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REVISION OF SOME RECENT FORAMINIFERAL GENERA

(With Four Plates)

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INTRODUCTION

For the past few years we have been restudying the genotype species of Foraminifera, with the aim of establishing a firmer basis for the taxonomy and classification of Foraminifera. As some of the early illustrations were quite generalized or inaccurate and the type specimens had not since been restudied, this reexamination is of extreme importance. As a result of it, some supposedly well-known genera are found to be synonymous with others and quite unlike what was commonly referred to them.

We are therefore here redescribing various genera of Recent Foraminifera, basing these diagnoses upon the type species, so that they may be better understood. Twenty-three Recent genera of Foraminifera are here described, for which ten generic diagnoses are emended, three genera are suppressed as being synonymous, and four new genera, one new species, and one new family are proposed.

Under each generic description which follows we have given the original reference, listed the type species, and how and when it was designated, given a generic diagnosis, as based upon the type species and in some cases an emendation of the original diagnosis, the location of the types (here again referring only to the type species), and a discussion of the various problems in taxonomy and morphology of the particular genus concerned, and in certain instances the reasons for the suppression of the generic name.

In the descriptive section of this paper and in the plate explanations

we have used the abbreviations U.S.N.M. for the U. S. National Museum, Washington, D. C., B.M.N.H. for the British Museum (Natural History), London, and M.N.H.N. for the Muséum National d'Histoire Naturelle, Paris, as nearly every type specimen figured and discussed was from one of these institutions.

ACKNOWLEDGMENTS

We have for the past few years been restudying all type species of genera available in this country or obtainable by loan or exchange from other countries. As many genera were not available in this country, approximately 10 months of the past year were spent in western Europe visiting museums and other institutions and searching for and restudying the European types of Foraminifera. New descriptions were written from the actual specimens and the types were refigured by Helen Tappan Loeblich in these institutions. Other specimens figured in the present paper, from the collections of the U. S. National Museum in Washington, D. C., were illustrated by Lawrence Isham.

In connection with the preparation of the present paper we wish to acknowledge the invaluable assistance given to us by various institutions and individuals. The British Museum (Natural History), in London, very graciously allowed us unrestricted access to their foraminiferal collections, and we were personally aided there by Dr. H. W. Parker, head keeper of zoology, Dr. Norman Tebble, and A. G. Davis. We not only examined types in the collections of Brady, Heron-Allen and Earland, Williamson, Sidebottom, Parker and Jones, and Carter, but also examined the original faunal slides and samples in many instances, and were allowed to designate lectotypes from the original cotypes of many of these workers.

In France, with the kind permission of M. Roger, we were allowed to borrow types from the Muséum National d'Histoire Naturelle, in Paris, and to select lectotypes for species of d'Orbigny and of Terquem. Other types were borrowed from the collections in the Sorbonne in Paris.

We are also grateful to the Bureau des Recherches Géologiques et Géophysiques, in Paris, for allowing us to use their laboratory during our stay in Paris, and to M. Pierre Marie, chief micropaleontologist there, who aided us in locating and borrowing various type specimens in Paris.

L'Institut Français du Petrole also allowed us to work in their laboratory at Rueil-Malmaison and to examine and illustrate types in their collection. We are especially grateful to Mme. Yvonne Gubler and M. Lys for their assistance.

In addition to these institutions and individuals that were of great assistance in the study of the Recent genera here included, we are also equally indebted to many of the other geologists, paleontologists, and zoologists of western Europe for their assistance in the study of fossil forms. We will more completely acknowledge their aid in forthcoming revisions of these fossil genera.

These generic studies cannot be made solely in museums, and it has often been necessary to obtain topotype material to understand better the genera. Therefore, in addition to our museum studies, we also collected large quantities of topotype foraminiferal material in western Europe, with the aid of the local specialists while in the field. We visited many university, museum, and petroleum company laboratories in order to observe the various methods of preparing samples, labeling slides, and storing collections, and received many valuable suggestions as to these techniques.

We are extremely grateful for the cooperation of the micropaleontologists throughout the world in our restudy of the genera. Many have cooperated by exchanges of material and literature, by showing us the localities in the field, and by demonstrating varied techniques in the laboratory.

DIFFICULTIES ENCOUNTERED IN FORAMINIFERAL SYSTEMATICS

We have been profoundly disturbed in our generic studies by certain factors which we have observed that seem to have added to confusion rather than to the clarification of taxonomic problems. Modern authors have sometimes been as lax with taxonomic matters as the worst of the early systematists. We are therefore giving here our observations on faults that future workers on Foraminifera would do well to avoid.

Lack of preparation of material.—It is obviously a time-consuming procedure to wash samples. Nevertheless, when material is found that is sufficiently interesting to warrant description, it is extremely important that the material be completely prepared and as clean as possible. The procedure used by us on all samples is first to wash by means of an extremely fine screen and spray or use the triple decanting method, sometimes with hydrogen peroxide or other aids as well, and then always to boil the samples for a length of time varying from a few hours to as long as a week if necessary.

It is also important to wash Recent samples thoroughly, although this has often been more or less neglected in the past. Merely because

the muds are not consolidated, it has been thought unnecessary to boil them. Strangely enough we have found that many Recent genera are very incompletely known, owing entirely to lack of sufficient preparation. Examples discussed later in this paper include one genus described as having a trematophore when actually the aperture was filled only by a shell fragment. Another genus was described as having an amorphous material between and around the chambers, which was in fact only the lime muds that had settled on the specimen and had not been removed by washing. In other forms, both Recent and fossil, the apertural characters or umbilical areas have been obscured by extraneous material which a little care in preparation could have removed. Another reason for the necessity of thoroughly washing samples is the fact that in Recent samples there is apparently sometimes a chemical action of the sea salts on the calcareous Foraminifera after a few years exposure to the air. We have seen specimen after specimen in museums that seem to have "exploded," and for no apparent reason other than this chemical reaction.

With the increased detail of foraminiferal studies it can be seen that many genera require additional techniques. In earlier years it was thought necessary to make thin sections only of the so-called "larger Foraminifera." Later workers have shown that extremely important features can be seen only by means of very careful dissection, and it has now become necessary to make dissections or thin sections of many genera of smaller Foraminifera in order to determine correctly their development. For example, one genus was described with a supposed early planispiral coil, but a thin section now shows the form to have a much more complex early chamber arrangement; others are found to have hitherto unsuspected internal tubes, chamberlets, or distinctive wall structures. Thus it becomes necessary to prepare material very thoroughly before describing new species and genera.

Too much dependence on literature.—It is of course imperative to have available as much literature as possible in order to do taxonomic work. It is equally important not to be too dependent on literature. In the final analysis, it is necessary to compare actual specimens. This is extremely important in describing new forms. Although it may seem certain that a specimen at hand is identical with that of Brady, Parker and Jones, or others, it is dangerous to assume this without recourse to the types. Thus various authors have cited so-called "classic species" as types for new genera, firmly believing their specimens to be identical with the original types, only to find later that the specimens were not even congeneric. It is always best to base genera

on species at hand, and if not a new species, it would be advisable to have or see authentic types of the species used.

Often misinterpretations of figures may cause difficulties—an internal tube may be shown in a figure but be thought to represent merely a highlight, or because the figures do not show certain important characters, such as apertures, septa, or other features, later workers may erroneously assume these to be like those of specimens at hand. For example, arenaceous genera have been described, and calcareous forms unknowingly selected as type species. Brady's *Challenger* monograph of Recent Foraminifera was one of the most inclusive foraminiferal works available, and many authors have selected species of Brady as types for new genera. Fortunately, his figures and descriptions are in general remarkably accurate and his types well labeled and preserved. This work covered only Recent species, however, and many fossil genera are not included in Brady's work. Other workers have used works of d'Orbigny, Terquem, Reuss, Quenstedt, and others as a basis for their taxonomic revisions, and with resultant confusion, as the original illustrations were often not accurate, nor the diagnoses thorough. In the last decade the Ellis and Messina Catalogue of Foraminifera has tended to supplant other works as a basis for taxonomic "revisions." Although an invaluable tool for research in supplying original descriptions and figures, this compilation can also be misused by modern students of Foraminifera who "discover" new genera by turning its pages. Too many of the "original figures" which it reproduces are not as reliable as those of Brady, and many errors arise when revisions are made on the sole basis of these illustrations and descriptions, without consideration of the reliability of their authors. As students of Foraminifera are to be found in almost every area of the globe, it would seem better to increase the frequency of exchanges of specimens, so that those wishing to make generic revisions can see at first hand the species or genera they are studying, and not depend solely on the literature.

Lack of responsibility for preservation of types.—It would seem that anyone describing new species or genera would have sufficient interest in their own work to desire its validation and preservation. Unfortunately, many writers seem to feel that their responsibility ends when their manuscript reaches an editor. Type specimens are not labeled, locality data are insufficiently given in publications and on the slides, the depository of the types is not always cited, and sometimes types are even kept in private collections. Naturally, it is convenient to have one's types at hand in case one wishes to consult them again at a future

date, but too often they are forgotten completely and eventually lost. Even such a pioneer systematist as d'Orbigny, having kept his types in a personal collection, was unable to prevent the loss of many. After his death the types that were located were sent to the Muséum National d'Histoire Naturelle in Paris, but only about one-third were thus preserved, the remainder having been lost or destroyed. Types can always be consulted again if deposited in a reliable institution.

Most museums have time after time received from authors types that were only partially labeled, perhaps in pencil, or even completely without labels. In some instances numerous specimens may be on a single slide with no indication as to which is the type or which have been figured. The curators in charge must then spend many days attempting to identify the types and label them properly, but we have seen instances in some institutions where many years after publication the "types" remain unlabeled and can be recognized only by their authors. In some instances genera have been based on species whose types, thus kept, cannot now even be identified.

Sometimes more than one specimen is present on a slide with no indication as to which is the type, or the author may have designated many cotypes rather than a holotype and paratypes. In this case a succeeding worker may select one of these specimens as lectotype, which takes the place of a holotype, thus delimiting exactly the species. We have done this in many instances—for example, in the d'Orbigny collection. The original d'Orbigny slides sometimes contained more than one species as they are now understood, and often more than one genus as well. Then the specimens selected as lectotype must determine the entire character of the genus, regardless of original descriptions or later understanding of the genus. When selecting lectotypes we have invariably attempted to locate the specimen figured by the author and that most clearly corresponding to his description. We have also in each instance noted on the slide that the specimen has been designated as lectotype for the aid of later workers.

It is far preferable, however, that the original authors definitely select the holotype for the new species, and furthermore that they so label their preparations that no doubt can remain. Not only should the specimen be labeled as to name and author and what sort of type, but also more exact locality data should be given so that future workers would be able to obtain topotype material. As many types have been lost through the years, it has been necessary to search for additional material from the original locality in order to determine the characters of the species. It is much easier to obtain authentic material from

well-documented localities than from one given simply as Cretaceous of Texas or fossil from Italy.

Furthermore, the original publication should state definitely which specimen is the holotype, or other primary type, give exact data as to locality and horizon, and also state in what institution the types are deposited and list the catalog numbers if such are available.

