulina repanda* Fichtel and Moll sp." If we assume that Brady has figured true *Nautilus repandus* (as he says, the dorsal sutures are not visible in Fichtel and Moll's figure), we may describe the species as follows:

Test strongly biconvex, with a subacute periphery. Wall smooth and polished on both sides, with fine pores, in transmitted light nearly opaque, not hyaline. Sutures on the dorsal side distinctly oblique, slightly curved, flush with the surface [the form with raised sutures being *E. concamerata* (Montagu)]; sutures on the ventral side very slightly depressed, running in a sigmoid curve from the non-umbilicate central portion toward the periphery. Chambers about 6 in a whorl, with a central protruding area near the center (especially in the last-formed one). Aperture an elongate slit with the distinct, peripheral end bent distally, the chamber wall above this slit being raised upward to form a poreless apertural face with a more or less distinct indentation near the curved part of the aperture near the margin. In section, the apertural face curves inward into the cavity of the chamber, forming a kind of toothplate, especially near the periphery. The septal foramen is small and areal. The walls in the earlier part of the test are very thick. The umbilicus is closed completely. In horizontal section, the curved parts of the apertural structure are seen as a folded structure just as is found in the genus *Alabamina.*

Though it may be that Redmond (1949, pp. 19-21) is right in supposing that Montfort's figure of *Eponides* is not in full agreement with what has been considered, since Brady's time, to be *E. repandus,* we emphasize here that at present the species figured by Brady is considered to be the type species of *Eponides.*

Comparing the structure of Brady's *E. repandus,* a common species in many parts of the world and notably in the Mediterranean, with that of *Alabamina wilcoxensis* Toulmin 1941 (the type species of *Alabamina*), it is obvious that both species must belong to the same genus. For, when we describe this common Paleocene and lower Eocene species, we find that it is quite similar:

Test lenticular, with a subacute periphery; the dorsal side less convex than the ventral. Total number of chambers in the final whorl about 5. Sutures on the dorsal side strongly oblique, slightly curved, flush with the surface; sutures on the ventral side nearly straight, running from the non-umbilicate central portion to the periphery. Apertural face strongly curved upward, with a distinct indentation (infundibulum) at the periphery. Aperture a narrow slit at the suture, running up into this indentation. Wall smooth, polished, with very fine pores, thickened, especially on the dorsal side, opaque in transmitted light. In transverse section, this species shows the thickened dorsal wall, the fine pores, the completely closed umbilicus and the distinct, reduced toothplate at the periphery (which can also be seen by transmitted light from the dorsal side when immersed in oil), a structure quite similar to that of *E. repandus.*

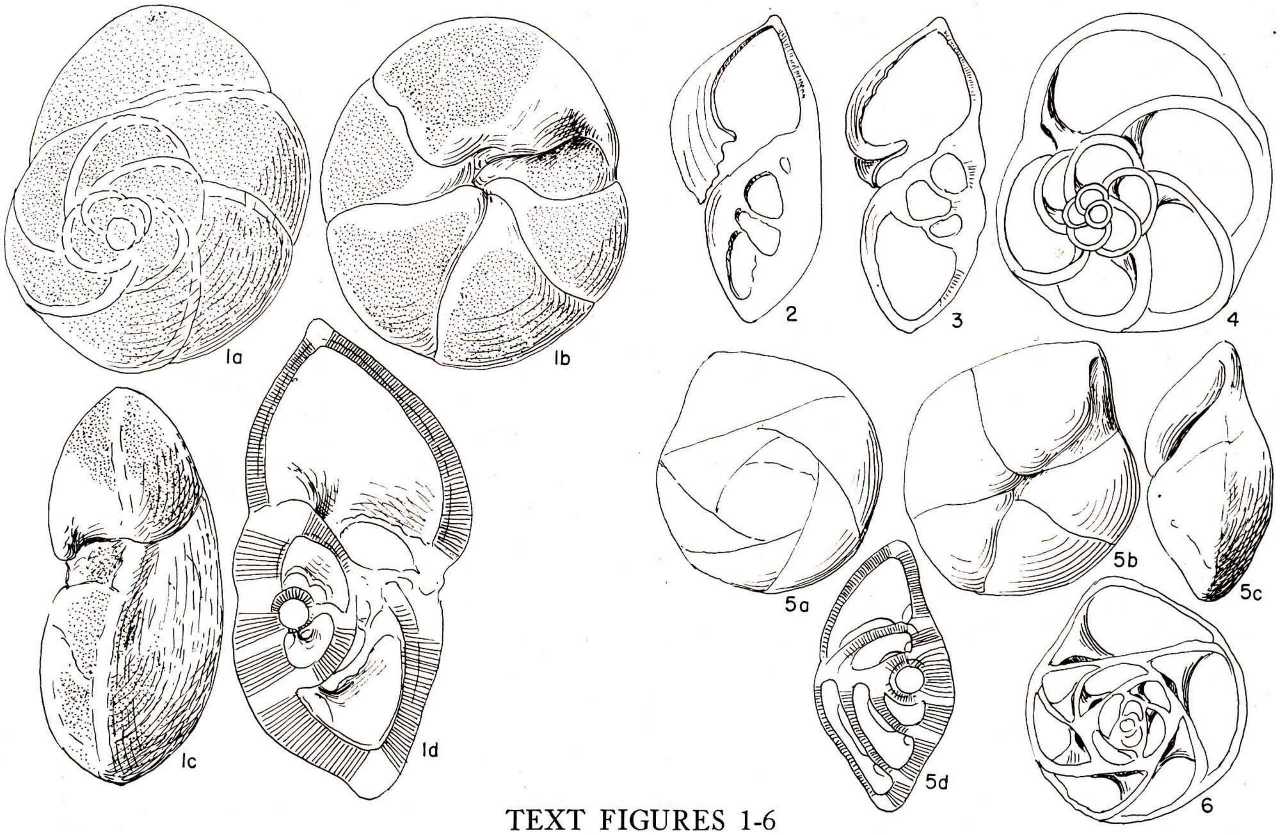
Thus, these two type species resemble each other so closely that one can distinguish them only by specific differences: the more convex dorsal side of *E. repandus,* the difference in size, etc. Common to both species are the following characters, which form genetic ones since they occur in all species of true *Eponides* and *Alabamina:*

Test thick, polished in reflected light, opaque in transmitted light.

Sutures nearly flush with the surface, strongly oblique on the dorsal side, nearly radial on the ventral.

Pores in the walls fine and dense.

Apertural face poreless, strongly curved upward, with a distinct indentation near the periphery.



TEXT FIGURES 1-6

Figs. 1-4, *Eponides repandus* (Fichtel and Moll). Bay of Naples, Mediterranean Sea. 1a, dorsal side; 1b, ventral side; 1c, apertural face; × 27. 1d, transverse section through another specimen, showing the aperture and toothplate, × 57. 2, tangential transverse section, × 27. 3, tangential section, more advanced than that of Fig. 2, showing the aperture and part of the toothplate, × 27. 4, horizontal section, showing the toothplates with their basal openings, × 27.

Figs. 5, 6, *Alabamina wilcoxensis* Toulmin. Vincentown formation. × 27. 5a, dorsal side; 5b, ventral side; 5c, apertural face; 5d, transverse section, showing the septal foramina and their toothplates. 6, horizontal section, showing the toothplates and their basal openings.

A reduced toothplate showing through the dorsal wall at the indentation.

Aperture an elongate slit at the ventral suture, ending at the indentation.

No umbilical depression, since the chamber walls reach the center and each other.

These common characters are numerous enough to postulate that the type species of *Eponides* and *Alabamina* belong to a single genus which must be *Eponides,* since that is the earlier generic name. The characters listed above are those of *Eponides.*

The structure of the toothplate has been fully described by Brotzen (1948, pp. 97, 98, text fig. 25) and his figure leaves no doubt as to the nature of his "infundibulum"; it is a true toothplate with the attached portion, while the free-folding part at its distal end is attached to the border of the aperture. Brotzen's foramen infundibulum is merely the free margin of the free-folding part of the toothplate. Exactly the same structure of the toothplate is seen in sections of *Eponides repandus.*

Thus, *Eponides* includes all forms with a smooth polished wall, lenticular shape, dorsal strongly oblique sutures, ventral radial sutures, no ventral umbilicus, apertural face curving upward, infundibulum (indentation) on the apertural face near the periphery, subacute periphery, elongate sutural aperture, reduced but often distinct toothplate ending in the infundibulum, rather fine pores, opaque wall in transmitted light. It may be that some forms, such as *Eponides toulmini* Brotzen, having much coarser pores also belong to the genus. *E. toulmini* also has the typical infundibulum, but the toothplate is much more reduced and scarcely detectable.

In the light of this investigation, which simplifies the system considerably, many species hitherto referred to *Eponides* must be restudied.

Eponides antillarum Cushman and Ponton also belongs to the group with coarser pores. Many species, which surely belong to *Eponides,* show clearly the indentation of the apertural face: *E. ellisorae* Garrett, *E. jacksonensis* (Cushman and Applin), *E. dorfi* Toulmin, *E. similis* (Bandy) (originally *Rotalia*), *E. yeguaensis* Weinzerl and Applin, *E. mexicanus* Howe, *E. lateralis* (Terquem), *E. concamerata* (Montagu), *E. umbonatus* (Reuss), etc. To this group with fine pores also belongs *E. beisseli* Schijfsma, an important guide fossil of the Upper Cretaceous of Europe. There are, however, many species which do not show the infundibulum and so must be revised. *To Eponides* also belong the various species (they mostly appear to form subspecies of *Alabamina dorsoplana* Brotzen) of *Alabamina.*

Previously, when dealing with the family Alabaminidae, the author (Hofker, 1956, pp. 164-167) said that *Rotalia trochidiformis* Lamarck, the type of the genus *Rotalia,* shows characters pointing toward *Alabamina* whereas *Eponides* does not have a toothplate. This latter statement must be corrected here; the toothplate, though much reduced, is present in the type species of *Eponides.* However, when one analyzes *Rotalia trochidiformis* from the type locality, in the Lutetian of Paris, one comes to the conclusion that this species also shows many characters pointing towards *Eponides,* when one includes in that genus the group with coarser pores. The characters of *Rotalia trochidiformis* are:

Test more or less lenticular, the dorsal side more convex than the ventral; the periphery subacute.

The sutures on the dorsal side flush with the surface, distinctly oblique.

The sutures on the ventral side radial, reaching the center to a greater or less extent, strongly depressed, however (unlike those of *Eponides repandus*). In addition, a secondary thickening of the test wall produces many knobs along the sutures giving rise to the typical ventral structure; the central part originally shows no umbilical depression but later chambers leave an umbilical area free which is filled with chalk knobs, thus producing a canal system.

The apertural face curved upward, just as in *Eponides.* There is a distinct indentation towards the periphery from which a short toothplate emerges. The apertural face is poreless.

The wall coarsely but regularly porous. These pores can be seen on the dorsal side but are mostly covered by the thickening of the wall on the ventral.

In the depressed sutures of the ventral side an opening can be seen from which a toothplate runs into the lumen of each chamber.

Only the latter structure differs somewhat from *Eponides;* the other characters correspond with those of that genus. This might lead to the conclusion that *Rotalia trochidiformis* must be more closely allied to *Conorboides* than to *Eponides,* although most of the characters point to a close relationship with the latter genus. There are very few species of *Rotalia* with the characters of the type species. Most species referred to this genus belong in other genera.

In the same paper mentioned above (Hofker, 1956) I pointed out that *Eponides antillarum* also should be placed in the genus *Rotalia.* In reality, it forms a somewhat transitional form between *R. trochidiformis* and the species of *Eponides* having coarse pores, such as *E. toulmini.*

Thus, we may assume that a large number of species occur, both Recent and fossil, associated with the type species *E. repandus.* They include the group related to *E. repandus,* a second group, with coarse pores, related to *E. toulmini,* a third group related to *Rotalia trochidiformis* (which bears no relation to *Streblus*!), and a fourth related to *Alabamina wilcoxensis.* If one were to retain these four genera, they would form the family Eponidae.

There are two genera allied to *Rotalia trochidiformis: Dictyoconoides* and, possibly, *Lockhartia.* Genera such as *Daviesina* and *Siderolites* seem to belong to another line which is not closely allied to the *Eponides* association.

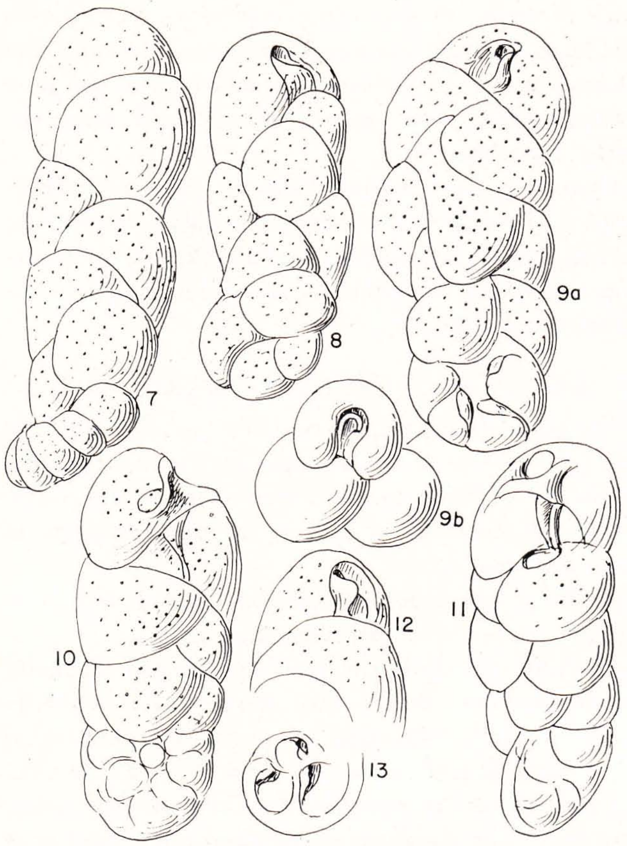
LACOSTEINA GOUSKOVI MARIE, 1945

The genus *Lacosteina* Marie (1945, pp. 295-298, text figs. 1-6) is known by a single species, *L. gouskovi* Marie. It is found in the Maestrichtian (not Campanian as reported by Marie) in many drillings in north and west Africa.

Study of specimens in rhicinus oil and with high magnification reveals the following data:

The tests are small, the walls hyaline and distinctly microcrystalline. At the base of the test a distinctly trochoid spiral, consisting of about 5 chambers, is found with the proloculus (in nearly all tests observed) not at the base but concealed by the later outgrowing chambers. The umbilicus of the basal coil is filled with a fine, grainy substance (chalk). The last-formed chamber of the single coil is larger than the earlier ones and grows partly over the dorsal side of the basal spire. Then, more chambers are added in a triserial arrangement, all more or less inflated. The last-formed chamber shows a wide, loop-shaped aperture in which a simple but typical toothplate is found having a slightly curved back and a free-folded part that does not protrude from the aperture. The pores are widely spaced and more distinct than in typical Cretaceous *Praebulimina,* but typical of those in lower Tertiary *Bulimina* (viz. *B. trigonata* Ten Dam). In each of the earlier chambers, in well-preserved specimens, the toothplates can be seen also, even in the first set of coiled chambers where they occur as small simple plates. From above (apertural face) the triserial arrangement of the chambers is obvious. The dimensions are those given by Marie.

There are two alternatives for the taxonomic status of this genus. Perhaps, as Marie suggested, it represents the most primitive stage of the genus *Bulimina.* Certainly, the first real *Bulimina* appear in the uppermost Maestrichtian; most species from the Cretaceous referred to *Bulimina* in reality belong to *Praebulimina,* with 4 chambers in a whorl and always having protopores. But, it may also be true that here we are dealing with an aberrant species of the genus *Conorboides,* having wild-growing later chambers for, in most tests observed, the base of the spiral portion forms an angle with the axis of coiling of the triangular portion and the character of the spiral portion suggests that it is attached to a substratum. We may be dealing therefore, with an aberrant *Conorboides,* comparable to tests



TEXT FIGURES 7-13

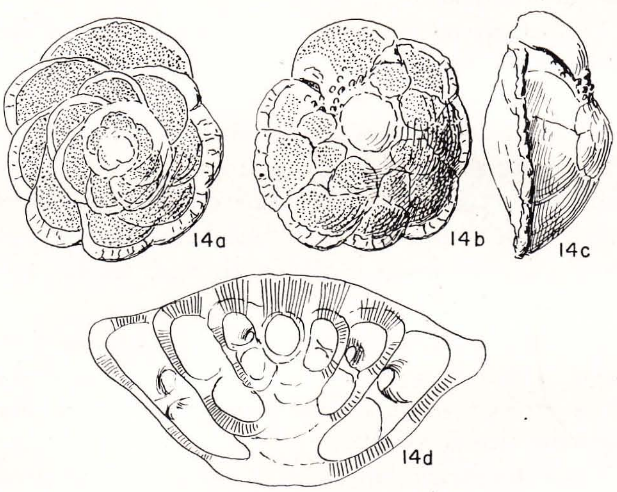
Lacosteina gouskovi Marie. × 210. From the upper Maestrichtian, west Africa. 7, large specimen showing the coiled portion from the side. 8, specimen showing the coiled portion from below; in the end chamber the toothplate and aperture are shown by transmitted light. 9a, specimen showing the coiled portion from the dorsal side; the toothplates of the coiled portion and end chamber can be seen; 9b, apertural view. 10, specimen showing toothplates in the two end chambers; the proloculus is seen on the dorsal side of the coiled portion. 11, same specimen seen from the opposite side, with toothplates. 12, end chambers of a specimen with a well preserved toothplate. 13, optical section through the coiled portion showing the simple toothplates.