GENERIC DIAGNOSES

Genus BRACHYSIPHON Chapman, 1906

Plate 1, figure 1

Original description.—New Zealand Inst., Trans. Proc., vol. 38 (21st of n. s.), pt. 2, art. 17, p. 83, 1906.

Type species.—*Brachysiphon corbuliformis* Chapman, 1906. Original designation; monotypic.

Diagnosis.—Test free, elongate, cylindrical; wall agglutinated, incorporating numerous small Foraminifera and other shell fragments, as well as sand grains, on a "chitinous" base or internal lining; aperture an irregular opening at the slightly constricted end of the tube.

Types.—Original types from lat. 36°8′ S., long. 175°55′ E., off Great Barrier Islands, North Island, New Zealand, at 110 fathoms depth, and are probably in the Melbourne Museum. The figured specimen is a topotype in the Sidebottom Collection, B.M.N.H. No. ZF 3572, from off the Great Barrier Islands, New Zealand.

Discussion.—Cushman (1948, p. 78) stated that this genus was possibly synonymous with *Proteonina* Williamson, 1858. As has been shown elsewhere in this article, *Proteonina* Williamson is synonymous with *Reophax* and hence quite unlike *Brachysiphon*.

Brachysiphon differs from *Saccammina* M. Sars, 1869, in the elongate cylindrical form and from *Lagenammina* Rhumbler, 1911, in the parallel sides and in lacking a constricted neck. It superficially resembles a *Bathysiphon,* but is closed at one end and much shorter. Galloway (1933, p. 74) stated that it was as wide as long and with a proloculum at one end, but these statements are not borne out by an examination of the topotypes in the British Museum.

Genus PROTEONINA Williamson, 1858, emended

Plate 1, figures 2, 3

Original description.—On the Recent Foraminifera of Great Britain, Ray Soc. London, p. 1, 1858.

Type species.—*Proteonina fusiformis* Williamson, 1858. Subsequent designation by Rhumbler (1904, p. 244).

Diagnosis.—Test elongate, fusiform in outline, consisting of a subglobular proloculus and elongate, flask-shaped later chambers, few in number; sutures somewhat obscure or slightly constricted from the exterior, nearly horizontal; wall agglutinated, with coarse particles; aperture terminal, rounded, slightly produced.

Types.—Williamson's types are deposited in the B.M.N.H., lectotype (here designated) No. ZF 3605 (fig. 2) and paratype No. 96.8.13.1 (figs. 3a, b), both Recent, from Skye, in sand dredged by Mr. Barlee.

Discussion.—Williamson's figured specimen was a three-chambered form (a typical *Reophax*) with somewhat indistinct sutures due to the coarseness of the particles in the agglutinated wall. Williamson (1858, p. 1) stated in his generic diagnosis that *Proteonina* possessed "a slight disposition in its young state to become convoluted"; but he says also, "I have hitherto failed in tracing any internal septa in the *Proteonina.*"

Williamson described also *P. pseudospiralis* (1858, figs. 2, 3), but his types are apparently lost. From the illustrations it seems to be generically distinct from *P. fusiformis,* as it is compressed and has a narrow slitlike aperture and the outline of the test suggests an initial coil.

Proteonina thus is a multilocular, uniserial agglutinated form, and not a single-chambered form as has been commonly considered. The name *Proteonina* is therefore suppressed as a synonym of *Reophax* Montfort, 1808. The majority of other species that have been placed in *Proteonina* can be placed in *Saccammina* Sars, 1869, *Lagenammina* Rhumbler, 1911, or other genera, and there seems no necessity to create another generic name to replace *Proteonina.*

PLANCTOSTOMA Loeblich and Tappan, new genus

Plate 1, figures 6-12

Type species.—*Textularia luculenta* Brady, Rep. voyage *Challenger,* vol. 9 (Zoology), p. 364, pl. 43, figs. 5-8, 1884.

Derivation.—*planktos* Gr., wandering, roaming+*stoma* Gr., mouth. Gender, neuter.

Diagnosis.—Test free, elongate, chambers biserially arranged, but in rare specimens the last chambers may lose the biseriality and become central, very rarely the last few chambers being uniserial; wall agglutinated, simple in structure; aperture at the base of the last

chamber in the young stage, but moves rapidly up into the face and typically consists of a rounded opening in the terminal face, commonly somewhat off-center; occasional specimens may even have a multiple aperture of two or three rounded openings.

Types.—Brady (1884, p. 365) recorded *Textularia luculenta* from five localities, three in the North Atlantic (off Sombrero Island, 450 fathoms; off Culebra Island, 390 fathoms; and off Bermuda, 435 fathoms) and two in the South Atlantic, near the coast of South America and a little south of Pernambuco, 675 fathoms and 350 fathoms respectively. Lectotype (here designated), the specimen figured by Brady (1884, pl. 43, fig. 5), in B.M.N.H. Hypotype of figure 8 (U.S.N.M. No. P 2185) and unfigured hypotypes (U.S.N.M. No. 16946) from *Albatross* station D 2150, lat. 13°34′45″ N., long. 81°21′10″ W., bottom temperature 45.75° F., 382 fathoms; unfigured hypotypes (U.S.N.M. No. P 2186) from *Albatross* station D 2355, lat. 20°56′48″ N., long. 86°27′00″ W., 399 fathoms; unfigured hypotype (U.S.N.M. No. 17025) from *Albatross* station D 2614, lat. 34°09′00″ N., long. 76°02′00″ W., 168 fathoms; unfigured hypotype (U.S.N.M. No. 17026) from *Albatross* station D 2644, lat. 25°40′00″ N., long. 80°00′00″ W., bottom temperature 43.4° F., 193 fathoms; hypotypes of figures 11, 12 (U.S.N.M. No. P 2195a, b) and unfigured hypotypes (U.S.N.M. No. 17027) from *Albatross* station D 2659, lat. 28°32′00″ N., long. 78°32′00″ W., bottom temperature 45.2° F., 509 fathoms; unfigured hypotype (U.S.N.M. No. P 2187) from *Albatross* station D 2660, lat. 28°40′00″ N., long. 78°46′00″ W., bottom temperature 45.7° F., 504 fathoms; unfigured hypotypes (U.S.N.M. No. 17028) from *Albatross* station D 2668, lat. 30°58′30″ N., long. 79°38′30″ W., bottom temperature 46.3° F., 294 fathoms; unfigured hypotypes (U.S.N.M. No. 17029) from *Albatross* station D 2677, lat. 32°39′00″ N., long. 76°50′30″ W., bottom temperature 39.3° F., 478 fathoms; unfigured hypotypes (U.S.N.M. Cushman Coll. No. 35149) from Harvard-Havana Expedition *Atlantis* station 2980, lat. 22°48′ N., long. 78°48′ W., 225 fathoms; unfigured hypotypes (U.S.N.M. No. P 2189) from Johnson-Smithsonian Expedition station 25, lat. 18°32′15″ N., long. 66°22′10″ W., lat. 18°32′05″ N., long. 66°22′10″ W., 240 to 300 fathoms; unfigured hypotypes (U.S.N.M. No. P 2190) from Johnson-Smithsonian Expedition station 37, lat. 18°13′50″ N., long. 67°39′20″ W., lat. 18°11′56″ N., long. 67°42′50″ W., 160 to 200 fathoms; hypotype of figure 6 (U.S.N.M. No. P 2191) and unfigured hypotypes (U.S.N.M. No. P 2192) from Johnson-Smithsonian Expedition station 93, lat. 18°38′00″ N., long. 69°09′30″ W., lat. 18°37′45″ N., long. 65°05′00″

W., 350 to 400 fathoms; hypotypes of figures 7 and 9 (U.S.N.M. No. P 2193a,b) and unfigured hypotypes (U.S.N.M. No. P 2194) from *Challenger* station 23, off Sombrero Island, West Indies, 450 fathoms; and hypotype of figure 10 (U.S.N.M. No. P 2188) and unfigured hypotypes (U.S.N.M. No. P 2194) from *Challenger* station 24, Culebra Island, north of St. Thomas, West Indies, 390 fathoms.

Discussion.—In the early stages (fig. 6) *P. luculentum* is typically textularian in that the aperture is at the base of the final chamber, but in mature specimens (figs. 8, 9) the aperture migrates into the face of the terminal chamber, becoming terminal, and a rare individual or "freak" develops a bigenerine stage as shown in figure 7.

A count was made of the apertural characters of our specimens of this species. Of 283 specimens examined, 249 had a biserial test and a terminal aperture (88 percent); 25 had a biserial test and textularian aperture (8.8 percent), but these were largely juvenile forms; 5 had terminal uniserial chambers and terminal aperture (1.8 percent); and 4 specimens showed a multiple terminal aperture (1.4 percent).

Brady (1884, p. 365) concluded that this migratory feature of the aperture was of minor importance and included his species in *Textularia.* He stated that this distinctive apertural character led to the proposal of a distinct genus *Proroporus;* however, the latter is a calcareous form and species referred to it probably belong to *Bolivina* and *Loxostomum.* Goës (1896, p. 24) has called attention to the fact that *Textularia saulcyana* d'Orbigny, 1839, may be a dwarfed form of this species and if so should take preference over this specific name. However, until types of d'Orbigny's species are examined, the writers prefer to keep the two forms separate inasmuch as d'Orbigny's drawings seem somewhat generalized.

Planctostoma, new genus, differs from *Textularia* Defrance in having an aperture in the later stages terminal on the last chamber rather than at the base of the last chamber. It is differentiated from *Bigenerina* in lacking the uniserial stage of that genus. The rare specimen here illustrated (fig. 7) with the bigenerine stage is regarded as a "freak." From *Siphotextularia* this genus is differentiated in lacking the quadrangular outline of that genus and also in having a rounded aperture instead of a slitlike aperture on the terminal face with a projecting rim. *Planctostoma* as presently known is represented by the species *luculentum* and *saulcyana,* both from the Caribbean region. Specimens figured by Lalicker and McCulloch (1940, pl. 16, fig. 22a-d) as *Textularia saulcyana* d'Orbigny from the Pacific are not this species and should not be confused with *T. saulcyana.*

Genus TEXTULARIOIDES Cushman, 1911, emended

Plate 1, figures 4, 5

Original description.—U. S. Nat. Mus. Bull. 71, p. 26, 1911.

Type species.—*Textularioides inflata* Cushman, 1911. Original designation.

Diagnosis.—Test attached at least in the early stages; chambers in a biserial textularian arrangement, somewhat flattened against the attachment, later portion often growing free of the attachment; wall agglutinated, with coarse grains embedded in a fine ground mass which is pierced by numerous tiny pores connecting the interior to the exterior; aperture a low arch or slit at the base of the final chamber.

Types and discussion.—Originally the genus was known from the holotype of the type species (U.S.N.M. No. 8337) from *Albatross* station D 4900, in 139 fathoms, off the coast of Japan. A prolonged search through the original sample by the writers has supplied a number of topotypes (U.S.N.M. No. 560423) which bring out additional characters not originally described. The specimen here illustrated, figure 4 (U.S.N.M. No. P 2196a), shows the final two pairs of chambers growing free of the attachment, and the typical low, slitlike aperture. Another specimen (fig. 5), which is broken free of the attachment, shows on the attached side the radial wall structure pierced by many pores. This type of structure has been noted in other agglutinated forms (see Wood, 1949, p. 234) such as *Tritaxia capreolus* Brady, *Textularia porrecta* Brady, and *Textularia rugosa* Reuss, and is undoubtedly more common in the agglutinated forms than has been suspected in the past.