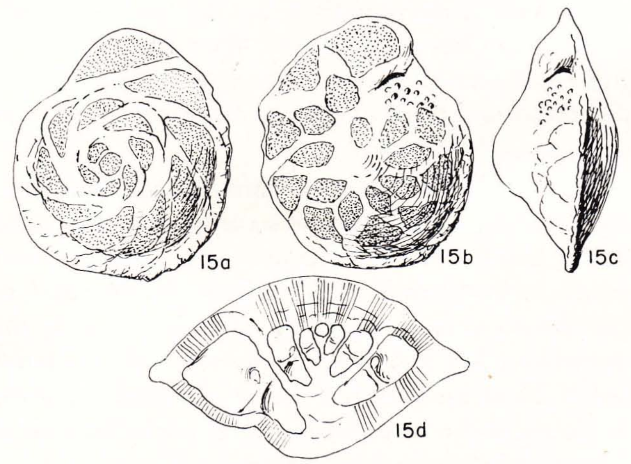
of *Planopulvinulina, Dyocibicides, Rectocibicides* or *Rupertia.* The genus *Conorboides* also shows toothplates which very much resemble those found here. Moreover, since we know that the first chambers of primitive *Bulimina* always show very fine pores, suggesting their relationship to fine-pored *Praebulimina,* it is unlikely that our genus is a primitive *Bulimina.* It seems likely that that group derives from coiled ancestors having a trochoid arrangement of chambers.

For the above reasons, the author is inclined to believe that *Lacosteina* is not a primitive *Bulimina* but a highly developed and aberrant species related to *Conorboides* or an allied genus. At any rate it belongs to the Dentata and cannot be allied to the rather dubious group included in the Heterohelicidae.

NUTTALLIDES FINLAY, 1939

Nuttall (1930, p. 287, pl. 24, figs. 9, 13, 14) described *Eponides trumpyi* Nuttall from the Guayabal formation of Mexico, given as middle Eocene. Since then this species has been found in the Eocene from all over the world. Finlay (1939) erected a new genus for it but his analysis of the form is not complete. As a result no one was aware of the fact that this species had been described already by several other authors under the name of *Rotalia campanella* Gümbel. Gümbel (1870, p. 650, pl. 2, fig. 86) described it from the Eocene of Europe; Terquem (1882, p. 74, pl. 7, figs. 1-4) reports it from the Lutetian of the Paris Basin as *Rotalina campanella;* Le Calvez (1949, p. 36) reports it as *Asterigerina campanella.* The author has confirmed the identity of the specimens from the Eocene of central Europe and France, although the specimens from Stockletten in Bavaria are somewhat more convex on the ventral side than are those from the





TEXT FIGURES 14, 15

Fig. 14, *Asterigerina trümpyi* (Nuttall), Guayabal formation, middle Eocene, Mexico, 2.5 km. northwest of Cervantes. a, dorsal side; b, ventral side; c, apertural face; × 27. d, transverse section, showing the toothplates dividing the normal chambers from the secondary ones; × 57.

Fig. 15, *Asterigerina campanella* (Gümbel), Lutetian of the Paris Basin. a, dorsal side; b, ventral side; c, apertural face; × 27. d, transverse section, showing toothplates dividing secondary chambers from the normal ones; × 40.

Paris Basin. The identity of these European forms with those from the Guayabal formation (the author has specimens from 2.5 km. northwest of Cervantes, a well-known locality of this Mexican Eocene) is certain.

The description of *Eponides trumpyi* is as follows: Test lenticular, the dorsal side slightly convex, the ventral one strongly convex. On the dorsal side there are 2.5 to 3 convolutions in the megalospheric form, with hyaline sutures between the chambers and a broad, spiral, hyaline suture. The sutures are strongly oblique, each chamber being somewhat triangular in shape. The pores are fine and are not found at the periphery of the dorsal side, which is hyaline. The periphery is subacute, poreless. The sutures are flush with the surface. The dorsal side is smooth and often polished. On the ventral side, the center is filled by a hyaline chalk mass which is flush with the surface. Hyaline, darker sutures are found between the normal chambers and the lozenge-shaped secondary chambers which alternate with them. This arrangement suggested to Nuttall the "sub-angular sinuousity" of the sutures which he described. The distinct keel of the periphery encloses the chambers. Near the aperture are found calcareous knobs like those in many other asterigerines. The aperture is a slightly arched slit at the ventral suture. In transverse section the normal chambers are separated from the secondary ones by distinct, poreless toothplates. The dorsal wall is thickened and the ventral umbilical area filled by hyaline chalk. Belford (1958, pp. 94, 95) figured and described the toothplate of *Nuttallides* but did not compare it with that of *Asterigerina,* though he mentions the transverse section through it given by Hofker (1956, p. 96).

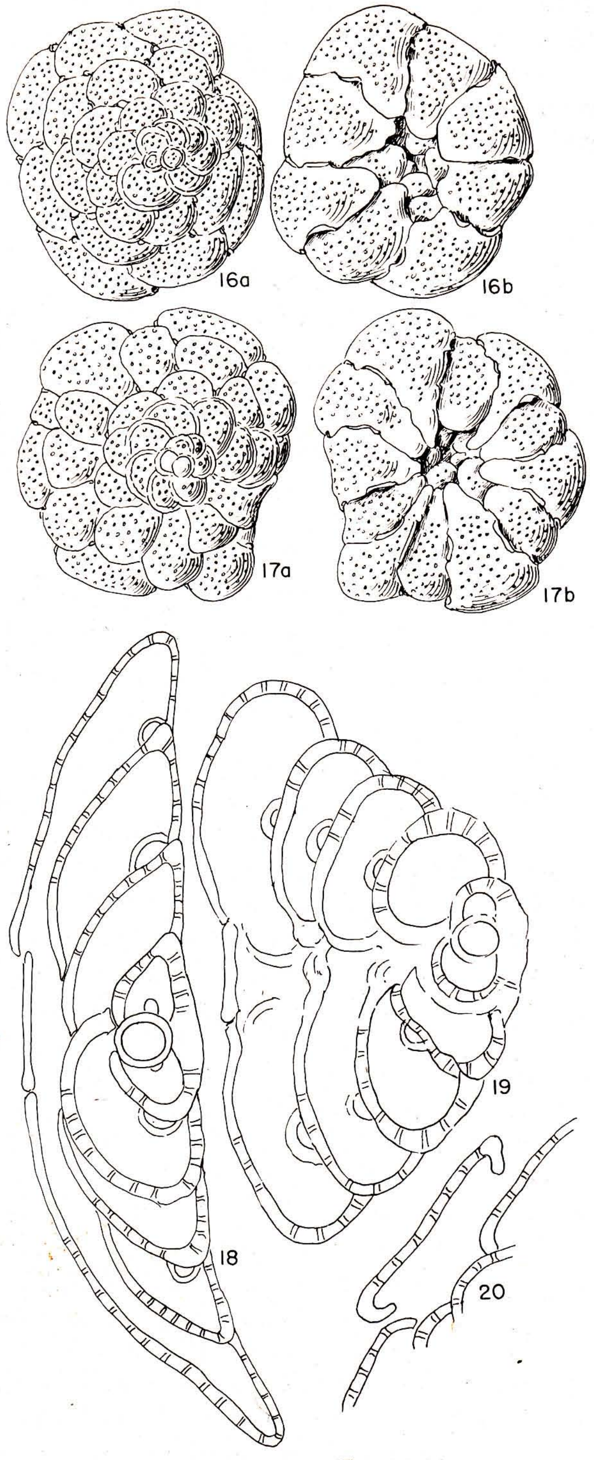
When we compare the Mexican species with specimens from the Lutetian of France, no real difference is found. Comparison with the type species of *Asterigerina* d'Orbigny, *A. carinata* from the Caribbean area (Recent), as analyzed by the author (Hofker, 1956, pp. 175-178, pl. 26, figs. 13-23) shows only specific difference. It is obvious that *Eponides trumpyi* is an *Asterigerina* and, therefore, *Nuttallides* is a synonym of *Asterigerina.*

The taxonomic position of *Asterigerina* with its flush surface, fine pores, oblique dorsal sutures, thick hyaline walls, and filled umbilical region must be near that of the genus *Eponides.* This, however, is not true of several other forms having secondary chamberlets such as *Asterigerinata, Asterigerinella, Asterigerinoides,* and *Heminwayina.* These genera, as will be shown in later papers, differ greatly from the general pattern of *Eponides* and are derived from quite other genera. This also is true of *Reinholdella,* already analyzed by the author (Hofker, 1952, pp. 15-29), which was derived from *Conorboides* Hofker. All groups with secondary ventral chamberlets, evolving from quite different sources, have the common character of a protoforaminal opening which is closed by a secondary porous plate. In quite different groups this phenomenon has occurred. They do not form a valid family, so that the family Amphisteginidae, as suggested by Cushman, does not include any astigerinid genus mentioned above. Yet it may be possible that more knowledge of fossil forms of *Amphistegina,* another genus with secondary ventral chamberlets, will lead to the assurance that this genus (having a smooth surface, fine pores, hyaline test, ventral filled umbilical region) is an offspring of some eponidid ancestor. *Asterigerinata, Asterigerinoides,* and *Heminwayina* have no eponidid characters. *Asterigerinella* Bandy, with its quite different aperture, must belong to another group of Foraminifera also. In this whole group of forms with secondary ventral chamberlets much has to be done before we can speak of a well-established taxonomic system.

PLANORBULINA D'ORBIGNY, 1826

The type species is *Planorbulina mediterranensis* d'Orbigny (1826, p. 280, pl. 14, figs. 4-6). In the relatively poor figure, d'Orbigny shows a flat, outspread form which, however, seldom is found in samples from the Mediterranean; most specimens are much smaller and, when attached to weeds, show characters which do not correspond to the description of the genus. In most cases observed (from Rimini, Italy, probably the type locality; Naples, Italy; Rhodes; coast of Holland, North Sea; many samples from the Caribbean area; etc.), the flattened test on the dorsal side shows a typical trochoidal coiling of the chambers, with mostly 5-6 chambers in a whorl. The first-formed chambers show a single aperture which becomes the septal foramen when a chamber is added. On the ventral side of these first chambers a distinct tenon is seen separating the main aperture from a second one which is smaller and seems to be the protoforamen. After about 6 chambers are formed, the ventral side of the next chamber seems to shift in such a way that the deuteroforamen and the protoforamen are placed more symmetrically to the left and right of the chamber while the tenon between extends out towards the center of the ventral side. From then on the chambers do not form a spiral but each foramen forms a chamber to the left and right of the previous one. In this way a test is formed which, at its periphery, shows several chambers protruding beyond the adjacent ones. In some overgrown attached forms, the ventral chamber walls do not reach the center of the ventral side and the earlier chambers can be seen there, but in other specimens they meet at the center or leave an umbilical hollow which is variable in size and in which the central chambers can be seen to a greater or less extent. On its ventral side each chamber shows both foramina, often having a thickened rim.

This situation of the foramina on the ventral side closely resembles the structure found in the genus *Cymbaloporetta,* as described by the author (Hofker, 1951a, pp. 477-484; 1956, pp. 186-189). Such a structure is not found in any other group of Foraminifera.



TEXT FIGURES 16-20

Figs. 16-18, 20, *Planorbulina mediterranensis* d'Orbigny. 16, specimen from Bay of Naples; × 27; a, dorsal side; b, ventral side. 17, specimen from Rimini, Italy; × 27; a, dorsal side; b, ventral side. 18, transverse section; × 160. 20, part of tangential section, showing both apertures; × 160.

Fig. 19, *Cymbaloporetta squammosa* (d'Orbigny), from Bonaire, Caribbean Sea; × 160; transverse section.

As was pointed out, the group of genera related to *Cymbaloporetta* (not *Cymbalopora*, which belongs to the Valvulinidae, agglutinated forms) must be closely allied to *Discopulvinulina* Hofker. When sections of *Planorbulina mediterranensis* are made and compared with those of typical *Cymbaloporetta*, the similarity of the two genera is striking. If one did not know that the Mediterranean species had been called *Planorbulina*, one would be inclined to describe it as a flattened *Cymbaloporetta*. We know from the investigations of Myers (1943) that the latter genus has an attached stage, living on weeds, as does *Planorbulina mediterranensis*. It may be that future investigations will prove that a free-living stage of *Cymbaloporetta* in the Mediterranean belongs in the generation cycle of that species.

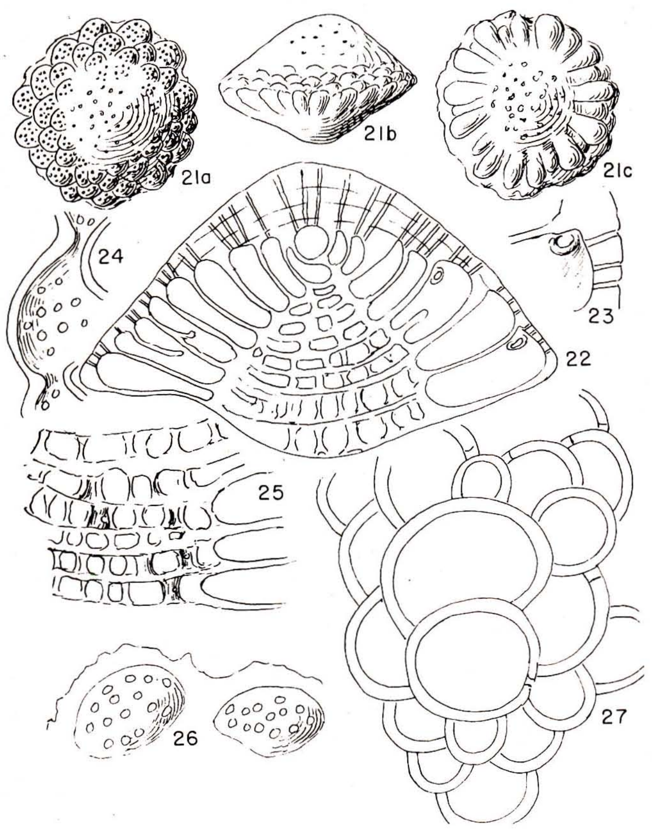
This would lead to the fact that *Planorbulina*, at least, belongs to the same group as *Cymbaloporetta* and its allies, associated with *Discopulvinulina*. Moreover, considering *Planorbulina mediterranensis* as a flattened form of *Cymbaloporetta* would lead to putting the latter genus into the synonymy of the former, older one. Thus, there would be but one family, Planorbulinidae, in which (if further investigation of the genera involved shows that their characteristics are like those of *Planorbulina*) the following genera would be placed: *Cymbaloporetta, Cymbaloporella, Tretomphalus*, etc., and *Planorbulina, Planorbulinoides* and possibly *Linderina*, etc. In this way the foraminiferal system would be further simplified, which must be our ultimate goal.

HALKYARDIA HERON-ALLEN AND EARLAND, 1919

The type species is *Cymbalopora radiata* Hagenow var. *minima* Liebus. The author obtained very well-preserved specimens from J. Mangin, Dijon, from the Eocene of Banis de Basques, Biarritz. Sections make it clear that the description given by various authors is not correct. The far too schematic figures given by Halkyard (1919) and reproduced by Cushman (1948, pl. 32, figs. 18, 19) are very misleading.

Description.—The test is lenticular, in most cases more convex on the dorsal than the ventral side. The central part of the dorsal side is covered by thick secondary layers of smooth chalk pierced by coarse pores whereas, nearer the periphery, the later chambers are visible having a distinctly annular arrangement and alternating. Here the slightly inflated chamber walls are distinctly pierced by the coarse pores. At the periphery the last-formed row of chambers protrudes slightly, forming a lobulate periphery which is acute.

On the ventral side, the central part is more convex than the peripheral. It shows no chambers and is provided with rounded openings which resemble pores. At the periphery the last row of chambers is clearly seen. These chambers are elongate, with radiating sutures which are completely closed and, thus, do not resemble the ventral sutures of *Cymbaloporetta*. The previous row of chambers is seen indistinctly between the last-formed ones and is more depressed. Each chamber has two very small foramina situated near the periphery.



TEXT FIGURES 21-27

Halkyardia minima (Liebus). Eocene, Biarritz, France. 21, × 57; a, dorsal side; b, edge view; c, ventral view. 22, × 160; transverse section through the test shown in Fig. 21; the umbilical filling does not consist of canals but of lamellae with pillars; only the dorsal walls of the chambers show pores. 23, × 210; one of the chambers in transverse section, showing the septal foramen near the margin. 24, × 210; horizontal section through a chamber at the periphery, showing its two foramina towards adjacent chambers. 25, × 210; part of the central umbilical filling; the lamellae, with the hollow pillars, some of which show a rounded opening in their walls. 26, × 210; dorsal surface of two peripheral chambers with the coarse pores. 27, × 210, horizontal section through the raspberry-type protoconch and some adjacent chambers.

The inner chamber walls are poreless, thin, slightly roughened.

In horizontal section, the initial chambers are of the raspberry type and are not arranged trochoidally as in *Cymbaloporetta.* In the megalospheric form, the only one which has been observed, the protoconch consists of two chambers, the rounded proloculus and a slightly larger second chamber, resting partly on the protoconch, as is seen in *Orbitoides.* The surrounding chambers are annularly arranged.

In transverse section, each row of chambers forms, in the central part under the initial chambers, a distinct, horizontal, thin, basal lamellum on which pillars are formed attaching this lamellum to the one above. These pillars are hollow cylinders such as are found in *Ferayina.* No canals connect the chambers, arranged below the surface of the test, to this central filling, as has been described by authors. The hollow pillars have, at their base, an opening in the basal lamellum and often in them round openings can be seen giving access into the other parts of the cavity between two lamellae. Thus, the total structure of the central part is very much like that found in *Ferayina.* On the dorsal side, older rows of chambers have developed a very thick dorsal wall by secondary thickening. The dorsal (outer) walls of the chambers show distinct pores. The walls of the chambers themselves are extremely thin.

The author has shown previously that *Cymbalopora* (type species, *Cymbalopora radiata* Hagenow), the central genus of the Cymbaloporidae, does not belong to the rotaliiform groups but is a valvulinid genus with a finely agglutinate wall and having pores only on the dorsal side of the chambers, whereas the ventral chambers open into a central ventral cavity. But, it is always possible that such an agglutinate form, especially when it belongs to the pore-bearing Valvulinidae, may, by reducing the grains of the agglutination, become the ancestor of a calcareous test, as has happened in most rotaliiform groups. The characteristic of having pores only on the dorsal side is, thus, in agreement with this view when we relate *Halkyardia* to *Cymbalopora.*

Cymbaloporetta, as stated previously by the author (Hofker, 1951b, 1956), bears no relation to *Cymbalopora,* since all species of the genus start with an initial stage which is like the typical structure of *Discopulvinulina,* a biforaminate genus. Moreover, the two foramina, separated by a distinct tenon, always occur at the two sides of the ventral suture of later chambers. The arrangement of the first sets of chambers in *Cymbaloporetta* is trochoidal.

The chamber walls of *Halkyardia* are microgranular in polarized light; this is in agreement with a closer relationship to agglutinate *Cymbalopora* than to *Cymbaloporetta.*

When, on the other hand, we consider *Ferayina* we find that that genus also has microgranular walls, large pores on the dorsal side, none on the ventral one, and that it likewise begins with an initial set of chambers which are suggestive of the raspberry type. Moreover, on the ventral side this genus develops horizontal lamellae with pillars quite similar to those found in *Halkyardia.* However, the annular arrangement of chambers is not found in *Ferayina,* but the chambers following the initial set become uniserial so that there is no longer any difference between the chambers and the lamellae. When we consider the development from *Conorboides,* a trochoidal genus, into *Colomia,* an uniserial one, we find an almost similar development to that when we consider *Ferayina* as a uniserially built *Halkyardia.* As I have pointed out previously (Hofker, 1956), the wall of *Ferayina* is microgranular and very suggestive of the valvulinid wall structure.

There is a possibility that in Maestrichtian *Cymbalopora* the large ventral cavity and the open chambers facing that cavity do not show the real structure of this genus. It is probable that there were lamellae filling this cavity but that they consisted largely of aragonite which always is dissolved in chalky sediments, such as those in which *Cymbalopora* has been found hitherto. In that case there would be a striking development series: *Cymbalopora-Halkyardia-Ferayina.* If this supposition is correct, the family Cymbaloporidae could be maintained, including, as known so far, these three genera. They would form a very distinct valvulinid group, in no way related to *Cymbaloporetta, Cymbaloporella, Tretomphalus* (which latter genus has no real status since it forms a generation of *Cymbaloporetta*) and *Pyropilus.* It may be that a closer analysis of *Fabiania* will show its alliance with the true Cymbaloporidae.

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199. THE FORAMINIFERAL SPECIES *FABIANIA CASSIS* (OPPENHEIM), IN JAPAN

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ABSTRACT

Specimens referred to the European species, **Fabiania cassis** (Oppenheim), have been found in a basal conglomerate of Eocene age on Shikoku Island, southwestern Japan. The various species of **Fabiania** are analyzed. All of the species are seemingly synonyms of **Fabiania cassis** which has a world-wide distribution in the tropical belt.

ACKNOWLEDGMENT

Appreciation and thanks are extended to Professor W. Storrs Cole not only for advice and suggestion, but also for reading this manuscript. The writer spent several months at Cornell University (as a part of a program of study of larger Foraminifera) as a Fulbright Exchange Visitor during the academic year 1958-1959.

INTRODUCTION

The foraminiferal species known as *Fabiania cassis* (Oppenheim) (1896, p. 55, 56, pl. 2, figs. 2, 3) was described originally as a gastropod and assigned to the genus *Patella* (*Cymbiola*). Later, Silvestri (1926, p. 15-22, pl. 1) correctly compared these specimens with certain Foraminifera, *Lituonella roberti* Schlumberger, *Lituonella liburnica* Schubert, *Coskinolina liburnica* Stache, *Dictyoconus aegyptiensis* (Chapman), and *Chapmania gassinensis* Silvestri, but concluded that they were some type of corals. However, he did assign them to a new genus, *Fabiania*. Cole (*in* Cushman, 1948, p. 310) was the first to recognize that *Fabiania* was a Foraminifera belonging to the family Cymbaloporidae.

Cushman and Bermudez (1936, p. 59, pl. 10, figs. 27-30) described specimens of *Pseudorbitolina cubensis* from Cuba which are seemingly the same as *Fabiania cassis*. Later, Cole and Bermudez (1944, p. 6-10, pl. 1, fig. 1; pl. 2, figs. 1-12; pl. 3, figs. 1-5) erected the genus *Eodictyoconus* for these Cuban specimens, and Keijzer (1945, p. 213, 214, pl. 7, figs. 105-112) assigned them to another new genus, *Tschoppina*.

In the Indo-Pacific area two species of *Fabiania* have been described: *Fabiania saipanensis* Cole (*in* Cole and Bridge, 1953, p. 28, pl. 15, figs. 1, 2) from Saipan Island and *Fabiania indica* Nagappa (1956, p. 192-195, pl. 30, figs. 1-9, text-figs. 1-3) from the Sylhet limestone of Assam. All of these species, both from the Caribbean area and the Indo-Pacific region, are seemingly the same as the European *Fabiania cassis*. Thus, the species has a world wide distribution in the middle and upper Eocene of the tropical belt.

THE STRATIGRAPHIC OCCURRENCE OF *FABIANIA CASSIS* (OPPENHEIM) IN JAPAN

Specimens of *Fabiania cassis* were found in thin sections of a calcareous sandstone which is the matrix of the basal conglomerate of the Tertiary formation of the Ishizuchi Mountains, Ehime Prefecture, Island of Shikoku, southwestern Japan. The marine sediments of these mountains were discovered first by Professor Kozo Nagai of Ehime University, Matsuyama City, Ehime Prefecture. Previously all the Tertiary sediments in the Ishizuchi Mountains had been considered to be non-marine in origin by other Japanese geologists.

The Ishizuchi Mountains extend from east to west along the longer axis of Shikoku Island in the vicinity of Matsuyama City and Kuma Town in Ehime Prefecture. The basal conglomerate of the so-called Ishizuchi Tertiary outcrops widely in this area, but the part which may be satisfactorily assigned to a marine origin has been found by Nagai and the writer to outcrop only at the top of a hill near Nimyo, Fujimine-mura, Kami-Ukeana-gun, which is close to Kuma Town. It is in these rocks that *Fabiania cassis* was found.

The basal conglomerate is variable in thickness and grades upward within a short stratigraphic interval into non-marine rocks consisting of shales and sandstones with some thin coal seams. These beds are followed by a thick section of the beds of non-marine origin of Miocene and Pliocene age. The Miocene and Pliocene beds, composed of clastic and pyroclastic sediments, are separated from the underlying non-marine sequence by an angular unconformity.

The non-marine sequence below the unconformity contains numerous well-preserved fossil plants of which Nagai has collected representatives of *Nelumbo nipponicus* Endo and *Sabalites nipponicus* Endo, both from the coal seams and the shales. These fossil plants occur also in similar non-marine beds of Kyushu, southwestern Japan, and Hokkaido, northern Japan, and are assigned to the Eocene.

The basal conglomerate in which *Fabiania cassis* was found is either horizontal or nearly so and overlies an erosion surface which is underlain by highly deformed, green-colored metamorphic rocks which outcrop from east to west across the entire northern part of Shikoku Island. Although the age of this metamorphic rock is not known, it is assumed to be Paleozoic in age. However, field evidence indicates only that it is older than Lower

Cretaceous as boulders derived from it have been found in the conglomerates of the lowest Lower Cretaceous Ryoseki formation and in the *Orbitolina* sandstone of Albian age in Shikoku.

The basal conglomerate of the Ishizuchi Tertiary section is composed of rounded boulders and cobbles embedded in medium to coarse sands all of which were derived from the underlying metamorphics. In the sandy matrix are rather numerous specimens of *Fabiania cassis* and less abundant specimens of *Discocyclina* sp. Moreover, there are rare specimens of smaller Foraminifera. In addition there are many fragments of mollusks, abundant bryozoans and numerous coralline algae.

DESCRIPTION OF SPECIES

Family CYMBALOPORIDAE

Genus **Fabiania** Silvestri, 1926

Fabiania cassis (Oppenheim)

Plate 9, figures 1-15

Patella (Cymbiola) cassis Oppenheim, 1896, p. 55, 56, pl. 2, figs. 2, 3.

Fabiania cassis (Oppenheim), Silvestri, 1926, p. 15-22, pl. 1.

Pseudorbitolina cubensis Cushman and Bermudez, 1936, p. 59, pl. 1, figs. 27-30; Cole, 1941, p. 22, 23, pl. 2, figs. 5-11; Cole, 1942, p. 18, 19, pl. 3, fig. 4; pl. 5, fig. 1; Cole, 1944, p. 35, 36, pl. 2, fig. 7; pl. 8, figs. 14, 15; pl. 13, figs. 1, 2.

Eodictyoconus cubensis (Cushman and Bermudez), Cole and Bermudez, 1944, p. 6-10, pl. 1, fig. 1; pl. 2, figs. 1-12; pl. 3, figs. 1-5; Cole, 1945, p. 98, pl. 12, figs. 10, 11.

Tschoppina cubensis (Cushman and Bermudez), Keijzer, 1945, p. 213, 214, pl. 7, figs. 105-112.

Fabiania, Silvestri, Furrer, 1949, p. 121, 128-132, text-fig. 3.

Fabiania cubensis (Cushman and Bermudez), Bermudez, 1952, p. 102, pl. 18, figs. 2-5.

Fabiania saipanensis Cole, *in* Cole and Bridge, 1953, p. 28, pl. 15, figs. 1, 2; Cole, 1957a, p. 337, pl. 102, figs. 7-9; pl. 118, fig. 8; Cole, 1957b, p. 767, 768, pl. 245, figs. 1, 2; Hanzawa, 1957, p. 62-64, pls. 28-30.

Fabiania indica Nagappa, 1956, p. 192-195, pl. 30, figs. 1-9, text-figs. 1-3.

As the specimens of the larger Foraminifera are embedded firmly in the matrix, they could be studied only in thin sections. Moreover, as the Foraminifera are relatively scarce, it was difficult to obtain accurately oriented sections. However, by observation of numerous random thin sections, it has been possible to make a complete analysis of this species.

Fabiania cassis has a depressed conical shape with a bluntly rounded apex. The base may be round, roughly elliptical or irregular in outline. The dorsal outer surface is covered with a moderately thick, coarsely perforated wall. However, these specimens do not show the peculiar wall structure which was found in specimens from Saipan Island (Hanzawa, 1957, pl. 30, figs. 6, 7).

The interior of the test below the dorsal surface layer is composed of a layer with two types of alveoli, one coarse, the other fine. Each alveolus is formed by horizontal and vertical partitions with compact walls which intersect. Each coarse alveolus is usually subdivided into two smaller alveoli, although occasionally there are three of the smaller alveoli. The partitions which form these smaller alveoli are thinner and shorter than those which form the larger alveoli.

Below this layer the internal cavity of the test is subdivided into several tiers of chambers by partitions which are formed by the inward extension of the vertical and horizontal partitions which formed the coarse alveoli of the intermediate layer.

These specimens are similar to specimens from Saipan Island which have been named *Fabiania saipanensis* and to the types of *Fabiania cassis*. Moreover, the specimens from the Caribbean area, known as *Fabiania cubensis,* appear to be within the specific limits of *Fabiania cassis*.

Nagappa (1956, *loc. cit.*) in his description of *Fabiania indica* recognized that it was closely related to *Fabiania cassis*. However, he believed that *Fabiania indica* was smaller than *Fabiania cassis* and developed smaller alveoli. These are minor differences, as size is not a specific criterion. *Fabiania cassis* is a variable species both in size and in the number of secondary alveoli within each large alveolus.

Examination of numerous specimens in the Cole collection at Cornell University has shown that specimens formerly referred to *Fabiania cubensis* (= *Fabiania cassis*) from St. Bartholomew Island, French West Indies (A. Senn loc. 37) and from Cuba (Bermudez loc. 161) are variable in shape. Moreover, these specimens normally have each major alveolus subdivided into two smaller alveoli, but occasionally there are three of these smaller alveoli. A few specimens have undivided, coarse alveoli in the initial stage of the test, and rare specimens are found in which the entire test is composed only of undivided alveoli.

Although *Gunteria floridana* Cushman and Ponton (1933, p. 25-30, pl. 3; Cushman, 1937, p. 196; Cole, 1942, p. 28, 29, pl. 16, figs. 1-4; Cole and Gravell, 1952, p. 712, 713, pl. 91, figs. 1-4) was not studied intensively, it probably represents another form of the variable species *Fabiania cassis*. Cole (1957a, p. 337) has already suggested that *Gunteria floridana* may prove to be a synonym of *Fabiania cassis*.

Küpper (1955, p. 133-139, pl. 19, text-figs. 1-7) described specimens from California which he named *Eofabiania grahami*. Although he placed these specimens in a new genus and species, it is probable that they are *Fabiania cassis* as there are many similarities between these specimens and typical specimens of *Fabiania cassis*. The illustrations given by Küpper seemingly show the presence of the small, secondary alveoli in parts of the cortical layer of the test.

However, the internal structure of *Eofabiania grahami* is somewhat similar to that of *Cymbalopora irregularis* Keijzer (1945, p. 212, 213, pl. 11, figs. 5-8) (= *Cymbalopora cushmani* Cole and Bermudez, 1947, p. 10, 11, pl. 3, figs. 6-8; pl. 7, fig. 3). Both have hollow chambers which are irregular in shape as viewed in axial section, and these chambers are enclosed by coarsely perforate walls.

Although it is impossible to be certain of the relationships without studying numerous specimens of *Eofabiania grahami,* it appears that *Eofabiania grahami* more nearly resembles certain specimens of *Fabiania cassis* than it does specimens of *Cymbalopora irregularis*.

Dimensions of *Fabiania cassis* (Oppenheim)
from various localities

Measurements of entire specimens (mm.)

	Conical specimens			Encrusting specimens	
	Height	Length	Width at base	Thickness	Width
1.	3-6		2.2-2.5	0.5	4-15
2.	0.6-0.85	5.5-6	1.2-1.5		
3.			1.6-2.8		
4.	2-4 (3)	4-7	2-3 (1.5)		
5.	1.2		2.4		
6.	1.1-1.26		1.9-2.3		
7.	0.67-1.85		1.96-3.77		

Measurements of internal structure (μ)

	Dorsal wall		Larger alveoli			
	Thickness	Pores, width	Height	Width	Length	Partitions, thick.
1.	62-100	25	250	88-100		87
3.	34-100	5-20	88-122	85-170	220	34-52
6.			140			
8.	52	5	120-220	120-220		34-52

	Finer alveoli				Proloculus, diam.
	Height	Width	Length	Partitions, thick.	
1.	125	30-40	350	25	
2.					170 x 222
3.	66-65	42-60		35	100 x 112
8.	68	50-68		10	

N. B. 1) Saipan specimens, 2) Cuban specimens (Bermudez loc. 161) (Cole and Bermudez, 1944), 3) Shikoku specimens, 4) Type specimens of Silvestri (of Oppenheim in parenthesis), 5) Florida specimens, V. G. Phillips No. 1 well (Cole, 1945), 6) Florida specimens, Turpentine Co. No. 1 well (Cole, 1944), 7) Assam specimens, 8) St. Bartholomew specimens (A. Senn loc. 37)

Family DISCOCYCLINIDAE

Genus **Discocyclina** Gümbel, 1868

Discocyclina sp.

Plate 9, figures 16, 17

Although more than twenty thin sections from this locality, with an average size of 3 x 4 cm., were examined, only two vertical sections of *Discocyclina* were found. These are illustrated. With so few specimens available, it was impossible to identify them specifically.

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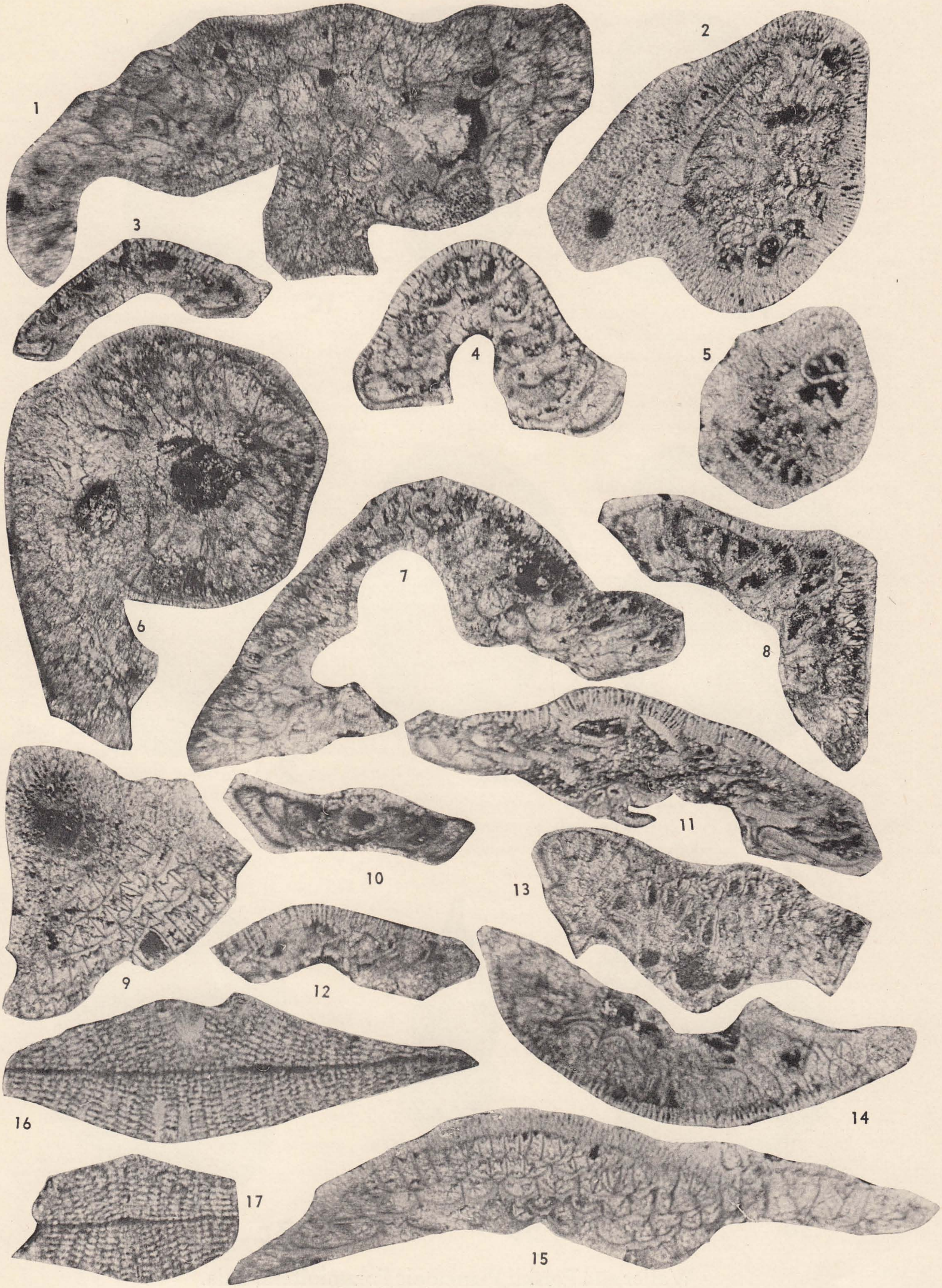
EXPLANATION OF PLATE 9

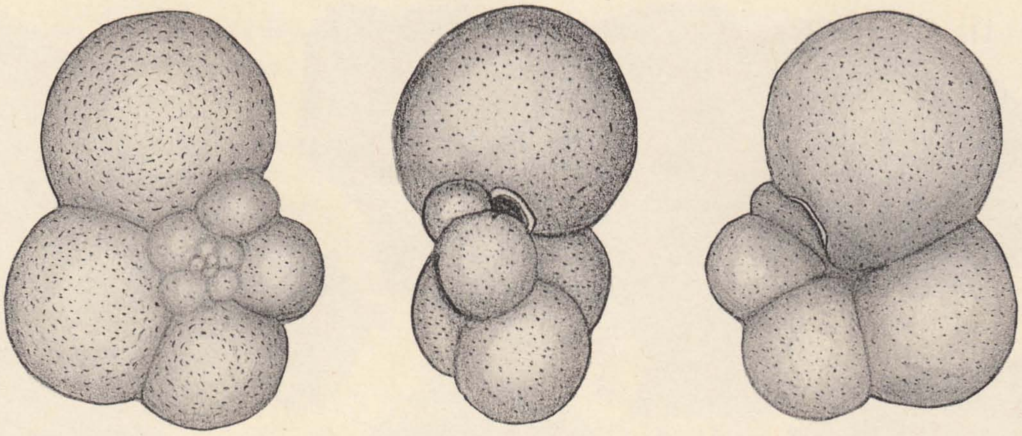
FIGS.		PAGE
1-15.	*Fabiania cassis* (Oppenheim)	120
	1, 6. Horizontal sections cut near base of tests. 2, 5. Oblique sections cut through (or near) proloculi. 3, 4, 7, 10-12. Vertical sections. 8, 9, 13-15. Tangential or slightly oblique sections of cortical layer.	
16, 17.	*Discocyclina* sp.	121
	Vertical sections.	