Genus JULLIENELLA Schlumberger, 1890

Plate 1, figures 13, 14

Original description.—Soc. Zool. France, Mém., vol. 3 (1890), pt. 1, p. 213, 1889.

Type species.—*Jullienella foetida* Schlumberger, 1890. Monotypic.

Diagnosis.—Test large, flabelliform, occasionally with large fan-shaped portions extending in two directions from a central attachment, margin produced into numerous tubules, interior irregularly subdivided by a series of intermittent radiating ridges, which are not reflected on the exterior (fig. 14b); interior surface has many large pores, which apparently connect with much more restricted openings at the surface, wall firm, finely arenaceous, with much ferruginous cement, insoluble in hydrochloric acid, surface transversely wrinkled;

apertures numerous, a small rounded opening at the end of each of the tubular extensions along the periphery; color reddish brown.

Types.—Topotype from paleontological collection in the Sorbonne, Paris, France, from the collection of Dr. Jullien, 1887, Warabo or Watabo, bank of Poor River, coast of Liberia, at 7 fathoms.

Discussion.—Galloway (1933, p. 200) referred to this genus as being chitinous, and Cushman (1948, p. 171) stated that it had a flexible test. Neither statement seems to agree with the specimens. Schlumberger stated that the wall consisted of siliceous sand grains cemented by chitinous material, but he also stated that it had a very resistant agglutinated test. The specimens we examined in Paris have a very rigid test, agglutinated and with ferruginous cement with no indication of "chitin."

Genus MILIAMMINA Heron-Allen and Earland, 1930, emended

Plate 1, figures 15, 16

Original description.—Journ. Roy. Micr. Soc. London, ser. 3, vol. 50, p. 41, 1930.

Type species.—*Miliolina oblonga* (Montagu) var. *arenacea* Chapman, 1916. Subsequent designation by Cockerell (1930, p. 975).

Diagnosis.—Test free, chambers arranged in a quinqueloculine plan; wall siliceous, insoluble in hydrochloric acid, composed of minute mineral grains in an excess of siliceous cement, smoothly finished or polished in appearance, more rarely roughened; aperture terminal, with a tooth formed by the infolding of the wall.

Types.—Chapman's type was from the Recent at 462 fathoms, lat. 76°46′ S., long. 163°26′ E., Ross Sea, Antarctic. We were unable to find this type in the collections of the British Museum. Our figures are of the specimens of Heron-Allen and Earland, in the B.M.N.H.

These specimens were included by Heron-Allen and Earland in Chapman's species at the time they described the genus *Miliammina.* However, in later publications they considered the South Georgia form to be distinct from *Miliammina arenacea* (Chapman), differing in a more ovate and rounded outline rather than having the parallel sides of Chapman's species. Originally described as the variety *arenacea* of *Miliolina oblonga* (Montagu) by Chapman, it was incorrectly referred to *Miliammina oblonga* (Chapman) by Heron-Allen and Earland (1930, p. 41) and then to *Miliammina arenacea* (Chapman) in later publications of Earland (1933, p. 92, and 1934, p. 110). Also Earland, considering their South Georgia form a separate species, renamed it *Miliammina oblonga* Heron-Allen and Earland (1933, p. 92), citing it again thus in 1934 (p. 111).

This specific name could not be thus used, however, as it had been previously used by Montagu for the species *Miliolina oblonga,* and as this species had been earlier placed, even though erroneously, in the genus *Miliammina,* the name was not available for another species of the same genus. Thus the South Georgia form lacks a specific name, and we here propose the new name *Miliammina earlandi,* for *M. oblonga* Heron-Allen and Earland (1933, p. 92).

The large specimen here figured (B.M.N.H. No. ZF 3406) is here designated lectotype and is from 200 meters, off South Georgia, R.R.S. *William Scoresby* station 43, lat. 54°54′ S., long. 36°50′ W. The sectioned specimen (ZF 3407) is from R.R.S. *William Scoresby* station 50, from 230 meters, lat. 54°30′30″ S., long. 38°40′30″ W., off South Georgia.

Discussion.—Cushman (1948, p. 174) stated that *Miliammina* is planispiral in the early stages. This statement is apparently based on a misinterpretation of the figured sections of Heron-Allen and Earland (*in* Earland 1933, pl. 5, figs. 7, 8), which were cut in the long axis of the test and not transversely. The transverse section here figured (fig. 16) shows that this genus is definitely quinqueloculine in plan.

Originally Heron-Allen and Earland included in *Miliammina* species with either a quinqueloculine or triloculine chamber arrangement. We are here emending *Miliammina* to include only those species which, like the type species, are quinqueloculine. The triloculine species are here separated in a new genus, *Trilocularena.*

TRILOCULARENA Loeblich and Tappan, new genus

Plate 2, figure 1

Type species.—*Miliammina circularis* Heron-Allen and Earland, 1930, Journ. Roy. Micr. Soc. London, ser. 3, vol. 50, p. 44, figs. 18-21.

Derivation.—*tri* L., three+*loculus* L., cell, dim. of *locus*+*harena* L.=*arena,* sand. Gender, feminine.

Diagnosis.—Test free, chambers arranged in a triloculine plan; wall arenaceous, composed of minute mineral grains in an excess of siliceous cement, surface smoothly finished; aperture terminal, with a broad, shallow tooth formed by an extension of the lip.

Types.—Heron-Allen and Earland selected no holotype for their species. The specimen here figured, B.M.N.H. No. ZF 3563, is here designated as lectotype, and the remaining specimens (ZF 3567) are paratypes. These are from *Discovery* station D 182, Schollaert Channel, Palmer Archipelago, Antarctica, lat. 64°21′ S., long. 62°58′ W., at a depth of 278 to 500 meters. Heron-Allen and Earland also

record the species from *Discovery* station 363 at 2.5 miles S. 80° E. of the southeast point of Zavodovski Island, South Sandwich Islands, at 329 to 278 meters depth.

Discussion.—Heron-Allen and Earland included this triloculine species with their quinqueloculine arenaceous forms in the genus *Miliammina*. However, in view of the distinctive chamber arrangements, long considered a valid reason for separation of the calcareous Miliolidae, we here consider the triloculine species to belong to a separate genus. *Miliammina oblonga* Heron-Allen and Earland forma *sabulosa* Rhumbler, 1936, is apparently also a typical *Trilocularena* and should be referred to *Trilocularena sabulosa* (Rhumbler).

Genus HAUERINA d'Orbigny, 1839

Plate 2, figure 2

Original description.—*In* Ramon de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, p. 38, Paris, 1839.

Type species.—*Hauerina compressa* d'Orbigny, 1846. First species published in the genus.

Diagnosis.—Test free, compressed, equilateral, subcircular in outline, early stages quinqueloculine, later planispiral with three or more chambers to a whorl; wall calcareous, porcellaneous, imperforate; aperture a series of pores in a sievelike plate, the trematophore.

Types.—The holotype (here figured) is deposited in the M.N.H.N., Paris, and is from the Miocene of the Vienna Basin.

Discussion.—D'Orbigny's original description of the type species stated that it had only an oval aperture, surrounded by numerous tubercles. Later references have stated that the species had a cribrate aperture, but most later references to this species have been misidentifications. The species is apparently restricted to the Miocene of the Vienna Basin. The holotype is here described and figured for comparison with the new genus *Involvohauerina*.

The figure shows the keeled form of this species, and a ridge shown to one side of the keel in the figure is the remains of a later chamber that was broken away.

INVOLVOHAUERINA Loeblich and Tappan, new genus

Type species.—*Involvohauerina globularis* Loeblich and Tappan, new species.

Derivation.—*involvo* L., to roll up, wrap up + *Hauerina,* patronymic name for de Hauer. Gender, feminine.

Diagnosis.—Test free, early portion quinqueloculine, later tending to become planispiral and involute with three chambers per whorl and only those chambers of the last whorl visible; wall calcareous, porcellaneous, imperforate; aperture consisting of numerous irregularly shaped pores extending up from the periphery over a broad area of the apertural face.

Discussion.—This genus is closest to *Hauerina* d'Orbigny but differs in being almost globular rather than compressed, and in being involutely coiled rather than showing many of the early whorls as does *Hauerina*.

INVOLVOHAUERINA GLOBULARIS Loeblich and Tappan, new species

Plate 2, figures 3-8

Diagnosis.—Test free, subglobular in form, early portion quinqueloculine, later becoming planispiral and involute, although some specimens are somewhat off center, only the three chambers of the last whorl visible externally, except in a single specimen, which is sufficiently off center to allow four chambers to be visible, periphery very broadly rounded; sutures distinct, slightly depressed; wall calcareous, porcellaneous, imperforate, surface smooth, but very minutely pitted; aperture consisting of numerous irregularly shaped pores extending up from the periphery over a broad area of the apertural face.

Greatest diameter of holotype 1.93 mm., least diameter 1.41 mm., greatest thickness 1.85 mm. Other specimens vary from 1.66 to 2.68 mm. in diameter.

Types and occurrence.—Holotype, figure 3 (U.S.N.M. No. P 2202), and paratypes of figures 4-7 (U.S.N.M. No. P 2203a-d) and unfigured paratype B.M.N.H., London, from *Albatross* station D 2035, lat. 39°26′16″ N., long. 70°02′37″ W., depth 1,362 fathoms, *Globigerina* ooze; paratype of figure 8 (U.S.N.M. No. P 2204) from *Albatross* station D 2859, lat. 55°20′00″ N., long. 136°20′00″ W., bottom temperature 34.9° F., depth 1,569 fathoms, gray ooze.

Discussion.—This species is closest to *Hauerina involuta* Cushman in general chamber arrangement, but differs in being subglobular in form, and not compressed with an acute periphery. *H. involuta* also has an ornamented surface, showing distinct transverse ridges, crossed by fine striae.

Genus TRISEGMENTINA Wiesner, 1920, emended

Original description.—Zool. Anzeig., vol. 51, p. 18, 1920.

Type species.—*Trisegmentina compressa* Wiesner, 1931. Subsequent designation by Wiesner, 1931, p. 70 (see discussion below).

Type.—The holotype of *Trisegmentina compressa* Wiesner (Sidebottom's *Hauerina compressa* d'Orbigny) is in the British Museum (Natural History).