All the specimens are from Nimyo, Fujimine-mura, Kami-Ukeana-gun, Ehime Prefecture, Shikoku, Japan.

All figures × 40.



Hanzawa: *Fabiania cassis* in Japan



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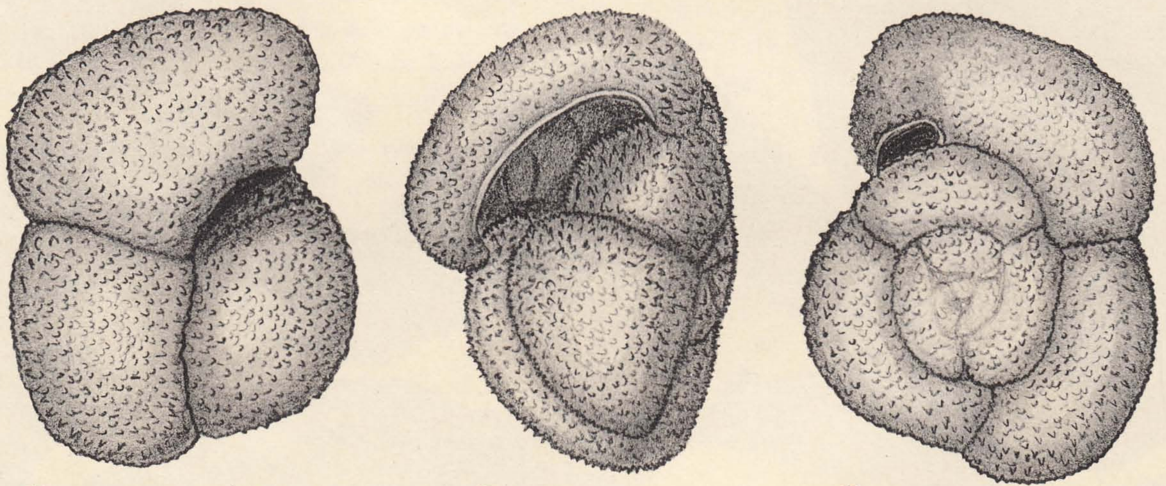

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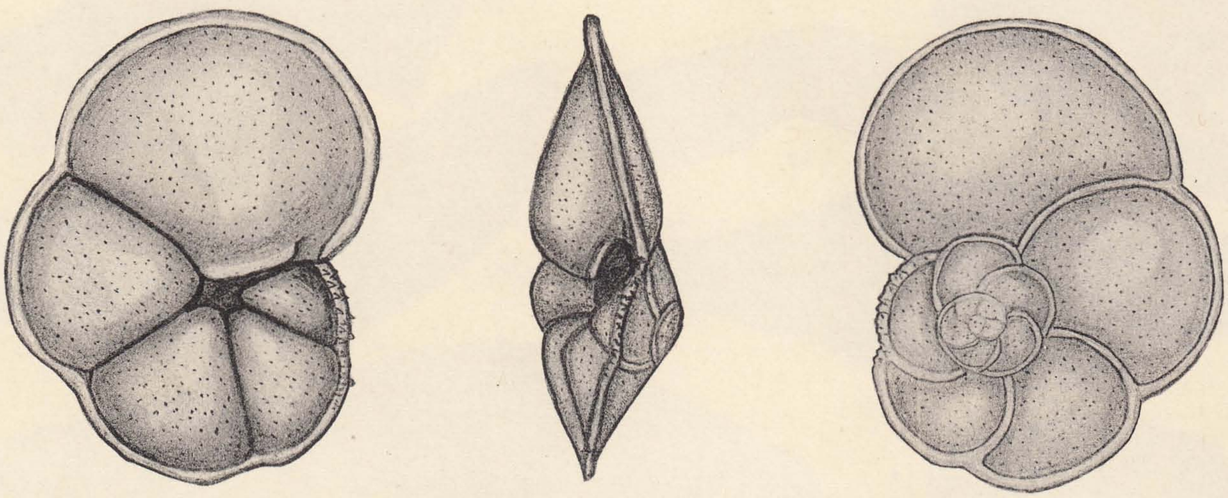

3a 3b 3c

Waller and Polski: Planktonic Foraminifera, Asia.

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200. PLANKTONIC FORAMINIFERA OF THE ASIATIC SHELF[1]

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ABSTRACT

About 300 bottom samples from the Gulf of Tonkin north to the Yellow Sea were examined for their content of planktonic Foraminifera. Faunal groups were established and related to thermal ranges and latitude. Average surface water temperatures higher than 20°C.-27°C. yield greater than 75 percent normal sized, unbroken tests, whereas average surface water temperatures less than 20°C.-27°C. produce mostly small, easily broken tests.

The distributions of some species suggest a zonation with depth. Coiling direction of **Globorotalia menardii** and **Globorotalia trigonula** is left whereas **Globigerina subcretacea** and **Pulleniatina obliquiloculata** coil right.

Four temperature restricted faunas are established: Warm Water Restricted, 19°C.-30°C.; Warm Water Preferred, 6°C.-30°C.; Transitional, 4°C.-30°C.; Cold Water, 4°C.-26°C.

INTRODUCTION

The value of planktonic Foraminifera as an ecologic tool is increasing as more data are accumulated on the parameters that affect the vertical and horizontal distribution of these animals. This study examines three parameters: temperature, latitude, and depth.

The area involved in this study is approximately 1500 miles by 100 miles, extending from the Gulf of Pohai south and west to the Gulf of Tonkin (Figure 1). High temperature, high salinity Kuroshio Current water sweeps northward into the Gulf of Tonkin, across the break in slope (400 feet) into the South China Sea, encircles Taiwan Island and advances into the East China Sea, Yellow Sea and the Gulf of Pohai. A low temperature, low salinity coastal countercurrent flows generally southward from the Gulf of Pohai to the South China Sea and out of the Gulf of Tonkin. Yearly summer and winter temperatures of these two currents are averaged to supply values used in Figure 2. All 300 bottom samples, except ten, were from depths between 49 and 400 feet.

This study was done by the writers at the University of Southern California, during 1957 and 1958. Samples were supplied by Dr. Hiroshi Niino, of the Tokyo University of Fisheries. Dr. Niino and Dr. K. O. Emery examined the sedimentologic properties of these and other samples in a joint study at the University of Southern California in 1956 and 1957.

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The writers wish to express their gratitude to Dr. Orville L. Bandy for his aid and suggestions. Thanks are due to Dr. Hiroshi Niino of the Tokyo University of Fisheries and Dr. K. O. Emery of the University of Southern California for supplying the samples and surface water temperature data.

DISCUSSION

There is an increase in the percentage of planktonic Foraminifera with depth on the floor of the ocean. This may be a result of the fact that the benthonic population lives on one plane, the ocean floor, whereas the planktonic population lives at many depths. The deeper the water, the greater the number of tests that can rain down on any given unit area. Assuming life cycles of planktonic Foraminifera to be approximately equal to those of benthonic Foraminifera, this relationship is straightforward.

Brackish water areas directly off the Hsi River estuary limit the distribution of planktonic Foraminifera. Surface salinity values of 27 parts per thousand are not consistent with prolific planktonic populations. Low planktonic percentages may be due in part to the invasion of shelf water by river waters that will not support planktonic Foraminifera.

Certain planktonic species prefer or are limited to certain densities of water resulting in a definite depth stratification in the water column. According to Emiliani (1954, p. 153) the controlling factors which determine the stratification are probably the density of the water, the specific gravity of the entire animal and the depth of light penetration. Parker (1948, p. 236) found that undiluted sea water is needed for planktonic species to thrive; dilution of coastal water by runoff from large rivers reduces the density of the water so that it falls below the specific gravity of the Foraminifera. Therefore, the volume of water displaced by the foraminiferal test and its protoplasm may limit its buoyancy and not permit it to rise beyond partic-

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[1] This study represents a contribution of the Allan Hancock Foundation, University of Southern California, Los Angeles, California.

[2] Caltex Pacific Oil Company, Rumbai, Pakanbaru, Sumatra.

[3] Shell Oil Company, Bakersfield, California.

EXPLANATION OF PLATE 10

FIGS.		PAGE
1.	*Globigerina hirsuta* d'Orbigny, 1839, × 85.	125
2.	*Globorotalia trigonula* (d'Orbigny, 1903), × 65.	125
3.	*Globorotalia cultrata* (d'Orbigny, 1839), × 50.	125

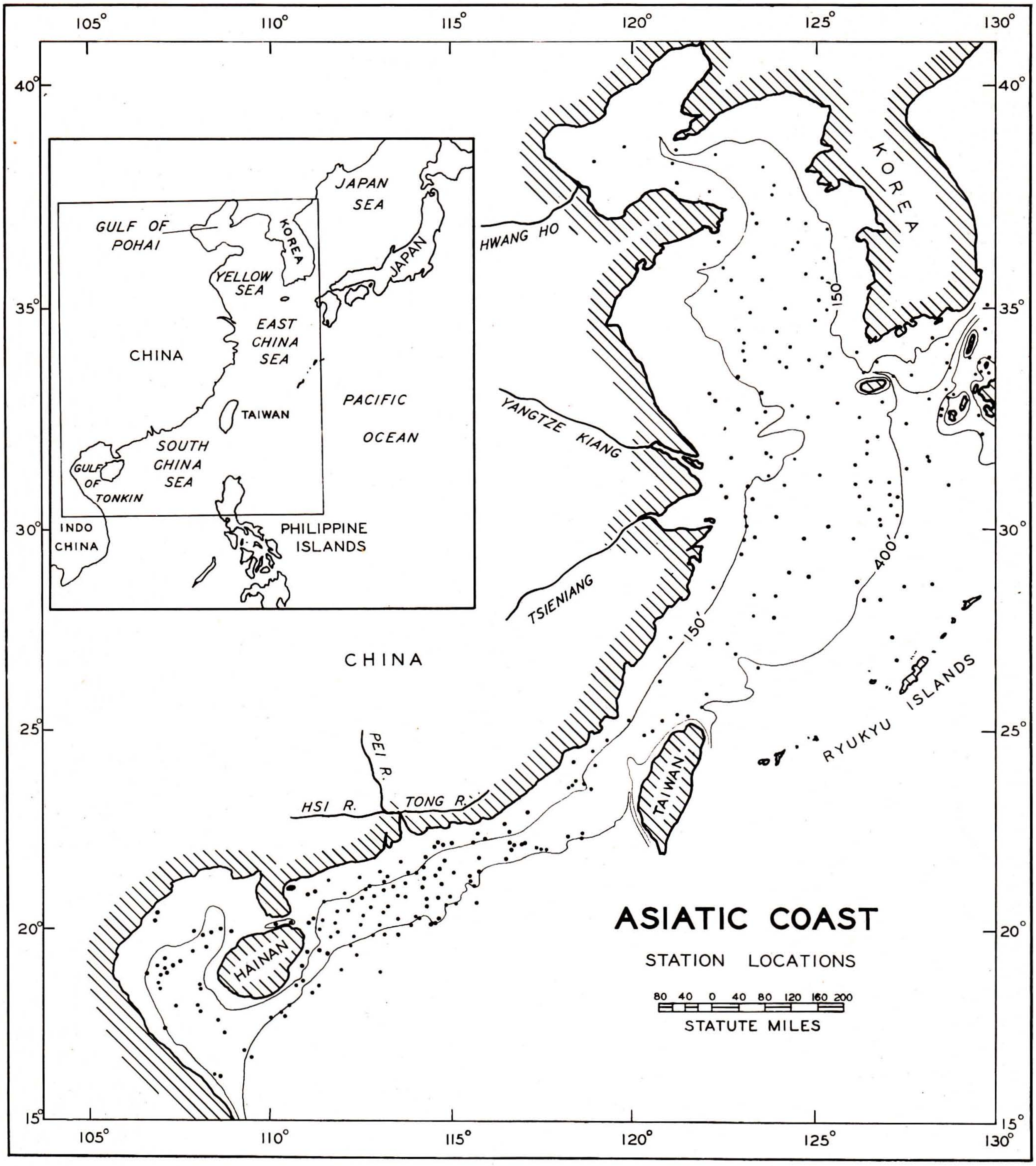

FIGURE 1
Station locations off the Asiatic coast

ular depths. Several species appear regularly below certain depths, suggesting a zonation with depths as follows:

Globigerina bulloides	150 feet
Globigerina subcretacea	160 feet
Globorotalia trigonula	200 feet
Pulleniatina obliquiloculata	220 feet
Orbulina universa	260 feet
Globorotalia menardii	300 feet
Globigerina quinqueloba	300 feet
Globigerinoides conglobatus	310 feet

Globigerinoides ruber is the most widely distributed species south of Taiwan occurring most consistently deeper than 200 feet. None of these specimens had the characteristic red color of the species.

The coiling direction is determined to be right-handed or dextral when viewed from dorsal side, the chambers being added in a clockwise direction, and left-handed or sinistral when the chambers are added in a counterclockwise direction. *Globigerina subcretacea* and *Pulleniatina obliquiloculata* coil right and *Globorotalia menardii* and *Globorotalia trigonula* coil left. All other planktonic species coil about equally to the right and left.

Some species diminish in abundance northward indicating warm water affinities (Figure 2). Four faunas are established as a result of this temperature-latitude restriction:

Warm Water Restricted - 19°C.-30°C.
- *Globigerina hirsuta* (Pl. 10, fig. 1)
- *Globorotalia cultrata* (Pl. 10, fig. 3)
- *Globorotalia truncatulinoides*
- *Hastigerina aequilateralis*
- *Orbulina universa*

Warm Water Preferred - 6°C.-30°C.
- *Globigerinoides conglobatus*
- *Globigerinoides cyclostoma*
- *Globigerinoides ruber*
- *Globorotalia menardii*

Transitional - 4°C.-30°C.
- *Globigerina druryi*
- *Globigerina subcretacea*
- *Globigerina quinqueloba*
- *Globigerinoides sacculifer*
- *Pulleniatina obliquiloculata*

Cold Water - 4°C.-26°C.
- *Globigerina bulloides*
- *Globigerina dutertrei*
- *Globigerina gibba*
- *Globorotalia trigonula* (Pl. 10, fig. 2)

Bradshaw (1959) related water temperature to four planktonic faunas which he terms "warm equatorial," "warm central," "transitional" and "cold sub-arctic."

A sharp decrease in abundance of large, unbroken tests occurs between 23 and 25 degrees north latitude, where average surface water temperatures are between

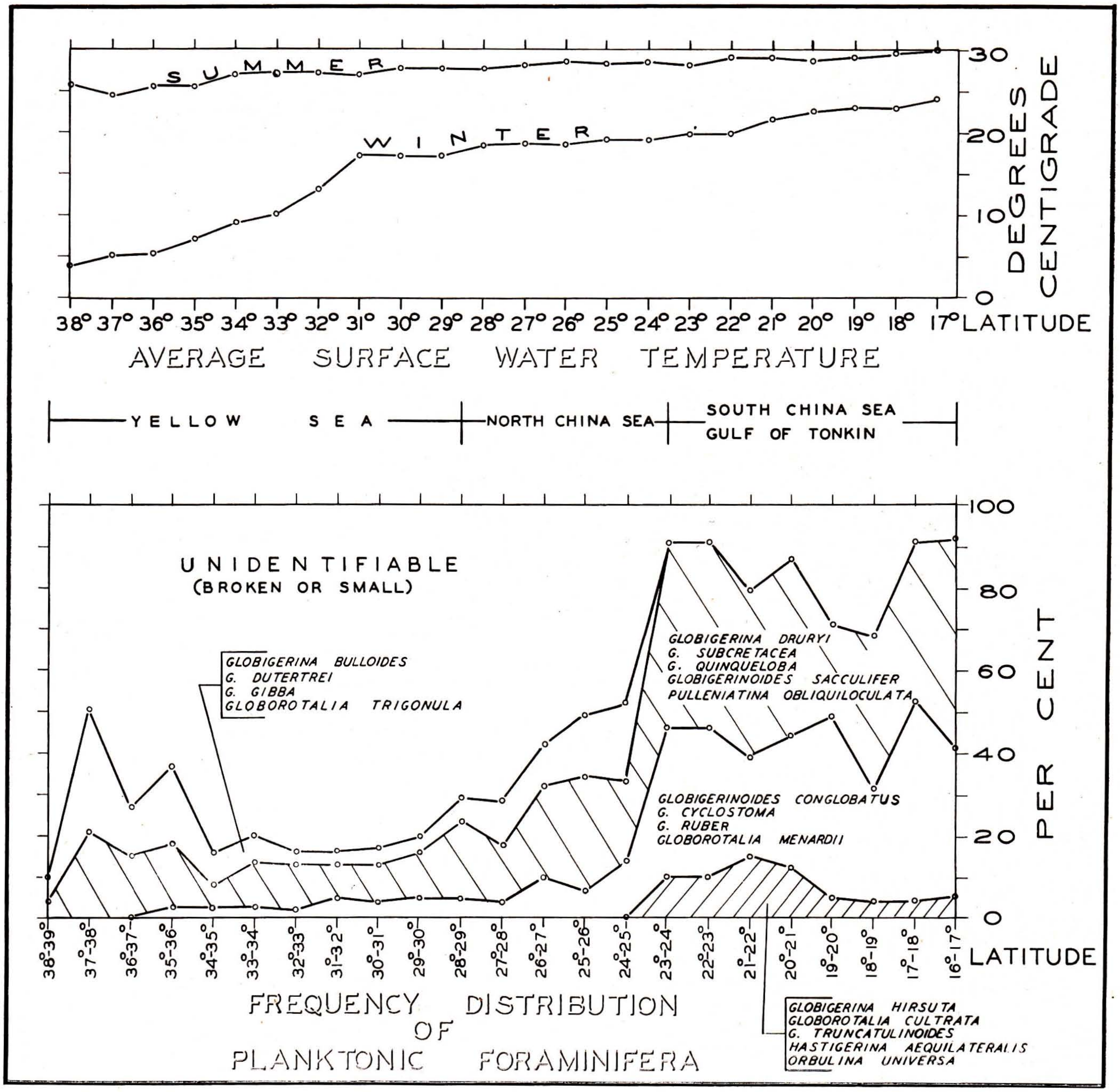

FIGURE 2

Average surface water temperature and frequency distribution of planktonic Foraminifera

20°C. and 27°C., and continue to decrease northward into cooler waters. Abundant large, unbroken tests appear to vary directly with the water temperature.

The balance of the planktonic fauna designated "Unidentifiable" consists of very small, presumably juvenile forms which may have contained *Globigerina bulloides*. Therefore, this species may not necessarily be restricted to the cold water group. The large percentage of unidentifiable species in the northern part of the area may be due to the influence of the Kuroshio Current. This current transports the juvenile forms into the rigid environment of the cold northern waters inhibiting their development.

CONCLUSIONS

1. Water temperature limits the size of planktonic foraminiferal tests with smaller, easily broken tests occurring in percentages greater than 50 in waters colder than 20°C.-27°C. and larger, unbroken tests occurring in percentages greater than 75 in water warmer than 20°C.-27°C.
2. Planktonic Foraminifera increase in abundance with depth.
3. Salinities less than 27 parts per thousand limit the distribution of planktonic Foraminifera.
4. Planktonic Foraminifera exhibit vertical zonation.
5. Throughout the Asiatic area *Globorotalia menardii* and *Globorotalia trigonula* coil left and *Globigerina subcretacea* and *Pulleniatina obliquiloculata* coil right.

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
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201. FORAMINIFERAL HOMONYMS

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During the compilation of foraminiferal literature for the annual "Bibliography and Index to Foraminifera" (Journal of Paleontology) the following homonyms have been recorded. They should be renamed by their respective authors *without delay* in accordance with the "International Rules of Zoological Nomenclature":

Fusulina elegans Rauser-Chernoussova and Beljaev, 1940, Trans. Geol. Oil-Prospect. Inst., n. s., fasc. 7, p. 18, pl. 2, figs. 8-11, text fig. 3, Middle Carboniferous, Samara, USSR,
preoccupied by: *Fusulina elegans* Stache, 1874, Jahrb. k. k. Geol. Reichs-Anst. Wien, vol. 24, p. 172.

Anomalina ammonoides (Reuss) var. *crassisepta* Vassilenko and Mjatliuk, 1947, (original 1947—publication not available) cited in: Vassilenko, 1954, Trudy Vses. Neft. Nauk-Issledov. Geol.-Razved. Inst., n. s., fasc. 80, p. 78, pl. 7, fig. 4; pl. 8, fig. 1, Upper Cretaceous, USSR,
preoccupied by *Anomalina crassisepta* Cushman and Siegfus, 1935, Contr. Cushman Lab. Foram. Research, vol. 11, p. 95, pl. 14, fig. 12.

Anomalina ammonoides (Reuss) var. *umbilicatula* Mjatliuk, 1947, (original publication not available), cited in: Vassilenko, 1954, *ut supra,* n. s., fasc. 80, p. 78, pl. 7, fig. 4, Upper Cretaceous, USSR,
preoccupied by *Anomalina umbilicatula* Heron-Allen and Earland, 1932, Discovery Reports, vol. 4, p. 426, pl. 14, figs. 40-42.

Anomalina schloenbachi (Reuss) var. *dainae* Vassilenko and Mjatliuk, 1947, cited in: Vassilenko, 1954, *ut supra,* n. s., fasc. 80, p. 99, pl. 13, fig. 2, Campanian, USSR,
preoccupied by *Anomalina daini* Schijfsma, 1946, Mededeel. Geol. Stichting, Haarlem, vol. 5, No. 7, p. 98, pl. 6, fig. 3, Upper Cretaceous, Holland.

Cibicides globigeriniformis Netskaja, 1948, var. *compressa* Netskaja, 1948, Vses. Neft. Naucho-Issledov. Geol.-Razved. Inst., Trudy, n. s., fasc. 31, p. 224, pl. 2, fig. 5, Senonian, Western Siberia,
preoccupied by *Cibicides floridanus* (Cushman, 1918) var. *compressa* Cushman and Renz, 1941, Contr. Cushman Lab. Foram. Research, vol. 17, p. 26, pl. 4, fig. 9; Oligo-Miocene, Venezuela.

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Anomalina suturalis Mjatliuk, 1949, var. *involuta* Mjatliuk, 1949, Trudy Vses. Neft. Naucho-Issledov. Geol.-Razved. Inst., n. s., fasc. 34, p. 218, pl. 5, figs. 3, 4, Middle Albian, Emba region, USSR,
preoccupied by *Anomalina involuta* (Reuss, 1851, *olim: Rotalina involuta*), Haidinger's Naturwiss. Abhandl., vol. 4, p. 35, pl. 2, fig. 14.

Bolivina parvissima Subbotina, 1950, var. *minuta* Subbotina, 1950, Trudy Vses. Neft. Naucho-Issledov. Geol.-Razved. Inst., n. s., fasc. 51, p. 98, pl. 5, fig. 6, Paleocene, Caucasus region, USSR,
preoccupied by *Bolivina minuta* Natland, 1938, Bull. Scripps Inst. Oceanogr., Tech. Ser., vol. 4, p. 146, pl. 5, fig. 10, Recent, Pacific, off California.

Miliolina caucasica Bogdanovitch, 1947, var. *longiuscula* Bogdanovitch, 1950, *ibid.,* n. s., fasc. 51, p. 152, pl. 3, fig. 1, Middle Miocene, Caucasus area, USSR,
preoccupied by *Miliolina longiuscula* Silvestri, 1896, Mem. Accad. Pont. Nuovi Lincei, Roma, vol. 12, p. 41, pl. 1, figs. 18-20, Pliocene, Italy.

Sigmoilina haidingeri (Orbigny, 1846) var. *tschokrakensis* Bogdanovitch, 1950, *ibid.,* n. s., fasc. 51, p. 159, Middle Miocene, Caucasus area, USSR,
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preoccupied by *Triticites jigulensis* Rauser-Chernoussova, 1938, var. *intermedia* Slykova, 1948, Trudy Vses. Neft. Naucho-Issledov. Geol.-Razved. Inst., n. s., fasc. 31, p. 122, pl. 3, figs. 2, 3, Upper Carboniferous, USSR.

Fusulina antiqua Rauser-Chernoussova, 1951, Akad. Nauk SSSR, Inst. Geol. Nauk, Ministr. Neft. Prom. SSSR, p. 276, pl. 43, fig. 5, Middle Carboniferous, Moscow Basin,
preoccupied by *Fusulina alpina* Schellwien, 1898, var. *antiqua* Deprat, 1912, Mém. Service Géol. Indochine, vol. 11, p. 139, pl. 11.

Fusulinella vozhganensis Safonova, 1951, var. *devexa* Rauser-Chernoussova, 1951, *ibid.,* p. 221, pl. 31, figs. 3, 4, Middle Carboniferous, Timan region, USSR,
preoccupied by *Fusulinella devexa* Thompson, 1948, Univ. Kansas Paleont. Contr., Protozoa, Art. 1, p. 94, pl. 32, figs. 6, 10; pl. 35, figs. 1-15; pl. 36, figs. 7-10, 12-17, Middle Pennsylvanian, New Mexico.

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Issledov. Geol.-Razved. Inst., n. s., fasc. 81, p. 264, pl. 6, fig. 8, Lower Carboniferous, USSR, preoccupied by *Endothyra spirilliniformis* Brazhnikova and Potievska, 1948, var. *evoluta* Reitlinger, 1950, Akad. Nauk SSSR, Inst. Geol. Nauk, Trudy, geol. ser. 47, fasc. 126, p. 36, pl. 6, fig. 9, Middle Carboniferous, USSR.

Uvigerina mediterranea Hofker, 1932, var. *compressa* Ansary, 1954, Bull. Fac. Engineer. Cairo Univ., 1953 (1954), p. 323, pl. 1, fig. 15, Upper Eocene, Egypt, preoccupied by *Uvigerina compressa* Cushman, 1925, Contr. Cushman Lab. Foram. Research, vol. 1, p. 10, pl. 4, fig. 5.

Sigmoilina plana Smigielska, 1955 (published 1957), Ann. Soc. Géol. Pologne, vol. 25, p. 260, pl. 16, fig. 5, Tortonian, Poland, preoccupied by *Sigmoilina tschokrakensis* Gerke, 1938, var. *plana* Gerke, 1938, Problems of Paleont., Moscow, vol. 4, p. 315, pl. 2, fig. 9; pl. 3, figs. 5, 6, 14-17, Miocene, Caucasus.

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Bolivina caucasensis Khalilov var. *carinata* Khalilov, 1956, *ibid.*, vol. 18, p. 190, pl. 2, figs. 2-4, Upper Eocene, Azerbaidzhan, preoccupied by *Bolivina beyrichi* Reuss var. *carinata* Hantken, 1875, Jahrb. Mitth. k. Ungar. Geol. Anst., vol. 4, p. 64, pl. 7, fig. 2, Tertiary, Hungary.

Bolivina compta Khalilov var. *carinata* Khalilov, 1956, *ibid.*, vol. 18, p. 212, pl. 4, fig. 13, Lower Oligocene, Azerbaidzhan, preoccupied by *Bolivina beyrichi carinata* Hantken, 1875, *ut supra.*

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Bolivina praebinaensis Khalilov var. *carinata* Khalilov, 1956, Trudy Akad. Nauk Azerbaidzhan, Inst. Geol., vol. 18, p. 210, pl. 4, fig. 8, Upper Eocene, Azerbaidzhan, preoccupied by *Bolivina beyrichi* Reuss var. *carinata* Hantken, 1875, Jahrb. Mitth. k. Ungar. Geol. Anst., vol. 4, p. 64, pl. 7, fig. 2, Tertiary, Hungary.

Bolivina praebinaensis Khalilov var. *crassa* Khalilov, 1956, Trudy Akad. Nauk. Azerbaidzhan, Inst. Geol., vol. 18, p. 209, pl. 4, fig. 7, Upper Eocene, Azerbaidzhan, preoccupied by *Bolivina incrassata* Reuss var. *crassa* Vassilenko and Mjatliuk, 1947, Trudy Vses. Neft. Naucho-Issledov. Geol.-Razved. Inst., Mikrofauna Caucasus, Emba, etc., p. 203, pl. 2, figs. 3-5, Upper Cretaceous, Emba region, USSR.

Bolivina serrata Khalilov var. *parallela* Khalilov, 1956, *ibid.*, vol. 18, p. 193, pl. 2, fig. 11, Upper Eocene, Azerbaidzhan, preoccupied by *Bolivina parallela* (Perner, 1892) teste Cushman, 1932, Contr. Cushman Lab. Foram. Research, vol. 8, p. 94 (for *Textularia parallela* Perner, 1892).

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preoccupied by *Elphidium umbilicatum* (Orbigny, 1826, *olim: Polystomella umbilicata*), Arch. Sci. Nat., vol. 7, p. 285, Nr. 9; figured in Fornasini, 1905, Mem. Accad. Sci. Ist. Bologna, ser. 6, vol. 1, p. 13, pl. 3, fig. 11.

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preoccupied by *Elphidium venustum* (Schultze, 1854, *olim: Polystomella venusta*) Organism. Polythalam., p. 67, pl. 6, figs. 6, 7.

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preoccupied by *Lagena ventricosa* Silvestri, 1903, Atti Accad. R. Sci. Torino, vol. 39, p. 10, pl. 4.

Miliolina rotunda Pobedina, Voroshilova, Rybina and Kuznetsova, 1956, Spravochnik mikrofaune etc., Azerbaidzhan, p. 117, pl. 13, fig. 8, Sarmatian, Azerbaidzhan,
preoccupied by *Miliolina akneriana* (Orbigny) var. *rotunda* Gerke, 1938, Problems of Palaeontology, Moscow, vol. 4, p. 296, pl. 1, fig. 1, Middle Miocene, Caucasus region.

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preoccupied by *Nodosaria contorta* Costa, 1856, Atti Accad. Pont., vol. 7, (pt. 2), p. 159, pl. 16, fig. 2; and also by *Nodosaria contorta* Hantken, 1868, and by *Nodosaria contorta* Clodius, 1912.

Nonion graniferus (Terquem) var. *miocenicus* Artchvadze in Djanelidze, 1956, Akad. Nauk Gruzinski SSR, Trudy, Sect. Paleobiol., vol. 3, p. 108, pl. 2, fig. 9, Miocene, Georgia USSR,
preoccupied by *Nonion miocenicus* Pobedina, Voroshilova, Rybina and Kuznetsova, 1956, Spravochnik mikrofaune etc. Azerbaidzhan, p. 129, pl. 18, fig. 5, Sarmatian, Azerbaidzhan, (or vice versa, depending on whose paper was first published during 1956.)

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preoccupied by *Spiroloculina elegantissima* Said, 1949, Spec. Publ. 26, Cushman Lab. Foram. Research, p. 15, pl. 1, fig. 41, Recent, Gulf of Suez.

Spiroloculina plana Pobedina, Voroshilova, Rybina and Kuznetsova, 1956, *ibid.*, p. 47, pl. 4, fig. 7, Middle Miocene, Azerbaidzhan,
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SACCAMMINOIDES Ireland, 1956, Jour. Paleontology, vol. 30, p. 841, Pennsylvanian, Kansas,
preoccupied by *Saccamminoides* Geroch, 1955, Ann. Soc. Géol. Pologne, vol. 32, p. 54, Eocene, Czechoslovakia.

Textularia pseudobliqua McLean subsp. *aspera* McLean, 1956, Bull. Am. Paleontology, vol. 36, No. 160, p. 320, pl. 36, figs. 8, 14, Miocene, Virginia,
preoccupied by *Textilaria aspera* Ehrenberg, 1838, Abhandl. k. Akad. Wiss. Berlin, p. 134, pl. IV, figs. iv, v, gamma; also by *Textularia aspera* Terquem, 1882, and by *Textularia aspera* Brady, 1882.
(According to a letter, dated March 26, 1959, J. D. McLean will rename his homonym: *Textularia yorktownensis*).

Frondicularia elegans Mamontova, 1957, Leningrad Univ., Uchenye Zapiski, No. 225, ser. geol. Nauk, vyp. 9, p. 187, pl. 1, fig. 8, Toarcian, Caucasus area, USSR,
preoccupied by *Frondicularia elegans* Orbigny, 1840, Mém. Soc. géol. France, vol. 4, p. 19, pl. 1, figs. 29-31, Upper Cretaceous, France.

Nodosaria multicostata (Bornemann) var. *cylindrica* Mamontova, 1957, *ibid.*, p. 167, pl. 1, fig. 2, Toarcian, Caucasus area, USSR,
preoccupied by *Nodosaria cylindrica* Deprat, 1899, Bull. Soc. Hist. Nat. Doubs, No. 1, p. 22, pl. 5, fig. 1, Middle Jurassic, France.

Whenever possible the compiler informed the author of a homonym, as soon as it was detected, and urged him to rename it. Some of the authors replied that they would propose a new name immediately while others authorized the compiler to publish in a separate article the change of names for their respective homonyms.

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 4, OCTOBER, 1959

202. NEW NAMES FOR FORAMINIFERAL HOMONYMS IV.

HANS E. THALMANN
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The following new names of foraminiferal homonyms are herewith proposed, based on the authorizations received from Jan Hofker (letter dated The Hague, February 25, 1959), Rushdi Said (letter dated Maadi, Cairo, February 24, 1959), A. F. M. Mohsenul Haque (letter dated Quetta, March 24, 1959), V. Standish Mallory (letter dated Seattle, April 27, 1959), and Emil R. Zalesny (letter dated Bogota, June 1, 1959):

Globigerina aequatorialis Hofker and Thalmann, nom. nov.

For: *Globigerina stainforthi* Hofker, 1956, Jour. Paleontology, vol. 30, p. 955, text figs. 96 and 97, Upper Eocene, Ecuador (non *Globigerina stainforthi* Bronnimann, 1952, Bull. Amer. Paleontology, vol. 34, No. 143, p. 23, pl. 3, figs. 10-12, Paleocene, Trinidad).