Discussion.—Wiesner first described this genus in 1920 and not in 1931 as stated by Cushman (1948, p. 198), or in 1923 as stated by Ellis and Messina (Catalogue of Foraminifera). Originally described without naming species, *Hauerina compressa* Sidebottom was later cited by Wiesner (1931, p. 70) as type species. This was the species described by Sidebottom (1904, p. 19) as *Hauerina compressa* d'Orbigny. Cushman (1933, p. 165) renamed Sidebottom's form *Trisegmentina sidebottomi,* but this name must be considered merely a junior synonym of *Trisegmentina compressa* Wiesner, 1931. This case is covered in detail in the recent Copenhagen Decisions on Zoological Nomenclature by Hemming (1953, p. 68). Quoting Hemming (p. 69), "A similar unsatisfactory situation arises where an author of a generic name, without designating a type species for the nominal genus so established, places in it a species under a name which he clearly indicates that he is using in a different sense from that of its original author, and the species so indicated is the first of the included species to be selected as the type species under Rule (g) in Article 30." In such a case as this "the type species of the new genus is to be treated as having been given a new binomen composed of the cited generic name and of a specific name consisting of the same word as that borne by the species under which the type species was erroneously cited by the author of the new generic name." Thus the type species must be cited as *Trisegmentina compressa* Wiesner, 1931, and Cushman's name *T. sidebottomi* is a junior synonym.

The figures given by Sidebottom (1904, pl. 5, fig. 8) show an apertural plate with pores (trematophore). An examination of the type specimen (B.M.N.H.) showed this apparent pore plate to be a fragment of extraneous calcareous material lodged in the aperture, but not an actual part of the specimen. The form is thus merely a *Planispirina,* and as *Planispirina* was described by Seguenza in 1880, the name *Trisegmentina* Wiesner is here suppressed as a junior synonym.

Genus POLYSEGMENTINA Cushman, 1946, emended

Plate 3, figures 1-3

Original description.—Contr. Cushman Lab. Foram. Res., vol. 22, pt. 1, p. 1, 1946.

Type species.—*Hauerina circinata* Brady, 1881. Original designation.

Diagnosis.—Test free, discoidal, early portion milioline in plan, later planispiral and slightly involute, with three to six chambers in the final whorl, the later chambers being relatively shorter, so that the number per whorl gradually increases; wall thickened, calcareous, imperforate; aperture consists of numerous irregular pores in a trematophore, the marginal row of pores being left exposed in the earlier chambers and remaining as sutural pores connecting with the interior.

Types.—The specimen of figure 1 (B.M.N.H. No. ZF 3629) is here designated as lectotype. It is from *Challenger* station 187A, at a depth of 8 fathoms, off Booby Island, and is the specimen figured originally by Brady. The sectioned specimens (figs. 2, 3) are in the collection of the U.S.N.M. (No. P 2197a,b) and are from Torres Strait. Brady's other syntypes are here considered paratypes (B.M.N.H. No. ZF 1565) and are from the same locality as the lectotype.

Discussion.—In the description of the genus *Polysegmentina,* Cushman (1946, p. 1) stated that "A study of the structure and development of this form [*Hauerina circinata* Brady] shows that it is not a *Hauerina,* as the early stages are not quinqueloculine but apparently planispiral and related to *Cornuspira.*" He described *Polysegmentina* as having "the early stages similar to *Cornuspira* with proloculum and planispirally coiled second chamber several coils in length." This description was apparently based on a misinterpretation of a figure given by Rhumbler (1906, pl. 3, fig. 40), an exterior view (copied by Cushman, 1946, pl. 1, fig. 4) which seemed to show a planispiral early development. Examination of Brady's types in the British Museum shows that this apparent planispiral coiling is only the faint surface reflection of the spiral suture, largely obliterated by the thin shell layers of the later nearly involute coils, and that only the chambers of the last one and one-half or two whorls can be determined surficially. We have had thin sections prepared and these show that the early portion is milioline and definitely not planispiral, and that there is no undivided second chamber of several coils in length.

Brady had even stated (1884, p. 190) that he placed in *Hauerina* only "the planospiral porcellaneous Foraminifera which are Milioline only in the very early stages of growth," and although he had not sectioned the species as proof, his statements, as so often found, were closer to being accurate than those of later workers. The bases on which Cushman separated this species from *Hauerina* are completely invalid and do not warrant its separation as a separate genus.

However, the genus *Polysegmentina* may be separated on a different basis, and we are here emending the diagnosis, separating this genus from *Hauerina* because of the peculiar retral processes along the

sutures which reflect the lateral pores of the apertures of earlier chambers. These pores continue to connect with the interior.

Genus TUBINELLA Rhumbler, 1906, emended

Plate 3, figures 11, 12

Original description.—Zool. Jahrb., Abt. Syst., vol. 24, p. 25, 1906.

Type species.—*Articulina funalis* var. *inornata* Brady, 1884. Subsequent designation by Cushman (1928, p. 151).

Diagnosis.—Test free, with a vestigial early milioline stage consisting of a bulbous proloculus and closely appressed second chamber, reversing the direction of growth; later chambers cylindrical and uniserially arranged; septa vestigial, consisting of slight transverse thickenings of the wall, visible in transmitted light; wall calcareous, imperforate; aperture at the open end of the tube.

Types.—Brady did not designate a holotype, having numerous specimens which are now labeled as syntypes. We are here designating as lectotype the larger specimen figured here (fig. 12), B.M.N.H. No. ZF 3656, from *Challenger* station 149 D at 20 to 60 fathoms, Balfour Bay, Kerguelen Island. Smaller paratype, here figured (fig. 11), also in the B.M.N.H.

Discussion.—The early portion has never been completely figured. Cushman (1948, p. 182) remarked "Test with an ovoid early portion." Galloway (1933, p. 131) referred to it as "initial chamber bulbous," basing these descriptions upon Brady's figures which do not show the subdivision of the early portion. However, in Brady's description of *Articulina funalis,* of which he considered *inornata* a variety, mention was made of this, as he stated "Milioline segments few and small, forming collectively a little inflated or bulbous projection at the narrower end of the shell."

At the time of original description of the genus *Tubinella,* Rhumbler included in it *Articulina funalis* Brady and *A. inornata* Brady, and a new species *Tubinella perforata* Rhumbler. He illustrated the species *T. perforata,* which is very close to his original definition of the genus, completely lacking any divisions in the early portion. It is probable that his definition of the genus was based on his own species, but unfortunately he failed to state this and no type was designated. In 1911 he described another species, *T. suspecta,* which also lacked any division of the early portion.

In 1928 Cushman selected Brady's species *Articulina funalis* var. *inornata* as the type species of *Tubinella.* In 1931 Wiesner (p. 67) described another genus, *Tubinellina,* for Brady's species *Articulina*

funalis, and stated that he would limit *Tubinella* to forms such as *T. perforata* Rhumbler. But this was impossible to do, as the type of *Tubinella* had previously been fixed. Thus Wiesner's genus *Tubinellina* immediately became a synonym.

The type species *Tubinella inornata* (Brady) is thus very close to *Articulina,* having in fact a milioline early stage, although in this species much reduced. The genus *Tubinella* is probably derived from *Articulina* by a reduction of the septa to mere wall thickenings.

Genus TRITAXIS Schubert, 1920, emended

Plate 3, figures 5, 6

Original description.—Paläont. Zeitschr., vol. 3 (1921), heft 2, p. 180, 1920.

Type species.—*Rotalina fusca* Williamson, 1858. Subsequent designation by Cushman, 1928, p. 171.

Diagnosis.—Test circular in outline, with a low trochoid spire, free in the early stage, later becoming attached by the ventral surface with an irregular spreading mass surrounding the regularly coiled early portion; chambers about 10 in number, at first nearly globular with 4 per whorl, then increasing in breadth much faster than in height so that chambers of the later whorls are low and crescentic when viewed from the dorsal side, and only 3 per whorl, last chamber occupying over one-half the ventral side but only a narrow crescent dorsally; sutures distinct, slightly depressed, strongly curved dorsally, nearly straight ventrally; wall agglutinated, comparatively coarse grained, surface roughened in appearance; aperture ventral, on free specimens an ovate opening at the base of the last formed chamber near the umbilicus, and surrounded by a distinct lip, not always visible in the attached later stages, but there may be tubularlike openings at the outer margins of the attached portion.

Types.—The types of Williamson's species are missing from the British Museum collections. The original localities given include Recent at Weymouth, Sandwich, Swansea, and dredged sands of Skye and Exmouth, British Isles. Figured hypotypes (U.S.N.M. No. P 2198a,b) from F. C. *Helga* Haul SR 331, lat. 51°12′ N., long. 11°55′ W., 610 to 680 fathoms, off southwestern Ireland.

Discussion.—Cushman designated *Rotalina fusca* Williamson as the type species for this genus in 1928, and at the same time placed *Tritaxis* in the synonymy of *Trochammina* Parker and Jones, 1860. Williamson did not figure the aperture of *R. fusca,* or describe the attached character, as his original specimens were free. Nevertheless,

this British form can be easily recognized by the low conical test with three chambers in the last whorl. Cushman defined *Trochamminella* in 1943, but as *T. siphonifera* is congeneric with *Rotalina fusca,* the name *Trochamminella* is a junior synonym of *Tritaxis* Schubert, 1920, and must therefore be suppressed.

Genus TROCHAMMINELLA Cushman, 1943

Plate 3, figure 7

Original description.—Contr. Cushman Lab. Foram. Res., vol. 19, pt. 4, p. 95, 1943.

Type species.—*Trochamminella siphonifera* Cushman, 1943. Original designation.

Diagnosis.—See under *Tritaxis* Schubert, 1920.

Types.—Holotype (U.S.N.M. Cushman Coll. No. 39619) from the Johnson-Smithsonian Expedition station 25, lat. 18°32′15″ N., long. 66°22′10″ W., at 240 to 300 fathoms, off Puerto Rico.

Discussion.—Cushman described *Trochamminella* as a specialized development from *Trochammina,* differing in the apertural characters. He figured both an unattached form with the ovate rimmed aperture, and an attached specimen surrounded by an irregular rim of material which extended at one side with an almost tubular protrusion, ending in a rounded opening. As can be seen from the figures, however, this form is identical with the genus *Tritaxis* Schubert, 1920 (type *Rotalina fusca* Williamson); hence *Trochamminella* Cushman, 1943, must be suppressed as a junior synonym.

Genus ROTALIAMMINA Cushman, 1924, emended

Plate 3, figure 4

Original description.—Carnegie Inst. Washington, Publ. 342 (Dept. Marine Biol. Papers, vol. 21), p. 11, pl. 1, figs. 4, 5, 1924.

Type species.—*Rotaliammina mayori* Cushman, 1924. Original designation.

Diagnosis.—Test attached, trochoid, all chambers visible dorsally, only those of the final whorl seen from the attached ventral side, ventrally umbilicate; wall very thin, agglutinated, with fine sand held in a small amount of cement; aperture indistinct, probably ventral.

Types.—Holotype (U.S.N.M. Cushman Coll. No. 511) from station 9, 50 fathoms, south of Breaker Point, between mouth of Pago Pago Harbor and Taema Bank, Tutuila, Samoa. Collected by A. G. Mayor.

Discussion.—The type species was originally described as having

"wall thick, of fragments of sponge spicules and fine amorphous material, the whole more or less flexible; sutures not apparent on the dorsal side, the outer portions of the chambers appearing as dark-brownish areas in the general mass of grayish-white amorphous material."

When we examined the "types," the dorsal surface showed a large amount of white "amorphous material," but which loosened when touched with a damp brush. The original figures of the holotype showed only the very highest points visible on the dorsal side, and all sutures and lower portions of the chambers were obscured. The so-called "amorphous material" was in fact only lime mud which had not been cleaned from the specimens. A gentle cleaning with a fine sable brush showed the characters to be much more like an attached *Trochammina*. We have figured the same specimen (the holotype, in fact) as is shown in the original description and in various editions of Cushman's text, but there is considerable difference in the appearance of the dorsal views.

Cushman's original description mentioned only the holotype. There is a single slide in the Cushman Collection which is marked holotype, but on which there are two specimens. As only one can be a holotype, we are assuming it to be that originally figured, and here reillustrated, and the other is considered to be a paratype.

Genus BDELLOIDINA Carter, 1877

Plate 3, figures 9, 10

Original description.—Ann. Mag. Nat. Hist., ser. 4, vol. 19, p. 201, (1877).

Type species.—*Bdelloidina aggregata* Carter, 1877. Original designation.

Diagnosis.—Test attached, with numerous broad and low chambers in a uniserial series or spreading and occasionally branching; wall agglutinated, rough externally, smooth inside with interior secondary septa vertically crossing the chambers from base to top, numerous internal pores pitting the interior and a row of communicating pores through the septal faces; aperture a single or double row of pores against the attachment on the terminal face of the last formed chamber.

Types.—Carter's specimens have not been found but were from excavations on the surface of a mass of *Siderastraea,* exact locality not given. Brady also recorded the species from *Challenger* station 218 A, Nares Harbor, Admiralty Islands, at 16 to 25 fathoms, and figured and described the internal secondary septa which had not been noted

by Carter. On this basis Elias (1950, p. 301) described as the variety *bradii* the specimens of Brady which showed the secondary septa. It seems very probable that the forms of Brady and Carter were identical, but Carter's figures were too diagrammatic to be diagnostic. The specimens here figured (fig. 9, U.S.N.M. No. P 2199) are from the Indian Ocean, exact locality unknown, and (fig. 10, U.S.N.M. No. P 2200) from the surface of a mussid coral on the seaward reef in about 3 feet of water, Namu Island, Bikini Atoll. Collected by F. M. Bayer.

Discussion.—Elias (1950, p. 301) discussed this genus from the literature and the problem as to whether it is labyrinthic (as stated by Carter, Brady, Chapman, and Galloway) or the interior simple as stated by Cushman.

The family position of this genus is also questionable. Cushman placed it in the Placopsilinidae, subfamily Placopsilininae, although this subfamily is not labyrinthic in the interior. Galloway placed it in the family Lituolidae, subfamily Neusininae, which is labyrinthic. Elias places *Bdelloidina* in his family Ptychocladiidae, although the type of this family is a calcareous genus, similar only in the attached character. It seems better kept in the Placopsilinidae, but in the subfamily Coscinophragminae with other labyrinthic forms.

Genus RIMULINA d'Orbigny, 1826, emended

Plate 3, figure 8

Original description.—Ann. Sci. Nat. Paris, sér. 1, vol. 7, p. 257, 1826.

Type species.—*Rimulina glabra* d'Orbigny, 1826. Monotypic.

Diagnosis.—Test free, elongate-ovate in outline, consisting of a single chamber in the holotype (and only specimen known); wall calcareous, smooth, finely perforate; aperture an elongate slit extending from the apex, about halfway down the side of the test, surrounded by a slight lip.

Types.—Holotype (here figured) from the Recent in the Adriatic, deposited in the M.N.H.N., Paris.

Discussion.—This species has been figured and described as possessing more than one chamber, and with very oblique sutures. These are not at all evident in the holotype, and a search failed to yield additional specimens to check this. Apparently no additional specimens have ever been seen. The writers examined the holotype in Paris, and both the color and appearance suggest that this specimen might well be a reworked fossil and not actually a Recent species.

Genus WEBBINA d'Orbigny, 1839

Plate 4, figure 6

Original description.—*In* Ramon de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, p. 26, Paris, 1839.

Type species.—*Webbina rugosa* d'Orbigny, 1839. Subsequent designation by d'Orbigny *in* Barker-Webb and Berthelot (1839, p. 126). First species published under the genus.

Diagnosis.—Test attached by entire lower surface, chambers few in number, inflated, surface marked by faint transverse "growth lines," margins of chambers bordered by a fimbriate "keel"; wall thin, calcareous, appearing milky white and imperforate, surface smooth except for transverse wrinkles; aperture terminal, surrounded by a phialine lip.

Type.—Holotype in M.N.H.N., Paris. From the Recent, l'Île de Ténériffe, Îles Canaries. As far as known it is represented by a single specimen.

Discussion.—According to Galloway (1933, p. 296) this form is "coarsely perforate, with much secondary material making the surface rough." Cushman (1948, p. 339) states that the test is perforate. The original figures given by d'Orbigny for this species are very misleading. The holotype does not appear either coarsely perforate or with a roughened surface except for the fimbriate-appearing keel.

Genus MONALYSIDIUM Chapman, 1900

Plate 4, figure 5

Original description.—Linn. Soc. Journ. Zool. London, vol. 28, No. 179, p. 3, 1900.

Type species.—*Peneroplis* (*Monalysidium*) *sollasi* Chapman, 1900. Original designation.

Diagnosis.—Test free, consisting of numerous subglobular chambers, early ones arranged in an evolute planispiral coil, later portion uncoiled and rectilinear, with chambers subglobular; wall calcareous, distinctly perforate in appearance; aperture terminal, somewhat produced on a neck with phialine, fimbriate lip.

Type.—Holotype (B.M.N.H. No. ZF 3577) from beach at Avalau Island, Funafuti Atoll.

Discussion.—*Monalysidium* was originally described as a subgenus of *Peneroplis* Montfort, 1808. It seems similar to *Spirolina,* and not congeneric with the straight, uncoiled forms such as *M. politum* Chapman. Chapman stated that the test wall was imperforate and

tuberculate "with vertical rows of puncta, not perforations." They appear very similar to perforations, but unfortunately there is only the holotype in the British Museum, and it could not be sectioned to determine the wall structure.

Genus SCHUBERTIA Silvestri, 1912

Plate 4, figure 3

Original description.—Riv. Italiana Paleont., vol. 18, fasc. 2, 3, p. 68, 1912 (new name for *Millettia* Schubert, 1911, Abh. K. K. Geol. Reichsanst. Wien, Österreich, vol. 20, heft 4, p. 89 [not *Millettia* Duncan, 1889, and not Wright, 1899]).

Type species.—*Sagrina tessellata* Brady, 1884. Subsequent designation by Schubert (1911, review, p. 320).

Diagnosis.—Test free, elongate, narrow, arcuate, very early portion biserial, later portion consisting of a few elongate subcylindrical chambers, rapidly increasing in height and subdivided into chamberlets by vertical and horizontal partitions in a honeycomb pattern, the chamberlets arranged in regular transverse rows; wall calcareous, surface marked into hexagonal patterns by the junction of the chamberlet walls with the outer wall; aperture terminal, rounded with a slight lip.

Types.—Lectotype here designated as the specimen figured by Brady (1884, pl. 76, fig. 17) deposited in the B.M.N.H., No. ZF 2359, from *Challenger* station No. 219A, at a depth of 17 fathoms, Admiralty Islands.

Discussion.—Cushman stated (1929a, p. 338) that Brady's species showed no early biserial stage and that all chambers were subdivided. Examination of the type specimen shows 2 pairs of biserial chambers and an undivided uniserial chamber before the subdivision into chamberlets.

However, both Cushman (1948, p. 270) and Galloway (1933, p. 376) correctly describe the genus as having an early biserial stage followed by uniserial chambers, at first undivided and later with chamberlets.

Genus ORTHOPLECTA Brady, 1884

Plate 4, figures 1, 2

Original description.—Rep. voyage *Challenger,* vol. 9 (Zoology), pt. 22, pp. 355, 428, 1884.

Type species.—*Cassidulina* (*Orthoplecta*) *clavata* Brady, 1884. Monotypic.

Diagnosis.—Test free, elongate, narrow, slightly arcuate, of nearly equal diameter throughout, no regular chamber arrangement, but with a spiraling internal column, which gives an extremely irregular septation as it spirals and occasionally touches the exterior wall; wall calcareous, finely perforate with radial structure, aperture subterminal, ovate, just above a sutural junction.

Types.—Holotype (B.M.N.H. No. ZF 2064) from *Challenger* station 219A, at 17 fathoms, Admiralty Islands. Dissected hypotype here figured (B.M.N.H. No. ZF 3630) from F. W. Millett Collection, *Challenger* station 185, off Raine Island, Torres Strait, at 155 fathoms.

Discussion.—*Orthoplecta* was originally defined as a subgenus of *Cassidulina* d'Orbigny, 1826. However, there is no cassiduline early portion, and the later part is neither biserial nor irregularly biserial. Interestingly, Wood (1949, p. 244) noted that *Orthoplecta clavata* had a perforate radial structure, unlike the majority of the Cassidulinidae which have a perforate-granular structure. This difference in wall structure supports the separation of *Orthoplecta* from the Cassidulinidae and suggests its placement perhaps with the Ceratobuliminidae.

Genus CIBICIDOIDES Thalmann, 1939

Plate 4, figure 4

Original description.—Originally described by Brotzen (1936, pp. 186, 194), but as Brotzen did not designate a type species the genus was invalid until Thalmann designated the type in 1939, p. 448.

Type species.—*Truncatulina mundula* Brady, Parker, and Jones, 1888. Subsequent designation by Thalmann (1939, p. 448).

Diagnosis.—Test free, trochoid, biconvex and biumbonate, all chambers visible dorsally, only those of the final whorl visible ventrally; wall calcareous, hyaline, with a series of coarse perforations on the dorsal side, appearing only near the previous spiral suture in the early portion of the test, but covering a large portion of the dorsal side of the later chambers; aperture at the base of the apertural face of the final chamber, against the peripheral margin of the preceding whorl, consisting of a low arch with a slightly projecting lip.

Types.—Lectotype, here designated (B.M.N.H. No. ZF 3585), and paratypes (B.M.N.H. No. ZF 3584), all from *Plumper* station 4, at 260 fathoms, lat. 22°54′ S., long. 40° 37′ W., over Abrohlos Bank, off the coast of Brazil, South America.

Discussion.—*Cibicidoides* was originally described as a subgenus of *Cibicides* by Brotzen (1936, pp. 186, 194), but as he did not at that time designate a type species, the genus was invalid. He cited two

species, *Cibicides eriksdalensis* Brotzen and *C. mundula* (Brady, Parker, and Jones), but according to the International Rules of Zoological Nomenclature, Art. 25, c (3), a definite statement must be made as to the type species selected in order for a genus to be validated. Therefore, *Cibicidoides* became a valid genus when Thalmann designated as type species in 1939 *Truncatulina mundula* Brady, Parker, and Jones, 1888, and the genus must therefore be credited to Thalmann.

Cushman (1948, p. 335) and Bermudez (1952, p. 87) both erroneously cite *Cibicidoides eriksdalensis* Brotzen as type species and credit the genus itself to Brotzen, 1936. Sigal *in* Piveteau (1952, p. 229) cites the genus as *Cibicidoides* Brotzen, 1942, and figures *C. eriksdalensis,* although not definitely citing it as type species.