Cibicides neocompressus Hofker and Thalmann, nom. nov.

For: *Cibicides compressus* Hofker, 1958, Ann. Soc. Géol. Belgique, vol. 81, p. B 490, pl. 7, fig. 41, Upper Cretaceous, Belgium [non *Cibicides floridanus* (Cushman, 1918) var. *compressa* Cushman and Renz, 1941, Contr. Cushman Lab. Foram. Research, vol. 17, p. 26, pl. 4, fig. 9, Oligo-Miocene, Venezuela, subsequently elevated to species rank by Renz, 1948, Geol. Soc. America, Mem. No. 32, p. 127].

Bolivina decurrens nekhliana Said and Kenawy, nom. nov.

For: *Bolivina decurrens parallela* Said and Kenawy, 1956, Micropaleontology, vol. 2, p. 143, pl. 4, fig. 18, Maastrichtian, Sinai, Egypt [non *Bolivina parallela* (Perner, 1892, olim: *Textularia parallela* Perner) teste: Cushman, 1932, Contr. Cushman Lab. Foram. Research, vol. 8, p. 94].

Vaginulina giddiana Said and Kenawy, nom. nov.

For: *Vaginulina longiformis* Said and Kenawy, 1956, *loc. cit.*, p. 134, pl. 3, fig. 5-a, Paleocene, Sinai, Egypt [non *Vaginulina longiformis* (Plummer, 1926, olim: *Cristellaria longiforma* Plummer, 1926) teste: Cushman, 1944, Contr. Cushman Lab. Foram. Research, vol. 20, p. 38, pl. 6, figs. 11-13, Paleocene, Alabama].

Cibicides alleni cristata Haque, nom. nov.

For: *Cibicides alleni* (Plummer) var. *carinata* Haque, Palaeont. Pakistanica, vol. 1, p. 208, pl. 20, fig. 12; pl. 33, fig. 2, Paleocene, Pakistan [non *Cibicides carinatus* (Terquem, 1882, olim: *Truncatulina carinata* Terquem, 1882), teste: Y. LeCalvez, 1949, Mém. Explic. Carte géol. dét. France, p. 45, pl. 4, figs. 72-74, Lutetian, France].

Cibicides multifarius ghalebi Haque, nom. nov.

For: *Cibicides multifarius* (Schwager) var. *limbata* Haque, *loc. cit.*, p. 205, pl. 26, fig. 5, Paleocene, Pakistan (non *Cibicides subspiratus* Nuttall var. *limbatus* Cita, 1950, Riv. Ital. Paleont. e Strat., vol. 56, p. 102, pl. 9, fig. 7, Middle Eocene, Italy).

Gaudryina laevigata saadi Haque, nom. nov.

For: *Gaudryina laevigata* Franke var. *elongata* Haque, *loc. cit.*, p. 36, pl. 1, fig. 5, Paleocene, Pakistan [non *Gaudryina ruthenica* Reuss var. *elongata* Dunikowski, 1879, Kosmos (Lvow), p. 133, Senonian, Poland].

Gyroidina girardana sarwari Haque, nom. nov.

For: *Gyroidina girardana* (Reuss) var. *limbata* Haque, *loc. cit.*, p. 151, pl. 27, fig. 3, Lower Eocene, Pakistan (non *Gyroidina limbata* Hussey, 1949, Jour. Paleontology, vol. 23, p. 136, pl. 28, figs. 6 and 7, Middle Eocene, Louisiana).

Nonionella excavata thalmanni Haque, nom. nov.

For: *Nonionella excavata* (Orbigny) var. *nammalensis* Haque, *loc. cit.*, p. 116, pl. 6, figs. 2, 5 and 8, Paleocene, Pakistan (non *Nonionella cretacea* Cushman var. *nammalensis* Haque, 1956, *loc. cit.*, p. 116, pl. 33, fig. 3, Paleocene, Pakistan).

Globotruncana küpperi Thalmann, nom. nov.

For: *Globotruncana* (*Praeglobotruncana*) *renzi* Gandolfi-Thalmann subsp. *primitiva* Küpper, 1956, Contr. Cushman Found. Foram. Research, vol. 7, pl. 8, fig. 2, Upper Cenomanian, California [non *Globotruncana* (*Globotruncana*) *ventricosa* White subsp. *primitiva* Dalbiez, 1955, Micropaleontologist, vol. 1, p. 168, text fig. 6, Upper Coniacian, Tunisia]. Klaus Küpper's subspecies is herewith elevated to species rank and named after him in order to perpetuate the memory of a young, highly promising, and enthusiastic scientist who had to die much too early.

Buliminella grata Parker and Bermudez var. **joaquinensis** Mallory, nom. nov.

For: *Buliminella grata* Parker and Bermudez var.

convoluta Mallory, 1959, Lower Tertiary Biostrat. California Coastal Ranges, Tulsa, p. 185, pl. 15, fig. 13, Eocene, California [non *Buliminella convoluta* (Williamson, 1858, olim: *Bulimina pupoides* Orbigny var. *convoluta* Williamson) teste: Cushman, 1922, Bull. 104, pt. 3, U. S. Nat. Mus., p. 109, pl. 18, figs. 4 and 5, Recent, Atlantic].

Bolivina argentea Cushman var. **resigi** Zalesny, nom. nov.

For: *Bolivina argentea* Cushman var. *monicana* Zalesny, 1959, Micropaleontology, vol. 5, p. 121, pl. I, fig. 1, Recent, Santa Monica Bay, California (non *Bolivina marginata* Cushman var. *monicana* Pierce, 1956, Jour. Paleontology, vol. 30, p. 1308, pl. 143, fig. 3, Upper Miocene, California.

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203. SOME ARENACEOUS FORAMINIFERA FROM THE LIAS OF ENGLAND

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ABSTRACT

A group of arenaceous Foraminifera is described from the Lias of England. Some species are recorded for the first time from England. The genera **Ammodiscus**, **Jaculella**, and **Proteonina** are discussed.

INTRODUCTION

Macfadyen (1941) and the author (1950 a & b) in the course of their work on the general foraminiferal faunas from the Lias described a few arenaceous foraminifera. More information, in the form of new and more material and some of Terquem's slides has now become available to the author. A further paper appears desirable, especially in view of the bearing these species have on the taxonomy of a number of genera.

SYSTEMATIC DESCRIPTIONS

Family AMMODISCIDAE

Subfamily AMMODISCINAE

Genus **Ammodiscus** Reuss, 1861

Genotype *Spirillina arenacea* Williamson, 1858

In 1952 I drew attention to the difficulties involved in separating genera of planispiral foraminifera. This statement could now be extended to include most of these forms from the whole Mesozoic. At a number of horizons only casts of foraminifera are preserved, a fact which renders accurate identification impossible. Even when the shell is preserved the outward appearance is often misleading. If the pores of some species are infilled then the test may appear translucent or even opaque instead of vitreous.

The genus *Ammodiscus* Reuss 1861 has recently been dealt with by Loeblich and Tappan (1954). These authors seek to prove *Ammodiscus* invalid and to suppress the name in favour of *Involutina* Terquem 1862. In the present paper the author retains *Ammodiscus,* in view of the fact that a case for its retention has been presented by Macfadyen and Barnard.

Ammodiscus siliceus (Terquem)

Plate 11, figures 1-4

Involutina silicea TERQUEM, 1862, p. 450, pl. vi, fig. 11a, b; TAPPAN, 1955, p. 39, pl. ix, fig. 1-4.

Involutina aspera TERQUEM, 1863, p. 221, pl. x, fig. 21a, b; TAPPAN, 1955, p. 38, pl. viii, fig. 10-13.

Ammodiscus aspera (TERQUEM). BORNEMANN, 1874, Zeitschr. deutsch. geol. Ges. 26, p. 710; SELLHEIM, 1893, p. 10, pl. i, fig. 31; ISSLER, 1908, p. 41, pl. i, fig. 9, 10; MACFADYEN, 1941, p. 15, pl. i, fig. 7; BARNARD, 1950a, p. 351, fig. 1a (i) (ii); USBECK, 1952, p. 381.

Ammodiscus infimus (STRICKLAND). FRANKE, 1936, p. 15, pl. i, fig. 14a, b.

Description.—In both generations a globular proloculus is followed by three to eight planispirally coiled whorls, which slowly increase in height. A mosaic of fine-grained quartz particles set in a siliceous cement comprises the wall. The form of the coiling varies in later whorls, specimens being found with excentric later stages, a point already discussed by the author (1950a).

The impression of the penultimate whorl is slight so that the aperture is almost circular, the open end of the tube.

Remarks.—In 1950a (p. 351) I drew attention to the fact that Terquem had separated *Involutina aspera* Terquem and *I. silicea* Terquem on the number of whorls in the test, and the rougher texture. In a footnote Macfadyen (1941, p. 17) states that on a slide in the Brady Collection labelled "*Involutina* (*Cornuspira*) *silicea* Terquem, Lias Moyen, Metz . . . . , are several good specimens, all of the form that I have identified as *Ammodiscus asper* (Terquem)". Tappan (1955, p. 39) states *I. silicea* Terquem "differs from *I. aspera* Terquem in the large amount of cement in the walls, as the test has an almost porcellaneous appearance, and that of *I. aspera* is definitely granular in appearance."

A study of some of Terquem's specimens from the Museum National d'Histoire Naturelle, Paris, shows a wide variety of forms present on the slides, so that it is impossible to differentiate between the "species."

The more rugose nature of *I. aspera* Terquem may be due to crushing of the wall, giving an apparent roughness. Loeblich and Tappan also selected a lectotype from material which has not yet been proved to be Terquem's type collection.

The material shows an extremely mixed set of slides, and this together with the fact that some of d'Orbigny's material is mounted in a similar manner, points to these slides being prepared by someone other than Terquem. It may be that a true type collection does still exist somewhere in France.

The author feels that any genus based on this material would be, to say the least, open to doubt, a view shared by some other workers on Lias foraminifera, for example Macfadyen (1941).

One important point not discussed by Tappan (1955) and Loeblich and Tappan (1954) is the type of cement binding the grains together. In the majority of cases tested no reaction was obtained on treating the specimens in acid, suggesting a primary siliceous cement, and not a secondary alteration product.

Material.—Many specimens in the author's collection.

Horizon.—Lower and Middle Lias.

Subfamily TOLYPAMMININAE

Genus **Tolypammina** Rhumbler, 1895

Genotype *Hyperammina vagans* Brady

The relationship between the genera *Tolypammina* and *Hyperammina* was discussed by the author (1950a, p. 353).

Tolypammina flagellum (Terquem)

Plate 11, figure 5

Webbina flagellum TERQUEM, 1870, Trois. Mém. Forams. Oolithique Metz, p. 273, pl. xxix, fig. 30.

Tolypammina flagellum (TERQUEM). MACFADYEN, 1941, p. 16, pl. 1, fig. 8; BARNARD, 1950a, p. 354, fig. 1b; USBECK, 1952, p. 384, pl. xiv, fig. 9.

Description.—The test is comprised of an adherent, irregular tube. The wall is composed of a mosaic of fine grained quartz, bound together by a calcareous cement in some specimens and siliceous in others.

Many specimens appear to have been crushed, due perhaps to the flexibility of the test. No initial chambers were seen, and the aperture appeared to be the open end of the tube.

Material.—British Museum (Nat. Hist.) P. 39878, 39893, 39935.

Locality.—Lyme Regis, Dorset.

Horizon.—*angulatum* - zone, *portlocki* - subzone.

Genus **Ammovertella** Cushman, 1928

Genotype *Psammophis inversus* Schellwien

Ammovertella liassica Barnard

Ammovertella liassica BARNARD, 1950a, p. 354, fig. 1c.

Description.—The adherent test consists of an initial coil of three to six whorls, wound round a globular proloculus, followed by a meandriform uncoiled portion. The latter often reverses the initial direction of coiling. The tube is of almost constant diameter.

Material.—British Museum (Nat. Hist.) P. 39938, and specimens in the author's collection.

Locality.—Lyme Regis, Dorset.

Horizon.—*semicostatum* - zone, *alcinoe* - subzone.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus **Ammobaculites** Cushman, 1910

Genotype *Spirolina agglutinans* d'Orbigny

Ammobaculites fontinensis (Terquem)

Haplophragmium fontinense TERQUEM, 1870, Trois. Mém. Forams. Oolithique Metz, p. 235, pl. xxiv, fig. 29, 30.

Ammobaculites fontinensis (TERQUEM). FRANKE, 1936, p. 127, pl. xii, fig. 24; BARTENSTEIN & BRAND, 1937, p. 186, pl. v, fig. 79a, b; pl. vi, fig. 43; pl. viii, fig. 37a-d; pl. x, fig. 44; pl. ixB, fig. 27; pl. xiiA, fig. 21a, b; pl. xiii, fig. 22; BARNARD, 1950b, p. 4, pl. i, fig. 1, 2.

Material.—Many specimens.

Locality.—Byfield, Northamptonshire.

Horizon.—Upper Lias *tenuicostatum* - zone.

Family VERNEUILINIDAE

Genus **Verneuilina** d'Orbigny, 1840

Genotype *Verneuilina tricarinata* d'Orbigny

Verneuilina cf. **V. mauritii** Terquem

Verneuilina mauritii TERQUEM, 1866a, p. 448, pl. xviii, fig. 18a, b; BARTENSTEIN & BRAND, 1937, p. 183, pl. iA, fig. 22; USBECK, 1952, p. 385, pl. xiv, fig. 10.

Verneuilina georgiae TERQUEM, 1866a, p. 448, pl. xviii, fig. 19a, b.

Remarks.—Terquem's slides of *V. mauritii* and *V. georgiae* show that the two forms are similar. The coloration that Terquem mentions is not diagnostic being due to iron staining. The present author has been unable to determine whether Terquem's specimens are triserial or biserial, or to observe the shape of the aperture. It may well be that Terquem's specimens belong to the genus *Textularia.*

Usbeck (1952) has described this form as being very variable, the figured specimen being much more elongate than Terquem's and resembling far more closely the present author's specimens. The preservation of the initial stages of the test, in my specimens, is so bad that the structure cannot be determined. The test rapidly becomes biserial and compressed. Some specimens appear to have an initial coil followed by a biserial portion, with the end-chamber occasionally occupying a central terminal position.

Usbeck and the author's specimens are recorded from the lowest zones of the Lower Lias whereas Terquem's are described from the *davoei* zone.

Material.—Three specimens.

Locality.—Stowell Park, Northleach, Gloucestershire.

Horizon.—1940′ - 1950′ *angulata* zone. Mik (M) 459009-011.

Family SACCAMMINIDAE

Subfamily SACCAMMININAE

Genus **Proteonina** Williamson, 1858

Genotype *Proteonina fusiformis* Williamson

The genus *Proteonina* Williamson 1858 was recently emended by Loeblich and Tappan (1955). Lectotype and paratype material were selected from the Williamson collection by Loeblich (1953). The lectotype *Proteonina fusiformis* Williamson, British Museum (Nat. Hist.) No. ZF 3605 is a broken specimen, consisting of three chambers with strongly constricted sutures, and closely resembles *Reophax*. A study of material in the Brady Collection leads the author to the opinion that this specimen belongs to the species *Reophax scorpiurus* Montfort. The specimen also agrees closely with one figured by Brady in his Challenger Report (1884, fig. 12, pl. 30).

Williamson emphasizes that he was unable to find any trace of internal septa. All the lectotype and paratype specimens show strong constrictions. The impression is also given by Williamson that the shell is unilocular bearing a superficial resemblance to *Gromia*. Paratypes British Museum (Nat. Hist.) ZF 3606 (two specimens) are juveniles or broken specimens of *Reophax*.

On one of the slides Loeblich states that "The specimen figured by Williamson showed two chambers, it was crushed during registering . . .". This is indeed unfortunate in view of the fact that selection of new lectotype and paratypes do not appear to agree with the original specimen described by Williamson. Loeblich and Tappan (1955) state: "*Proteonina* thus is a multilocular, uniserial agglutinated form, and not a single chambered form as has commonly been considered."

Based on the evidence of the newly selected forms, there would be little justification for the retention of the genus, as already stated by Loeblich and Tappan: "The name *Proteonina* is therefore suppressed as a synonym of *Reophax* Montfort 1808."

However, other well established Recent species exist, and a more complete examination of the Williamson Collection may yield specimens similar to those described by Williamson.

Proteonina jurassica, sp. nov.

Plate 11, figures 6, 7, 8

Proteonina ampullacea (Brady). Franke, 1936, p. 13, pl. i, fig. 7a, b; Bartenstein & Brand, 1937, p. 128, pl. viii, fig. 2a, b; pl. x, fig. 2a, b.

Proteonina difflugiformis (Brady). Bartenstein & Brand, 1937, p. 128, pl. iA, fig. 1; pl. iB, fig. 1, 2; pl. iiA, fig. 1; pl. iiB, fig. 3; pl. iii, fig. 1; pl. iv, fig. 1; pl. v, fig. 1; pl. viii, fig. 1a-d; pl. x, fig. 1a-c; pl. xiA, fig. 1a-c.

Diagnosis.—The test usually consists of one flask-shaped chamber, occasionally specimens have a second chamber. The test is usually strongly compressed, probably due to the fact that it is flexible, the compression being due to subsequent crushing. Considerable variation takes place in the initial part of the test, which may be circular to oval in plan. This initial bulbous portion of the test is drawn out into a long tubular neck. This neck is of about the same length as the diameter of the early portion of the test. The tube is of almost constant diameter, the aperture forming the open end. The test is made up of a mosaic of small quartz fragments set in a siliceous cement.

Remarks.—This form is common in the whole of the Jurassic and differs appreciably from *Proteonina ampullacea* (Brady) which is a more robust, rigid Recent form. Many specimens throughout the Jurassic show crushing, but no apparent injury to the test. It is possible, therefore, that the tests were originally flexible. The shape of the chamber varies from spherical to elliptical, and this is partly due to subsequent crushing.

Material.—Many specimens.
Holotype.—Mik (M) 459006.
Horizon.—1360′ - 1370′.
Other specimens.—Mik (M) 459007, 459008.
Horizons.—1400′ - 1410′; 1410′ - 1420′.
Locality.—Stowell Park, Northleach, Gloucestershire.