ALANWOODIA Loeblich and Tappan, new genus

Plate 4, figures 7, 8

Type species.—*Patellina campanaeformis* Brady, Rep. voyage *Challenger,* vol. 9 (Zoology), p. 634, text figs. 19a-c, 1884.

Derivation.—Patronymic. Gender, feminine.

Diagnosis.—Test free, conical, high-spired, ventrally flattened or slightly excavated, consisting of a proloculus and long, undivided, broad and low tubular chamber in a high, open conical spire, the central area being filled with clear or laminated calcite, tiny pores around the exterior spiral suture, wall calcareous, with the test composed of a single crystal of calcite; aperture ventral, at the open end of the spiraling tube.

Types.—Holotype (sectioned specimen, fig. 8), B.M.N.H. No. ZF 2065, is that figured by Brady in text figure 19c, p. 635, from *Challenger* station 185, off Raine Island, Torres Strait, at 155 fathoms. Paratype (exterior figured, fig. 7), B.M.N.H. No. ZF 3614, from the same locality and the specimen figured by Brady, 1884, text figures 19a,b, p. 635.

Discussion.—Describing it as a species of *Patellina,* Brady stated that the species appeared to be biserial at least in part, but that the last whorls were apparently undivided. A careful examination showed no septation, and this form differs from *Patellina* in having a broad and low undivided tube rather than a biserial series of chambers, in being extremely high-spired, and in having the central portion filled with calcite. There are faint transverse undulations of the ventral surface but no internal secondary septa as in *Patellina.* It is closer, perhaps, to *Trocholina* Paalzow, 1922, although the central filling is not in the

form of vertical pillars ending in pustules as in *Trocholina,* but consists of horizontally laminated structure. It also shows superficial resemblance to *Howchinia* Cushman, 1927, in the nonseptate tube coiled in a high spire about a calcite-filled center; however, *Howchinia* shows extensions of shell matter crossing the spiral suture, leaving a series of pores between, which extend into the interior. Furthermore, there is less of an open spiraling in *Howchinia* and its wall structure is of minutely granular calcite, not formed of a single crystal as in the present form, as was shown by Wood (1949, p. 245).

We have named this genus in honor of Prof. Alan Wood of Aberysthwyth, Wales, in recognition of his excellent work on the wall structures of Foraminifera, which has supplied an additional useful tool for the systematics of the Foraminifera.

Family CARTERINIDAE Loeblich and Tappan, new family

Test free or attached, chambers arranged in a trochoid coil, all visible from the dorsal side and only those of the last whorl on the ventral side, and may have subdivisions of the chambers due to secondary septa; wall composed of secreted calcareous spicules embedded in a calcareous ground mass; aperture in free forms ventral in position, in attached forms not observed.

Discussion.—This family is erected to include the genus *Carterina* because of the unique wall character. This is the only form as yet known to have a test composed of calcareous spicules secreted by the animal itself.

Genus CARTERINA Brady, 1884, emended

Plate 4, figures 9, 10

Original description.—Rep. voyage *Challenger,* vol. 9 (Zoology), pt. 22, pp. 66, 345, 1884.

Type species.—*Rotalia spiculotesta* Carter, 1877. Original designation.

Diagnosis.—Test free, trochoid and ventrally umbilicate in the early stages, attached and spreading irregularly in the later stages; chambers arranged in a trochoid coil, with five per whorl in the young, with the crescentic chambers of approximately equal height throughout, becoming much more irregular and longer in later whorls, chambers fewer in later whorls, only three to four, and these appear extremely low and long, and in a very irregular spiral; in the later stages the test is surrounded by a wide flangelike and undivided portion, which spreads over the surface of the substratum; sutures distinct, thickened, oblique

dorsally and slightly depressed, radial ventrally; beginning in the third whorl the chambers are subdivided by partial secondary septa coming in from the outer wall, at first only as minor projections, but in the later chambers becoming almost complete partitions, secondary septa also thickened and perpendicular to outer wall, not oblique dorsally as are the true septa, secondary septa not visible dorsally except when specimen is dampened, but slightly depressed on the ventral side of the free specimens (fig. 10b), the earlier chambers having only two or three of these secondary septa, but after the third whorl they increase in number per chamber as the chambers increase in relative length, leaving the chamberlets all of approximately equal size, and thus there may be as many as 15 subdivisions in the later chambers; wall thin, composed of calcareous spicules (secreted by the protoplasm) frequently aligned parallel to the periphery of the test, embedded in a calcareous areolated ground mass; aperture not observed in attached specimens, ventral in free specimens.

Types.—The holotype of Carter was from the Recent, East Oceania, Pacific Ocean. A prolonged search in the British Museum in London produced no trace of the type specimen. A specimen was found in the M.N.H.N., Paris, mounted on a slide of Carter's, and apparently sent by him to a French colleague. This specimen is here figured (fig. 9) and is from Bass Rock, Ceylon. The slide has the number 26.9.79, thus giving the date of identification as 2 years after the original description. The specimen from the Recent at Port Gaura, Philippines (figs. 10a-c) is in the U.S.N.M. (No. P 2201).

Discussion.—This genus, like many others, seems to have been better understood by Brady than by many later workers. Originally monotypic, only the species *Rotalia spiculotesta* Carter was known by Brady. Both Carter's original definition (1877b) and that of Brady clearly state that the wall is composed of numerous fusiform calcareous spicules, with interstitial material calcareous and areolated. Carter mentioned that the spicules increase in size from the most minute of the early chambers to attain a maximum size in the third whorl, beyond which they do not increase further.

Brady stated further that "it is obvious that the presence of spicula, not collected from external sources for the construction of the test, but proper to the animal itself, is a character of more than specific significance." It was thus on the basis of the secreted calcareous spicules that he separated *Carterina* as a genus distinct from *Rotalia*.

Later authors apparently lost sight of this and assigned the genus to the Trochamminidae (Flint, 1899, p. 260; Galloway, 1933, p. 183;

Cushman, 1940, p. 204). Other treatises do not mention the genus at all (Colom, 1946; Glaessner, 1948, Pokorný, 1954).

It remained for Wood (1949, p. 245) to call attention again to the unique character of this species. He mentioned that "each of the elliptical spicules which form its test is a single crystal of calcite. . . Each crystal lies with its *c*-axis parallel to the length of the spicule. It seems extremely probable that these spicules are a direct secretion of the protoplasm, they appear to be usually larger in the larger specimens, and nothing identical in form is known in any other animal." He also suggested the interesting hypothesis that because of its completely distinctive wall character *Carterina* is undoubtedly a recent offshoot and "might in the future give rise to a whole galaxy of new types," perhaps eventually as distinctive as the Porcellanea.

A feature of *Carterina* which has apparently escaped the observation of all workers is the subdivision of the chambers by secondary septa. This is not usually apparent from the dorsal exterior (fig. 10a), but when the specimen is dampened, the septa can be very easily seen through the thin wall (figs. 9a,b) and their development can be determined. On young free specimens the secondary septa are visible externally on the ventral side (fig. 10b). The earliest chambers are not subdivided, then only two or three subdivisions occur per chamber, and the early secondary septa consist of slight projections from the outer wall. With progressive growth the later chambers have more numerous partitions, up to as many as 15 per chamber, and the partitions are nearly complete, extending nearly or completely across the chambers. These subdivisions can be easily distinguished dorsally from the regular septa, as the true septa are oblique, the chambers crescentic, and the secondary partitions perpendicular to the peripheral wall.

As far as is known this genus is monotypic. Only one species other than the type species has been referred to *Carterina, C. fulva* Cushman (1924, p. 10) and Cushman and Wickenden (1929, p. 5), but the latter is a *Trochammina*-like form and agglutinated, not formed of calcareous spicules secreted by the organism itself, and thus completely different from *Carterina.*

REFERENCES

Bermudez, P. J.

1952. Estudio sistematico de los Foraminiferos Rotaliformes. Estados Unidos de Venezuela Bol. de Geol., vol. 2, pp. 7-230, pls. 1-35.

Brady, H. B.

1881. Notes on some of the reticularian Rhizopoda of the *Challenger* Expedition; Pt. 3. Quart. Journ. Micr. Sci. London, n. s., vol. 21, pp. 31-71.

1884. Report on the scientific results of the voyage of H.M.S. *Challenger*, vol. 9 (Zoology), pp. 1-814, pls. 1-115.

BRADY, H. B., PARKER, W. K., and JONES, T. R.

1888. On some Foraminifera from the Abrohlos Bank. Trans. Zool. Soc. London, vol. 12, pt. 7, pp. 211-239, pls. 40-47.

BROTZEN, F.

1936. Foraminiferen aus dem schwedischen untersten Senon von Eriksdal in Schonen. Sver. Geol. Unders. Avh., ser. C, No. 396 (Årsb. 30, No. 3), pp. 1-206, pls. 1-14.

CARTER, H. J.

1877a. Description of *Bdelloidina aggregata*, a new genus and species of arenaceous Foraminifera, in which their so-called "imperforation" is questioned. Ann. Mag. Nat. Hist., ser. 4, vol. 19, pp. 201-209, pl. 13.

1877b. Description of a new species of Foraminifera (*Rotalia spiculotesta*). Ann. Mag. Nat. Hist., ser. 4, vol. 20, pp. 470-473, pl. 16.

CHAPMAN, F.

1900. On some new and interesting Foraminifera from the Funafuti Atoll, Ellice Island. Linn. Soc. Journ. Zool. London, vol. 28 (1900-1903), No. 179, pp. 1-27, pls. 1-4.

1906. On some Foraminifera and Ostracoda obtained off Great Barrier Island, New Zealand. New Zealand Inst., Trans. Proc., vol. 38 (21st of n. s.), pp. 77-107, pl. 3.

1916. Report on the Foraminifera and Ostracoda out of marine muds from soundings in the Ross Sea. British Antarctic Exped. 1907-1909, Reps. Sci. Invest., Geol., vol. 2, pt. 3, pp. 53-80, pls. 1-6.

COCKERELL, T. D. A.

1930. Siliceous shells of Protozoa. Nature, London, vol. 125, p. 975.

COLOM, G.

1946. Introduccion al estudio de los microforaminiferos fosiles. Inst. "Lucas Mallada" de Invest. Geol., Madrid, pp. 1-376, pls. 1-26.

CUSHMAN, J. A.

1911. A monograph of the Foraminifera of the North Pacific. Pt. 2, Textulariidae. U. S. Nat. Mus. Bull. 71, pp. 1-108, text figs. 1-156.

1924. Samoan Foraminifera. Carnegie Inst. Washington, Publ 342 (Dept. Marine Biol. Papers, vol. 21), pp. 1-75, pls. 1-25.

1928. Foraminifera, their classification and economic use. Cushman Lab. Foram. Res. Spec. Publ. 1, pp. 1-401, pls. 1-59.

1929a. The development and generic position of *Sagrina* (?) *tessellata* H. B. Brady. Journ. Washington Acad. Sci., vol. 19, pp. 337-339.

1929b. A late Tertiary fauna of Venezuela and other related regions. Contr. Cushman Lab. Foram. Res., vol. 5, pt. 4, pp. 77-101, pls. 12-14.