Family HYPERAMMINIDAE

Subfamily HYPERAMMININAE

Genus **Jaculella** Brady, 1879

Genotype *Jaculella acuta* Brady

A study of the material in the Brady Collection shows that considerable variation in the amount of

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EXPLANATION OF PLATE 11

Figs.		Page
1.	*Ammodiscus siliceus* (Terquem). × 45. Specimen from Terquem Lias Collection, Museum National d'Histoire Naturelle, Paris.	132
2-4.	*A. siliceus* (Terquem). × 45. L. Lias - Lyme Regis - *raricostatum* zone. Showing tendency for later whorls to become irregularly coiled.	132
5.	*Tolypammina flagellum* (Terquem). × 30. L. Lias - Stowell Park 1310′ - 1320′ - *raricostatum* zone. Geological Survey and Museum Collection Mik (M) 459003.	133
6, 7, 8.	*Proteonina jurassica*, sp. nov. × 45. L. Lias - Stowell Park 1360′ - 1370′, 1400′ - 1410′, 1410′ - 1420′ - *raricostatum* zone. Geological Survey and Museum Collection Mik (M) 459006-008.	134
9, 10.	*Jaculella liassica* Brand. × 45. L. Lias - Stowell Park 1410′ - 1420′, 1390′ - 1380′ - *raricostatum* zone. Geological Survey and Museum Collection Mik (M) 459004-005.	135
11, 12.	*Reophax metensis* Franke. × 45. L. Lias - Stowell Park 1360′ - 1370′ - *raricostatum* zone. Geological Survey and Museum Collection Mik (M) 459001, 459002.	135

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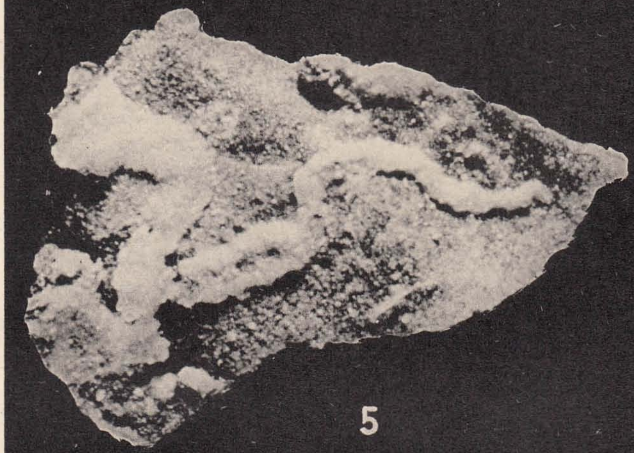

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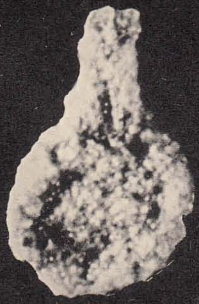

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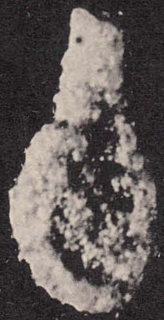

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Barnard: Arenaceous Foraminifera, Lias, England.

cement, size of the agglutinated material, shape of the test, amount of taper of the test, and the size of the proloculus exists in Brady's two species *J. acuta* and *J. obtusa.* The major difference between the genera *Jaculella* and *Hyperammina* appears to be in the shape of the tube. In the former the tube diverges towards the aperture, whilst in the latter it is either parallel-sided or slightly convergent, however there are exceptions to this.

Jaculella liassica Brand

Plate 11, figures 9, 10

Jaculella liassica BARTENSTEIN & BRAND, 1937, p. 129, pl. iiB, fig. 1; pl. iii, fig. 4a, b; pl. iv, fig. 3; pl. v, fig. 4; pl. vii, fig. 5.

Description.—The test consists of a long tapering tube, widening towards the aperture. The test is composed of a mosaic of fine quartz particles set in a siliceous cement. Both generations were seen. The megalospheric form has an initial globular portion, with a slight constriction at the point of contact with the tube; no septum separates these two parts of the test. The microspheric form has no initial bulge, but tapers more rapidly than the megalospheric. The aperture is the open end of the tube.

Material.—Ten specimens.

Locality.—Stowell Park, Northleach, Gloucestershire.

Horizon.—*raricostatum* zone.

Family REOPHACIDAE

Subfamily REOPHACINAE

Genus **Reophax** Montfort, 1808

Genotype *Reophax scorpiurus* Montfort

Reophax metensis Franke

Plate 11, figures 11, 12

Reophax metensis FRANKE, 1936, p. 19, pl. i, fig. 17a, b; BARTENSTEIN & BRAND, 1937, p. 133, pl. x, fig. 8; pl. xiii, fig. 1a, b, 4.

Reophax dentaliniformis BRADY. FRANKE, 1936, p. 19, pl. i, fig. 20 and n. f. *liassica* FRANKE p. 20, pl. i, fig. 21; BARTENSTEIN & BRAND, 1937, p. 133, pl. iA, fig. 4; pl. iB, fig. 4-13; pl. xivA, fig. 1a, b; pl. xivB, fig. 1; pl. xvA, fig. 5a-c; USBECK, 1952, p. 376, pl. xiv, fig. 3.

Description.—The test consists of a rectilinear or curvilinear series of three to eight chambers. The wall of the test is composed of a mosaic of fine quartz particles cemented by silica. Sometimes the test is circular in cross-section, or compressed flat. In this latter the wall shows no sign of damage and possibly the test was flexible. The chambers are spherical to ellipsoidal in shape, with a tendency for the end chamber to be drawn out into a neck; the aperture being the open end of the chamber.

Material.—Many specimens.

Locality.—Stowell Park, Northleach, Gloucestershire.

Horizon.—*raricostatum* zone.

ACKNOWLEDGEMENTS

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CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH
VOLUME X, PART 4, OCTOBER, 1959

RECENT LITERATURE ON THE FORAMINIFERA

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

AKAGI, SABURO. **Pseudoschwagerina miharanoensis**, a new Permian Fusulinid, and its growth and form.—Sci. Repts. Tokyo Kyoiku Daigaku, sec. C, v. 6, no. 54, Aug. 15, 1958, p. 147-156, pl. 1, text figs. 1-7.

ANTONOVA, Z. A. Foraminifery srednej Jury Bassejna r. Laby.—Vses. neft. nauchno-issl. instit., Trudy, vyp. 17, 1958, p. 41-80, pls. 1-5.—Thirty-two species and 2 varieties, all new except 2 species. **Sublamarckella** gen. nov. (genotype **S. terquemi** sp. n.) in the Epistominidae.

AUBOUIN, JEAN, and NEUMANN, MADELEINE. Contribution a l'étude stratigraphique et micropaléontologique de l'Éocene en Grèce.—Revue de Micropaléontologie, v. 2, no. 1, June 1959, p. 31-49, pls. 1-5, text figs. 1-8 (map, sections).—Larger Foraminifera illustrated in thin section.

BERGQUIST, HARLAN R. Micropaleontologic study of test wells in the Titaluk and Knifeblade areas, northern Alaska, **in** ROBINSON, FLORENCE M.—U. S. Geol. Survey Prof. Paper 305-G, April 6, 1959, p. 417-419.—Two Foraminifera zones, one of Cenomanian age and the other Albian, penetrated by four wells.

Micropaleontology of Square Lake test well 1 and the Wolf Creek test wells, northern Alaska, **in** COLLINS, FLORENCE RUCKER.—U. S. Geol. Survey Prof. Paper 305-H, April 22, 1959, p. 479-482.—Upper and Lower Cretaceous rocks (Turonian to Albian), penetrated by four wells, are identified by their Foraminifera.

BHATIA, S. R., and MOHAN, KRISHNA. Miocene (Burdigalian) Foraminifera from Kathiawar, western India.—Jour. Paleontology, v. 33, no. 4, July 1959, p. 641-661, text figs. 1-6 (pls.), table 1.—Fifty-five species (1 new and 12 indeterminate) and 5 varieties.

BOLLI, HANS M. Planktonic Foraminifera from the Cretaceous of Trinidad, B. W. I.—Bull. Am. Paleontology, v. 39, no. 179, April 1, 1959, p. 253-277, pls. 20-23, chart 1 (range chart).—Thirty-one species (7 new) and 2 subspecies recorded and some illustrated. Stratigraphic ranges are shown and 5 foraminiferal zones are proposed for the 3 formations of the lower part of the Lower Cretaceous.

CHANG, LI-SHO. Smaller Foraminifera from the Test Well St-3 in the Shantzuchiao structure to the southwest of Taipei, Taiwan.—The Formosan Science, v. 12, no. 4, 1958, p. 165-168, pl. 1, text fig. 1 (columnar section).—A meager fauna of late Miocene age.

A biostratigraphic study of the Miocene in western Taiwan based on smaller Foraminifera (Part I: Planktonics).—Proc. Geol. Soc. China, no. 2, March 1959, p. 47-72, pls. 1-5, text figs. 1-5 (maps), tables 1-4.—Important paper in which are included illustrations and local stratigraphic ranges and occurrences of 23 species and subspecies (2 indeterminate), several probably useful for worldwide correlation.

CHRISTIANSEN, BENGT. The Foraminifer Fauna in the Dröbak Sound in the Oslo Fjord (Norway).—Nytt Magasin for Zool., v. 6, 1958, p. 5-91, text figs. 1-24, tables 1-3.—Quantitative study of the arenaceous part (96 species and 2 varieties) of the fauna based on 109 bottom samples. Living individuals of 80 species were found. Two species are new, one is given a new name, and the new genus **Radicula** (genotype **R. limosa** n. sp.) is described and placed questionably in the Hyperamminidae. Relationships to depth and substrate are determined for many species.

CITA, MARIA BIANCA. Stratigrafia micropaleontologica del Miocene Siracusano.—Boll. Soc. Geol. Ital., v. 77, 1958 (1959), p. 1-97, text figs. 1-54.—The five Miocene stages (Aquitanian to Sarmatian) in the Siracusa region of Sicily are distinguished by their smaller Foraminifera. Faunas from various samples are compared quantitatively. Descriptions and illustrations are included for a few selected species and varieties (1 variety new).

COLE, W. STORRS. Names of and variation in certain Indo-Pacific Camerinids.—Bull. Am. Paleontology, v. 39, no. 181, May 8, 1959, p. 345-371, pls. 28-31, tables 1-7.—**Operculinella** and **Operculinoides** are synonyms of **Operculina. O. ammonoides** and **O. venosa** are distinguishable by the variability of coiling in the former and by the limbate sutures recurved at their distal ends in the latter species. Specimens occur abundantly between 8 and 62 fathoms.

COLLINS, A. C. Report on Foraminiferal samples from King Island, Tasmania, App. III **in** The Coastal Geomorphology of King Island, Bass Strait, in relation to changes in the relative level of land and sea, by J. N. JENNINGS.—Rec. of the Queen Victoria Museum, Launceston, Tasmania, n. ser., no. 11, March 15, 1959, p. 36-39.—Paleoecological interpretations based on smaller Foraminifera. Occurrence of over an hundred species and varieties listed for 9 shallow bore-hole samples.

DAVIS, E. Les foraminifères néogènes d'Elide (in Greek with French résumé).—Akad. Athenon, Athens, Praktika, tom. 32, 1957 (1958), p. 332-337.—A fauna of 36 species interpreted as Astian stage of the Pliocene.

DUBOURDIEU, G., and HOTTINGER, L. Présence de Néoalvéolines dans le Miocène du Mesloula (Algérie orientale).—Revue de Micropaléontologie, v. 2, no. 1, June 1959, p. 3-7, pls. 1, 2.

DURAND DELGA, MICHEL, and MAGNÉ, JEAN. Notes sur certaines formations Tertiaires situées entre Almería et la Sierra de Carthagène (Espagne Meridionale).—Notas y Comunicaciones Instit. Geol. Min. España, Año 1958, no. 51, p. 129-144, 1 distrib. table.—Occurrence in 11 samples is plotted for 28 planktonic and 81 benthonic species.

DUSZYNSKA, STANISLAWA. Devonian Foraminifers from Wydryszow (Holy Cross Mountains).—Acta Pal. Polonica, v. 4, no. 1, 1959, p. 71-89, pls. 1, 2, text figs. 1-8.—Seven species, 4 new.

EISENACK, ALFRED. Chitinöse Hüllen aus Silur und Jura des Baltikums als Foraminiferen.—Paläont. Zeitschrift, Band 33, Nr. 1/2, Feb. 1959, p. 90-95, pl. 9, text fig. 1.—New genus **Archaeochitosa** (type species **A. lobosa** n. sp.) and 3 new species.

ERICSON, DAVID B. Coiling direction of **Globigerina pachyderma** as a climatic index.—Science, v. 130, July 24, 1959, p. 219, 220, text fig. 1 (map).—The 7.2°C April isotherm in the North Atlantic separates left dominant coiling in the colder area from right dominant coiling in the warmer area. In submarine cores from the warmer area, alternations to left coiling record southward shifts of isotherms during the ice age.

FORBES, C. L., and McGUGAN, A. A Lower Permian fusulinid fauna from Wapiti Lake, B. C.—Jour. Alberta Soc. Petr. Geol., v. 7, no. 2, Feb. 1959, p. 33-42, pl. 1, text figs. 1-3 (maps, columnar section). **Schwagerina emaciata** (Beede).

FORTI, AUGUSTO. Studi statistici su una microfauna aquitaniana dell'Appennino pavese-vogherese.—Riv. Ital. Pal. Stratig., v. 64, no. 4, 1958, p. 349-358, pl. 18, text figs. 1-3 (graphs).—An Aquitanian microfauna is listed and the family composition is graphically represented. The assemblage is illustrated.

FUJIMOTO, HARUYOSHI, and IGO, HISAYOSHI. The Fusulinid Zones in the Japanese Carboniferous.—Sci. Repts. Tokyo Kyoiku Daigaku, sec. C, v. 6, No. 53, Aug. 15, 1958, p. 127-145.

GARRISON, LOWELL E. Miocene Foraminifera from the Temblor formation north of Coalinga, California. —Jour. Paleontology, v. 33, no. 4, July 1959, p. 662-669, pls. 83-86, text figs. 1-4.—A shallow-water fauna (33 species and 1 variety) from a well core, divisible into two parts based on restriction of two species. Three new species and one new variety.

GEROCH, STANISLAW. Stratigraphic significance of arenaceous Foraminifera in the Carpathian Flysch.—Paläont. Zeitschrift, Band 33, Nr. 1/2, Feb. 1959, p. 113-122, pls. 12, 13, text figs. 1, 2.—Occurrence of 26 species (1 new) is recorded in various beds ranging in age from Valanginian to Eocene. Twelve of the species are illustrated.

GLAESSNER, M. F., and WADE, MARY. Revision of the foraminiferal family Victoriellidae.—Micropaleontology, v. 5, no. 2, April 1959, p. 193-212, pls. 1-3, text figs. 1-6, table 1.—Four genera included in the family, 1 new: **Maslinella** (type species **M. chapmani** n. sp.); **Hofkerina** is excluded. Two new species are described.

GRIGELIS, A. About the **Cardioceras zenaidae** zone (Middle Oxford) in southwestern and western Lithuania (in Lithuanian with abstracts in English and Russian). —Acad. Sci. Lithuanian SSR, Geol. and Geogr. Instit., Sci. Repts., v. 8, 1958, p. 165-175, text figs. 1-3, table. —Beds dated by Foraminifera.

GRIMSDALE, T. F. Evolution in the American Lepidocyclinidae (Cainozoic Foraminifera): an interim review. I and II.—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 62, no. 1, 1959, p. 8-33, text fig. 1.—Diphyletic origin of the family with two lineages from middle Eocene to Miocene. Commensalism with zooxanthellae, increasing potential speed of growth, may have resulted in adoption of annular mode of growth and hence have been the cause of convergent evolution among large Foraminifera. Notes on synonymity and on nomenclatural validity of 26 generic names of the Lepidocyclinidae.

GRIMSDALE, T. F., and VAN DER VLERK, I. M. A review of some subgeneric nomenclature among the Lepidocyclinae (Tertiary Orbitoidal Foraminifera).—Proc. Kon. Nederl. Akad. Wetenschappen, ser. B, v. 62, no. 1, 1959, p. 1-7.—Comments on type species of 2 subgenera and on validity and invalidity of 7 others.

HAMILTON, EDWIN L., and REX, ROBERT W. Lower Eocene phosphatized **Globigerina** ooze from Sylvania Guyot.—U. S. Geol. Survey Prof. Paper 260-W, June 11, 1959, p. 785-798, pls. 250-254, text fig. 255 (map). —Three dredge hauls brought up bottom material containing fossil oozes: one of early Eocene age in crack-fillings in volcanic rock; one of Miocene age (**Globigerinatella insueta** zone) in a pocket in altered basalt; and one of late Miocene age in a manganese-coated boulder. Thirty-six planktonic species and varieties, none new, are recorded and illustrated.

HENDRIX, W. E. A new method of foraminiferal correlation.—Jour. Paleontology, v. 33, no. 4, July 1959, p. 588-605, text figs. 1-14.—Examples of local correlation within Los Angeles Basin by means of the consistent patterns of small breaks in occurrences of individual species.

HOFKER, J. Foraminifera from the Cretaceous of Limburg, Netherlands. XXXIX. Arguments for a lower Paleocene age of the sediment above the upper Md in the quarry of Curfs, near Houthem.—Natuurhist. Maandblad, 48ᵉ Jrg., nos. 1-2, Feb. 27, 1959, p. 18-30, text figs. 1-5.—Disagreement with age assignment of Montian equivalent to Danian.

XXXX. The age of the Cr 4, Craie Tuffoide.—Natuurhist. Maandblad, 48ᵉ Jrg., nos. 3-4, April 29, 1959, p. 46-50, text figs. 1, 2.—Check list of many species from 6 uppermost Cretaceous horizons in Holland, Belgium, and Denmark.

XLI. The Danian age of the Maestrichtian Chalk Tuff proved by the orthogenesis of **Gavelinopsis involuta** (Reuss).—Natuurhist. Maandblad, 48ᵉ Jrg., nos. 3-4, April 29, 1959, p. 51-53, tables.—Pore diameters increasing with younger age.