1933. Foraminifera, their classification and economic use. Cushman Lab. Foram. Res. Spec. Publ. 4, pp. 1-349, pls. 1-31.

1940. Foraminifera, their classification and economic use, 3d ed., pp. 1-535, pls. 1-48. Cambridge, Mass.

1943. A new genus of the Trochamminidae. Contr. Cushman Lab. Foram. Res., vol. 19, pt. 4, pp. 95-96, pl. 16.

1946. *Polysegmentina*, a new genus of the Ophthalmidiidae. Contr. Cushman Lab. Foram. Res., vol. 22, pt. 1, p. 1.

1948. Foraminifera, their classification and economic use, 4th ed., pp. 1-605, pls. 1-55. Cambridge, Mass.

CUSHMAN, J. A., and WICKENDEN, R. T. D.

1929. Recent Foraminifera from off Juan Fernandez Islands. Proc. U. S. Nat. Mus., vol. 75, art. 9, pp. 1-16, pls. 1-6.

D'ORBIGNY, A.

1826. Tableau méthodique de la classe des Céphalopodes. Ann. Sci. Nat. Paris, sér. 1, vol. 7, pp. 96-314, pls. 10-17.

1839a. Foraminifères. *In* Ramon de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, pp. 1-224. Paris.

1839b. Foraminifères des Îles Canaries. *In* P. Barker-Webb and S. Berthelot, Histoire naturelle des Îles Canaries, vol. 2, pt. 2, Zool., pp. 119-146, pls. 1-3. Paris.

EARLAND, A.

1933. Foraminifera. Pt. 2, South Georgia. *Discovery* Reports, vol. 7, pp. 27-138, pls. 1-7.

1934. Foraminifera. Pt. 3, The Falklands sector of the Antarctic (excluding South Georgia). *Discovery* Reports, vol. 10, pp. 1-208, pls. 1-10.

ELIAS, M. K.

1950. Paleozoic *Ptychocladia* and related Foraminifera. Journ. Paleont., vol. 24, No. 3, pp. 287-306, pls. 43-45.

FLINT, J. M.

1899. Recent Foraminifera. Ann. Rep. U. S. Nat. Mus. for 1897, pp. 249-349, pls. 1-80.

GALLOWAY, J. J.

1933. A manual of the Foraminifera, pp. 1-483, pls. 1-42.

GLAESSNER, M. F.

1948. Principles of micropaleontology, pp. 1-296, pls. 1-14.

GOËS, A.

1896. Reports on the dredging operations carried on by the U. S. Fish Commission Steamer *"Albatross,"* during 1891; xx, The Foraminifera. Bull. Mus. Comp. Zool., vol. 29, pp. 1-104, pls. 1-9.

HEMMING, F.

1953. Copenhagen decisions on zoological nomenclature, London, pp. 1-135.

HERON-ALLEN, E., and EARLAND, A.

1930. Some new Foraminifera from the South Atlantic. Pt. 3. Journ. Roy. Micr. Soc. London, ser. 3, vol. 50, pp. 38-45, 1 pl.

LALICKER, C. G., and MCCULLOCH, I.

1940. Some Textulariidae of the Pacific Ocean. Allan Hancock Pacific Exped., vol. 6, No. 2, pp. 115-143, pls. 13-16.

POKORNÝ, V.

1954. Základy zoologické mikropaleontologie. Nakladatelstrí Československé Akad. Věd, pp. 1-651.

RHUMBLER, L.

1904. Systematische Zusammenstellung der recenten Reticulosa. Archiv. Protistenk., vol. 3 (1903), pp. 181-294, text figs. 1-142.

1906. Foraminiferen von Laysan und den Chatham Inseln. Zool. Jahrb., Abt. Syst., vol. 24, pp. 21-80, pls. 2-5.

SCHLUMBERGER, C.

1890. Note sur un foraminifère nouveau de la côte occidentale d'Afrique. Soc. Zool. France, Mém., vol. 3, pt. 1, pp. 211-213, pl. 7.

SCHUBERT, R. J.

1911. Die fossilen Foraminiferen des Bismarckarchipels und einiger angrenzender Inseln. Abh. K. K. Geol. Reichsanst. Wien, vol. 20, pp. 1-130, pls. 1-6. Review of above, Neues Jahrb. Min. Geol. Pal., vol. 2, pp. 18-320, 1911.

1920. Palaeontologische Daten zur Stammesgeschichte der Protozoen. Paläont. Zeitschr., vol. 3, heft 2, pp. 129-188.

SIDEBOTTOM, H.

1904. Report on the Recent Foraminifera from the coast of the Island of Delos (Grecian Archipelago), Pt. 1. Manchester Lit. Philos. Soc., Mem., vol. 48, pp. 1-26, pls. 2-5.

SIGAL, J.

1952. Foraminifères. *In* J. Piveteau, Traité de Paléontologie. Pt. 1, pp. 133-178, 192-301.

SILVESTRI, A.

1912. Review of R. J. Schubert, "Die fossilen Foraminiferen des Bismarckarchipels und einiger angrenzender Inseln. Abh. K. K. Geol. Reichsanst. Wien, vol. 20, pp. 1-130, pls. 1-6, 1911." Riv. Italiana Paleont., vol. 18, fasc. 2, 3, pp. 66-71.

THALMANN, H. E.

1939. Bibliography and index to new genera, species, and varieties of Foraminifera for the year 1936. Journ. Paleont., vol. 13, pp. 425-465.

WIESNER, H.

1920. Zur systematik der Miliolideen. Zool. Anzeig., vol. 51, pp. 13-20.

1931. Die Foraminiferen. *In* E. von Drygalski, Deutsche Südpolar Exped., 1901-1903, vol. 30 (Zool. vol. 12), pp. 53-165, pls. 1-24.

WILLIAMSON, W. C.

1858. On the Recent Foraminifera of Great Britain, pp. 1-107, pls. 1-7. Ray Soc., London.

WOOD, A.

1949. The structure of the wall of the test in the Foraminifera; its value in classification. Quart. Journ. Geol. Soc. London, vol. 104, pp. 229-255, pls. 13-15.

EXPLANATION OF PLATES

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Figs. 1-3, 14-16 are camera lucida drawings by Helen Tappan Loeblich; figs. 4-12 are camera lucida drawings by Lawrence Isham; fig. 13 is a photograph prepared for the writers by the Bureau des Recherches Géologiques et Géophysiques, Paris.

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All figures are camera lucida drawings; figs. 1, 2 by Helen Tappan Loeblich; figs. 3-8 by Lawrence Isham.

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All figures are camera lucida drawings; figs. 1-3, 8, 11-12 by Helen Tappan Loeblich; figs. 4-7, 9-10 by Lawrence Isham.

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Figs. 1, 2. *Orthoplecta clavata* Brady 24

1a, Side view of holotype (B.M.N.H. No. ZF 2064), showing elongate, arcuate test, very irregular septa and subterminal ovate aperture, adjacent to sutural junction. 1b, Top view. From *Challenger* station 219A, Admiralty Islands. 2, Dissected hypotype (B.M.N.H. No. ZF 3630), showing spiraling internal column, which gives the irregular appearing septation where it touches the outer wall. From *Challenger* station 185, off Raine Island, Torres Strait. × 109.

Fig. 3. *Schubertia tessellata* (Brady) 24

3a, Side view of lectotype (B.M.N.H. No. ZF 2359), showing early biserial stage, followed by a single undivided uniserial chamber and later uniserial chambers subdivided into honeycomblike chamberlets. 3b, Top view showing circular terminal aperture, surrounded by a slight lip. × 109. From *Challenger* station 219A, Admiralty Islands.

Fig. 4. *Cibicidoides mundula* (Brady, Parker, and Jones) 25

4a, Dorsal view of lectotype (B.M.N.H. No. ZF 3585), showing central umbo, thickened sutures, and extremely coarse perforations, which occur at first only along the spiral suture, but increase gradually in number and chamber area covered. 4b, Ventral view, showing large umbo, peripheral keel, and smooth surface, lacking the coarse perforations of the dorsal side. 4c, Edge view, showing lenticular form, and low arched aperture at the base of the apertural face, on the periphery, and surrounded by a projecting lip. × 109. From *Plumper* station 4, over Abrohlos Bank, off the Coast of Brazil, South America.

Fig. 5. *Monalysidium sollasi* Chapman 23

5a, Side view of holotype (B.M.N.H. No. ZF 3577), from beach at Avalau Island, Funafuti Atoll, showing subglobular chambers, at first in a planispiral coil and later rectilinear, and aperture produced on a neck with a phialine fimbriate lip. 5b, Edge view. × 79.

Fig. 6. *Webbina rugosa* d'Orbigny 23

6a, Dorsal view of holotype (M.N.H.N.), showing ovate chambers with fimbriate keel, and rounded terminal aperture. 6b, Ventral view, showing attached side. From Recent, l'Île de Ténériffe, Îles Canaries. × 58.

Figs. 7, 8. *Alanwoodia campanaeformis* (Brady) 26

7a, Dorsal view of paratype (B.M.N.H. No. ZF 3614), showing proloculus and undivided second chamber. 7b, Ventral view, showing filled umbilical region, and transverse wrinkles of the undivided chamber. 7c, Edge view, showing undivided spiraling chamber and minute pores

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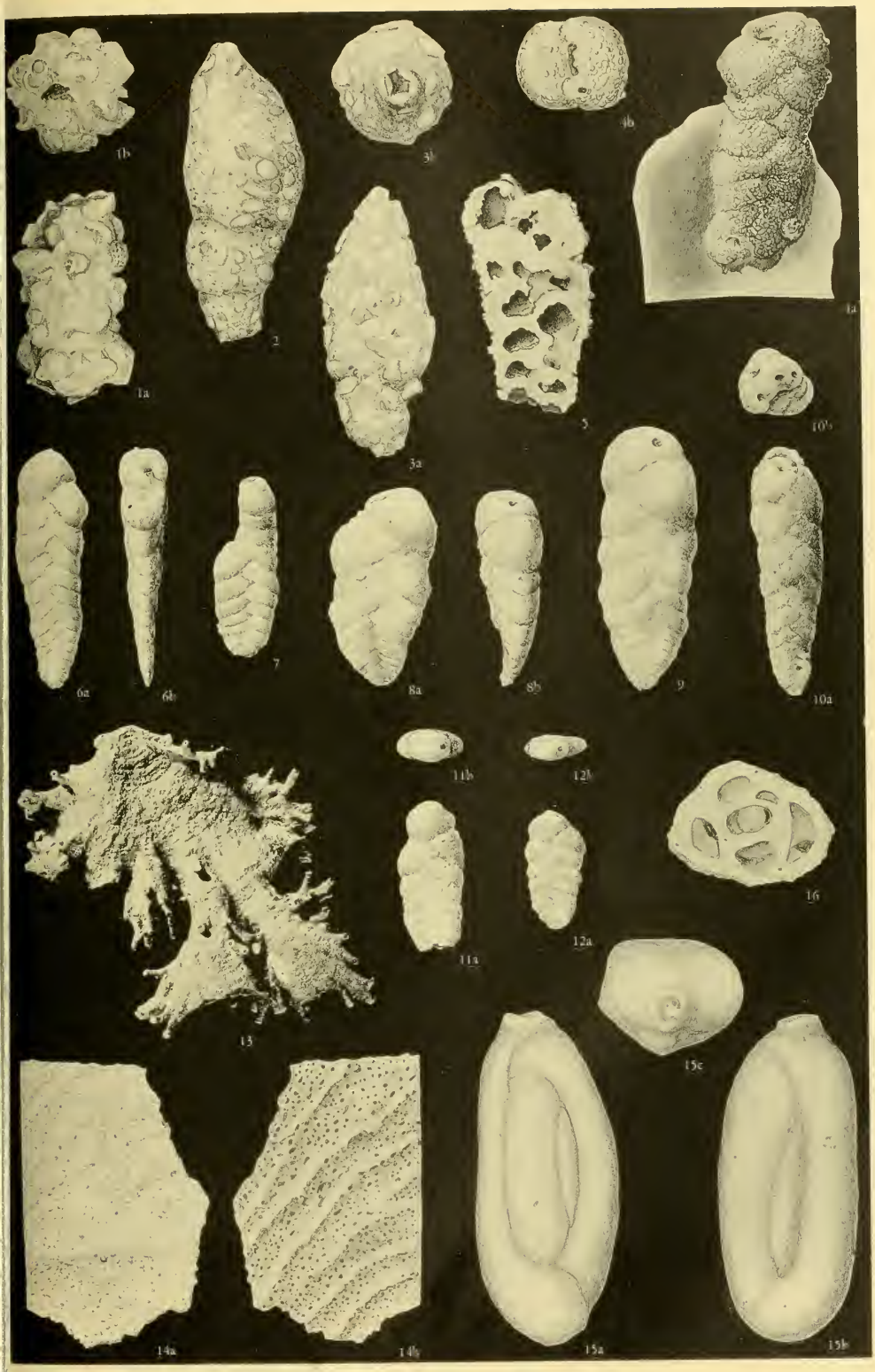
along the spiral suture. 8, Axial section of holotype (B.M.N.H. No. ZF 2065), showing central filling of laminated calcite, with spiral chamber in an open coil. From *Challenger* station 185, off Raine Island, Torres Strait. × 109.