HOOPER, KENNETH. X-ray absorption techniques applied to statistical studies of foraminifera populations. —Jour. Paleontology, v. 33, no. 4, July 1959, p. 631-640, pls. 80-82, text figs. 1-7.—A speedy, accurate, and nondestructive method of measuring internal structures of large numbers of specimens.

HOPPENER, H. Brief report on the paleontology of the Cuanza Basin—Angola.—Bol. Soc. Geol. Portugal, v. 12, fasc. 3, 1958, p. 75-82.—A few Foraminifera listed from beds between Pliocene and Paleocene.

ISHII, KEN-ICHI. Fusulinids from the middle Upper Carboniferous Itadorigawa group in western Shikoku, Japan. Part I, Genus **Fusulina.**—Osaka City Univ., Instit. Polytechnics Jour., ser. G, Geoscience, v. 4, Nov. 30, 1958, p. 1-28, pls. 1-5, tables 1-3.—Four new species and 2 indeterminate ones.

On the phylogeny, morphology and distribution of **Fusulina, Beedeina** and allied fusulinid genera.—Osaka City Univ., Instit. Polytechnics Jour., ser. G, Geoscience, v. 4, Nov. 30, 1958, p. 29-70, pls. 1-4, text figs. 1-5.

ISHIWADA, YASUFUMI. Studies on the brackish water. III, Recent Foraminifera from the brackish lake Hamana-ko (in Japanese with English abstract).—Geol. Survey Japan, Rept. No. 180, 1958, p. 1-19, pls. 1, 2, text figs. 1-10 (maps, diagrams), photographs; description of 3 new species in English, p. 17, 18, text figs. 1-3.—Three facies, one subdivided into 3 subfacies. Sixteen species (3 new) are illustrated.

JURKIEWICZ, HENRYK. Foraminifers of the Magura and Submagura beds in the vinicity of Pielgrzymka (Carpathians) (in Polish).—Przeglad Geol., No. 5, 1959, p. 202-204, text figs. 1-3.—Foraminifera listed and illustrated.

JURKIEWICZ, H., and KARNKOWSKI, P. Age of **Inoceramus** beds in the Magura Nappe (English summary of Polish text).—Acta Geol. Polonica, v. 9, no. 1, 1959, p. 17-54, pls. 1-4, text figs. 1-9 (maps, sections), distrib. table.—Foraminifera listed and illustrated from Upper Cretaceous, Paleocene, and Eocene.

JUX, ULRICH, and PFLUG, HANS D. Über Aufbau und Altersgliederung des Rheinischen Braunkohlenbeckens.—Geologie (Berlin), Jahrg. 7, Beiheft Nr. 20, 1958, p. 1-48, text figs. 1-11.—Occurrence of Foraminifera in middle and upper Oligocene section of a boring.

KAPTARENKO-CHERNOUSOVA, O. K. Foraminifera of the Jurassic deposits of the Dnieper-Donets basin (in Russian).—Akad. Nauk Ukrain. RSR, Kiev, Instyt. geol. Nauk Trudy, ser. strat. i paleo., vyp. 15, 1959, p. 1-120, pls. 1-18, tables 1, 2.—Illustrations and descriptions of 84 species (34 new) and 4 varieties (2 new). Three new genera of the Epistominidae: **Praelamarckina** (genotype **P. humilis** n. sp.), **Lamarckella** (genotype **L. media** n. sp.) and **Garantella** (genotype **G. rudia** n. sp.).

Pro Mors'kij Neocom Dnihprovs'ko-Doneth'koji Zapadini. —Akad. Nauk Ukrain. RSR, Geol. Zhurnal, tom 19, vyp. 1, 1959, p. 37-46, 1 pl., 1 map.—Five species, none new.

KECSKEMÉTI, T. Bis jetzt in Ungarn unbekannte **Discocyclina** und **Asterocyclina** aus dem Eozän von Ajka. —Ann. Hist.-Nat. Mus. Nat. Hungarici, n. ser. 9, tom. 50, 1958, p. 39-43, 1 pl., text figs. 1, 2.—**Discocyclina chudeaui** and **Asterocyclina taramellii.**

KOCHANSKY-DEVIDÉ, VANDA. Die Neoschwagerinenfaunen der Südlichen Crna Gora (Jugoslavien).—Geol. Vjesnik (Zagreb), Sv. 11, God. 1957 (1958), p. 45-76, pls. 1-6.—Sixteen species (4 new and 5 indeterminate) and 1 new subspecies.

Generationswechsel der **Orbitopsella praecursor** im Lias von Plitvice (Kroatian) (German summary).—Geol. Vjesnik (Zagreb), Sv. 11, God. 1957 (1958), p. 77-86, pls. 1-3.

KURC, GEORGES. Note préliminaire sur les sédiments de l'etang de Thau.—C. R. séances Acad. Sci. Paris, t. 248, April 13, 1959, p. 2230-2232.—Seventeen species listed from a salt-water pond.

LIPNIK, O. S. Pro dejaki osoblivosti fauni foraminifer Maastrikhts'kikh vidkladiv khutova Dubrivki Poltavs'koji oblasti.—Akad. Nauk Ukrain. RSR, Geol. Zhurnal, tom 18, vyp. 4, 1958, p. 102-105, 1 table.—Distribution and abundance of many Foraminifera in borings of Maestrichtian age.

MAYNC, WOLF. **Martiguesia cyclamminiformis** n. gen. n. sp., un nouveau genre de Lituolidés a structure complexe.—Revue de Micropaléontologie, v. 2, no. 1, June 1959, p. 21-27, pls. 1-3, text fig. 1 (graph).—Genus belonging in the Choffatellinae, from the Santonian of France.

McGLASSON, ROBERT H. Foraminiferal biofacies around Santa Catalina Island, California.—Micropaleontology, v. 5, no. 2, April 1959, p. 217-240, text figs. 1-18 (maps, diagrams, graphs), tables 1-8.—From a quantitative study of living and dead specimens 3 depth zones can be recognized: 0-20, 21-40, and 41-100 fms. About 100 identified species are involved. Depth, temperature, sediments, and submarine topography affect distribution of species.

M.-MACLAY, A. D. The system and phylogeny of the fusulinids (the genus **Triticites** and other genera similar to it) (in Russian).—Leningrad Univ. Vestnik, ser. geol. geogr., No. 6, vyp. 1, 1959, p. 5-23, 1 text fig., tables 1, 2.

Znachenie Gomeomorfii dlja Sistematiki Fuzulinid.—Leningrad Univ. Uchenye Zapiski, no. 268, vyp. 10, 1959, p. 155-172, text figs. 1, 2, tables 1-3.—Ten genera are discussed, one new: **Occidentoschwagerina** (type species **Schwagerina fusulinoides** Schellwien).

On the stratigraphic role, taxonomy and phylogenesis of **Stafella**-like foraminifers (in Russian).—Doklady Akad. Nauk SSSR, tom 125, no. 3, 1959, p. 628-631, text figs. 1, 2.—**Eostaffelloides** n. gen. (type species **E. orientalis** n. sp.) in the Ozawainellinae and **Neostaffella** n. gen. (type species **Pseudostaffella sphaeroidea** Ehrenberg) in the Pseudostaffellininae. New subfamily Reichelininae erected.

MONTANARO GALLITELLI, E. Specie nuove e note di Foraminiferi del Cretaceo Superiore di Serramazzoni (Modena).—Accad. Sci. Lett. Arti Modena, Atti e Mem., ser. 5, v. 16, 1958, p. 127-152, pls. 1-4, text fig. 1.—Thirty-nine species and subspecies, 6 new.

MOROZOVA, V. G. Stratigraphy of Danian-Montian deposits of the Crimea, based on the foraminifera (in Russian).—Doklady Akad. Nauk SSSR, tom 124, no. 5, 1959, p. 1113-1116, text fig. 1, table 1.—**Eoglobigerina,** new subgenus of **Globigerina,** with **G. (E.) eobulloides** n. sp. from the lower Danian as type of the subgenus. **Acarinina indolensis** n. sp. from the upper Danian.

NAGAPPA, YEDATORE. Foraminiferal biostratigraphy of the Cretaceous-Eocene succession in the India-Pakistan-Burma region.—Micropaleontology, v. 5, no. 2, April 1959, p. 145-181, pls. 1-11, text figs. 1-11 (maps, sections, columnar sections), tables 1-9, charts 1-4 (range chart, generic evolution charts).—Significant larger and smaller Foraminifera are illustrated in rock sections, thin sections, and as free specimens, and stratigraphic ranges between Cretaceous and Oligocene are shown for 32 genera. Four cycles of deposition (transgression-regression) are recognized; one each in Upper Cretaceous and Paleocene, and two in Eocene.

NOGAMI, YASUO. Fusulinids from the Maizuru Zone, southwest Japan. Part I. Ozawainellinae, Schubertellinae and Neoschwagerininae.—Mem. College Sci. Univ. Kyoto, ser. B, v. 25, no. 2, Dec. 1958, p. 97-114, pls. 1, 2.—Eleven species (1 new and 3 indeterminate) and 1 new subspecies from Upper Permian.

NØRVANG, AKSEL. **Islandiella** n. g. and **Cassidulina** d'Orbigny.—Vidensk. Medd. fra Dansk naturh. Foren., v. 120, 1958, p. 25-41, pls. 6-9.—**Islandiella** (type species **Cassidulina islandica** Nørvang) separated on the basis of radiate wall and internal tooth partially closing the rounded aperture. **Cassidulina** has a granular wall and a tripartite aperture with the opening obstructed by plate-like lips. Thirteen species (1 new) are described and illustrated.

On **Nonion pompilioides** (Fichtel & Moll).—Medd. Dansk Geol. Forening, v. 14, pt. 2, 1959, p. 141-150, text figs. 1-6.—Inclusion of 5 synonyms within this species, and impossibility of recognizing the many species that have been set up within this highly variable form.

NYIRO, REKA M. The studying of Foraminifera in thin sections.—Ann. Hist.-Nat. Mus. Nat. Hungarici, n. ser. 9, tom. 50, 1958, p. 31-38, 1 pl.—Description of technique and illustration of results obtained in arenaceous and calcareous smaller Foraminifera.

ÖZTEMÜR, VECIHE. Note on some foraminiferal species encountered in the well samples of southeastern Turkey.—Bull. Min. Res. Explor. Instit. Turkey, Foreign Ed., no. 52, April 1959, p. 59-66, pls. 1-4, map.—Five Upper Cretaceous and 3 Paleocene species, none new.

PAPP, ADOLF. Grundzüge regionaler stratigraphie, erster teil **in** Tertiär by A. PAPP and E. THENIUS. —Ferdinand Enke Verlag, Stuttgart, 1959, 411 p., 89 text figs., 63 tables [Foraminifera, p. 24-48, text figs. 1-11, tables 4-9].—Compilation of stratigraphic ranges of selected species and genera of large and small Foraminifera in the Tertiary.

PERICOLI, SERGIO. Sulla presenza del genere **Hantkenina** Cush. nella "scaglia" dell'urbinate.—Boll. Soc. Natural. Napoli, v. 67, 1958 (1959), p. 68-90, pls. 1, 2, tables 1, 2.—Eight species, 1 new, and 1 subspecies from Urbino.

PIERAU, HERRIBERT. Zur Stratigraphie und Tektonik Jungtertiärer Ablagerungen im Nordwestlichen Krsko Polje in Slowenien.—Geologija, Razprave in Porocila, knj. 4, 1958, p. 111-148, text figs. 1-3 (map, sections), tables 1-10.—Local ranges and abundance of smaller Foraminifera in several profiles. Nine zones are set up in the Tortonian and Sarmatian.

POLSKI, WILLIAM. Foraminiferal biofacies off the North Asiatic coast.—Jour. Paleontology, v. 33, no. 4, July 1959, p. 569-587, pl. 78, text figs. 1-8 (maps, graph, distrib. chart), tables 1-3.—Quantitative analysis of Foraminifera in 158 bottom samples from the Yellow Sea, East China Sea, Korea, and Taiwan Strait, ranging from 50 to 4400 feet in depth. Five depth zones are recognized. Only dominant species (those comprising more than 3%) were included in the study; 29 species restricted to depth or area; 17 semicosmopolitan, and 11 cosmopolitan. Two new varieties are described. Discussion of controlling factors in distribution, abundance, and preservation of species.

POTIEVS'KA, P. D. Foraminiferi Verkhn'obashkirs'kikh Vidkladiv zakhidnoi Chastini Donets'kogo Baseinu.—Akad. Nauk Ukrain. RSR, Kiev, Instyt. geol. Nauk Trudy, ser. strat. i paleo., vyp. 31, 1958, p. 1-73, pls. 1-7, tables 1-3.—Thirty-one species (13 new) and 9 varieties (7 new) from rocks of Middle Carboniferous age.

POZARYSKI, WLADYSLAW and KRYSTYNA. Comparaison entre le Crétacé de la Belgique et de la Pologne.—Ann. Soc. Géol. Belgique, v. 82, 1959, p. B1-B14, 1 text fig. (columnar section).—The Dano-Paleocene species, **Discorbis binkhorsti** and **Eponides toulmini**, appear earlier in Belgium than in Poland.

RAFFI, G., and FORTI, A. Micropaleontological and stratigraphical investigations in "Montagna del Morrone" (Abruzzi-Italy).—Revue de Micropaléontologie, v. 2, no. 1, June 1959, p. 8-20, pls. 1, 2, text figs. 1-3 (map, columnar sections), table 1.—Three stratigraphic sections, mostly in Jurassic and Cretaceous, are studied. Foraminifera illustrated in rock sections.

REISS, Z. Notes on Foraminifera from the Gulf of Eylath, Ras Muhamed and Tiran.—Bull. No. 20, Sea Fisheries Research Sta., Haifa, Jan. 1959, 3 p.—Check list of 66 species, over a third indeterminate, from 3 samples.

REITER, MARTIN. Seasonal variations in intertidal Foraminifera of Santa Monica Bay, California.—Jour. Paleontology, v. 33, no. 4, July 1959, p. 606-630, pl. 79, text figs. 1-10 (maps, graphs), tables 1-11.—Quantitative study based on weekly collections (from September to April) of sand from 7 stations. Out of 129 species found, only 17 were found to be living in the intertidal environment. Greatest concentrations of specimens occur in protected areas and in sand less than 0.5 mm. in diameter. One new miliolid is described.

REYMENT, R. A. Zur Fassung der Foraminiferengattung **Aragonia**.—Paläont. Zeitschrift, Band 33, Nr. 1/2, Feb. 1959, p. 108-112, text figs. 1-4.—Genus is not related to **Bolivina**. Wall is composed of agglutinated calcareous granules and is without pores.

RIVERO, FRANCES CHARLTON DE. Introducción al estudio de los macroforaminiferos de la familia Orbitolinidae.—Geos, Venezuela Univ. Central, Caracas, Escuela de geologia, minas y metalurgia, No. 1, Jan. 1959, p. 4-19, 2 pls., text figs. 1-5.

SCHAROVSKAJA, N. V. Nekotorye novye Vidy Foraminifer iz srednejurskikh Otlozhenij Norvikskogo Rajona.—Sbornik statej po paleont. i biostratig., Leningrad, 1958, p. 31-65 (mimeographed), pls. 1-3.—Twelve new species from Middle Jurassic of Nordvik region.

STCHEDRINA, Z. G. Ob Iskopaemykh Foraminiferakh v Donnykh Otlozhenijakh Karskogo Morja.—Sbornik statej po paleont. i biostratig., Leningrad, 1958, p. 66-72 (mimeographed), table 1 (distrib. chart).—Foraminifera listed from a boring that penetrated to Paleocene strata.

STEWART, WENDELL J. **Fusulina pseudochomatata,** new name for **Fusulina valida** Stewart.—Jour. Paleontology, v. 33, no. 4, July 1959, p. 700.

TAMAJO, ELEONORA. Presenza di complessi solfurici di origine sedimentaria nelle rocce argillose e minerogenesi dello zolfo.—Boll. Serv. Geol. Italia, v. 79, fasc. 3-5, 1958, p. 759-835, text figs. 1-30, diagrams.—Unstable sulphuric complexes in argillaceous rocks, formed in a highly reducing environment, occur as granules formed by filling of shells of Foraminifera and other fossils under conditions equivalent to Recent sulphurous marine bottoms.

TINOCO, IVAN DE MADEIROS. Observações sôbre a microfauna de Foraminíferos da Lagoa de Araruama, Estado do Rio de Janeiro.—Anais Acad. Brasileira Ciencias, v. 30, no. 4, Dec. 31, 1958, p. 575-584, pl. 1.—Small fauna (6 forms) from a high salinity coastal lagoon.

UJIIÉ, HIROSHI. Standard age-division of the Middle Tertiary by means of pelagic Foraminifera (Review) (in Japanese).—Chikyu Kagaku (Earth Science), No. 42, April 1959, p. 25-40, text figs. 1-5 (correl. charts and range charts).

UJIIÉ, HIROSHI, and IIJIMA, HARUO. Miocene Foraminifera from the Akahira group, Saitama Prefecture, Japan.—Bull. Chichibu Mus. Nat. Hist., No. 9, March 1959, p. 69-94, pls. 1, 2, text figs. 1-5, table 1 (check list), map.—Aquitanian age interpretation based on planktonics. Six species and 1 subspecies are described as new.

VITERBO, ILEANA. Sull'età di alcuni Lembi di "Flysch" del Massiccio del Matese (Appennino Meridionale).—Boll. Serv. Geol. Italia, v. 79, fasc. 3-5, 1958, p. 541-553, table 1.—List of Foraminifera.

WELSH, JOHN E. Faunizones of the Pennsylvanian and Permian rocks in the Paradox Basin.—Intermountain Assoc. Petr. Geol., 9th Ann. Field Conf., Guidebook to the geology of the Paradox Basin, 1958, p. 153-162, pls. 1-4, text figs. 1, 2 (sections).—Fusulinids from well cuttings, cores, and outcrop samples.

WOLANSKA, HENRYKA. **Agathammina pusilla** (Geinitz) from the Lower Zechstein in the Sudeten and Holy Cross Mountains (English summary of Polish text).—Acta Pal. Polonica, v. 4, no. 1, 1959, p. 27-59, pls. 1-3, text figs. 1-4, tables 1, 2.—Emendation of genus and species.

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