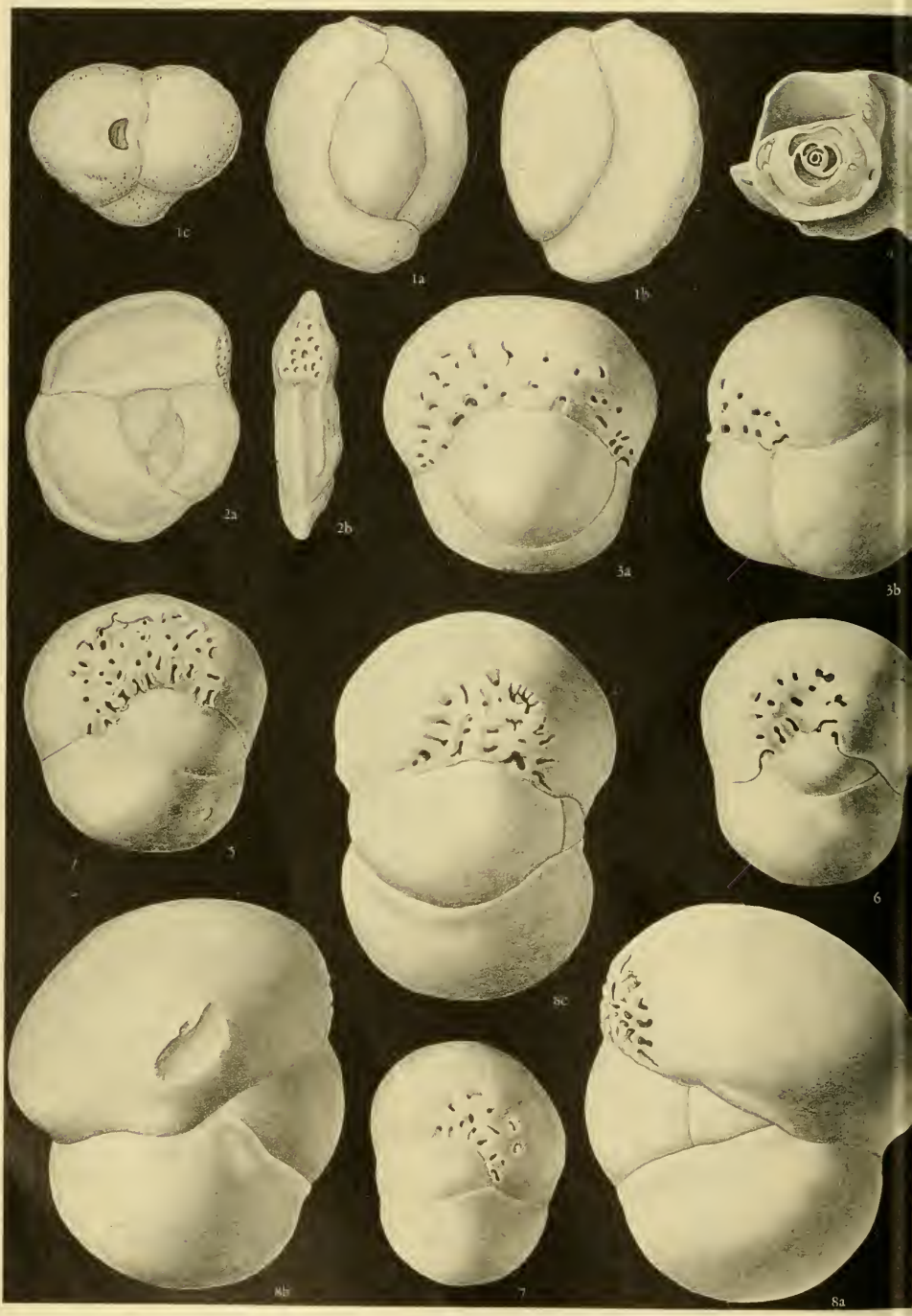
Figs. 9, 10. *Carterina spiculotesta* (Carter) 27

9a, Dorsal view of large hypotype (specimen of Carter in M.N.H.N.), showing early *Discorbis*-like coil and later irregularly arranged crescentic, low and broad chambers, all subdivided by radial partitions visible only when specimen is dampened, and surrounded by a spreading attached portion which is undivided, the entire test composed of fusiform calcareous spicules. × 21. 9b, Central portion of same specimen, enlarged to show early chamber development, arrangement of the calcareous spicules, and the gradual development of the radial partitions, from 2 only partial secondary septa in the third whorl chambers to as many as 15 complete subdivisions in the later elongate cresentic chambers. From Bass Rock, Ceylon. × 79. 10a, Dorsal view of hypotype (U.S.N.M. No. P 2201), a young form, showing the typical appearance before becoming attached in the later stage, with only five chambers in the final whorl, and showing the appearance of a dry specimen with the secondary partitions invisible dorsally. 10b, Ventral view, showing open umbilicus, radial sutures, and the slightly depressed secondary septa, which can be determined surficially and are scarcely separable ventrally from the five true septa. 10c, Edge view, showing low spire and rounded periphery. × 60. From Recent at Port Gaura, Philippines.

All figures are camera lucida drawings; figs. 1-9 by Helen Tappan Loeblich; fig. 10 by Lawrence Isham.

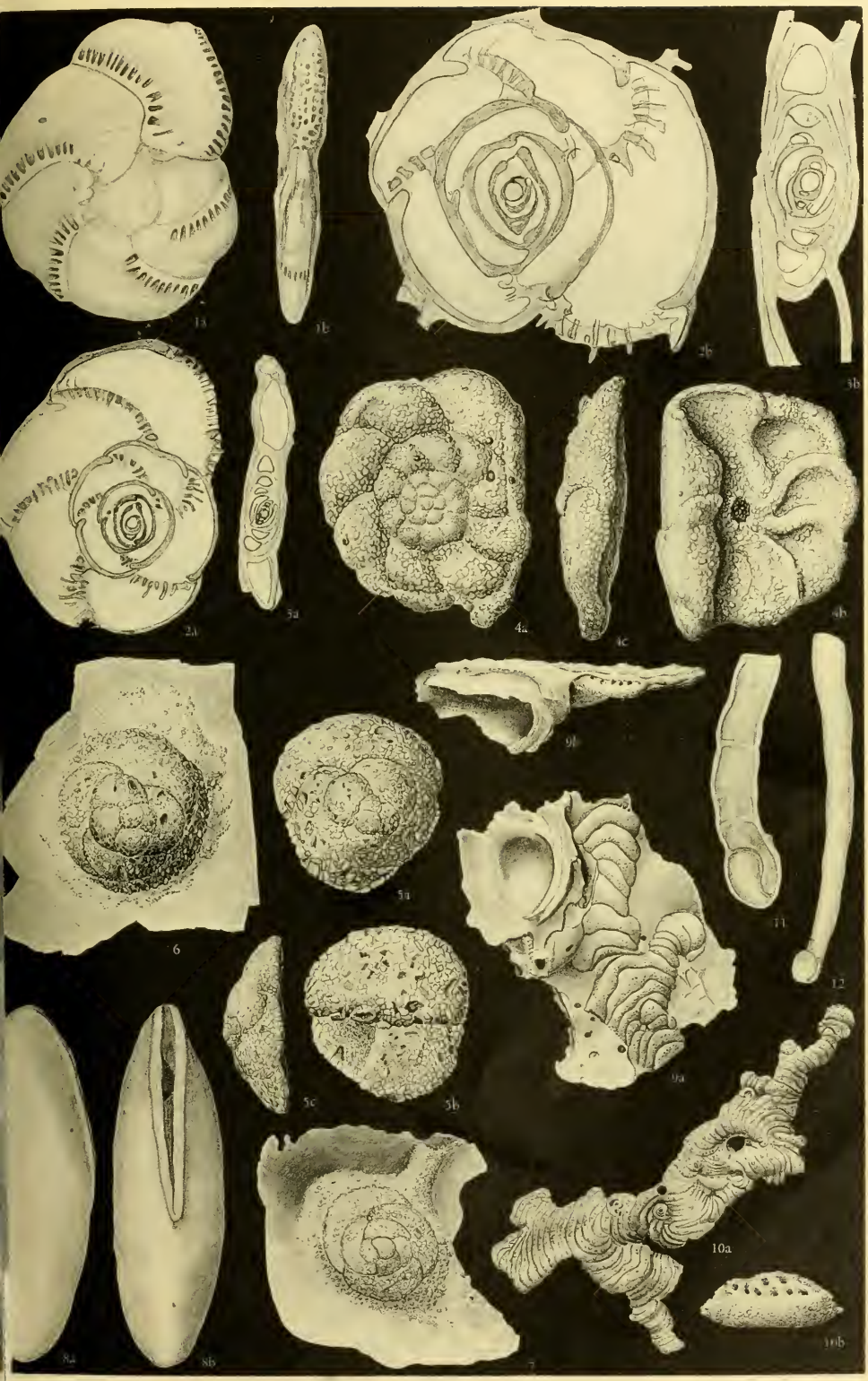


BRACHYSIPHON, PROTEONINA, TEXTULARIOIDES, PLANCTOSTOMA, JULLIENELLA, AND MILIAMMINA

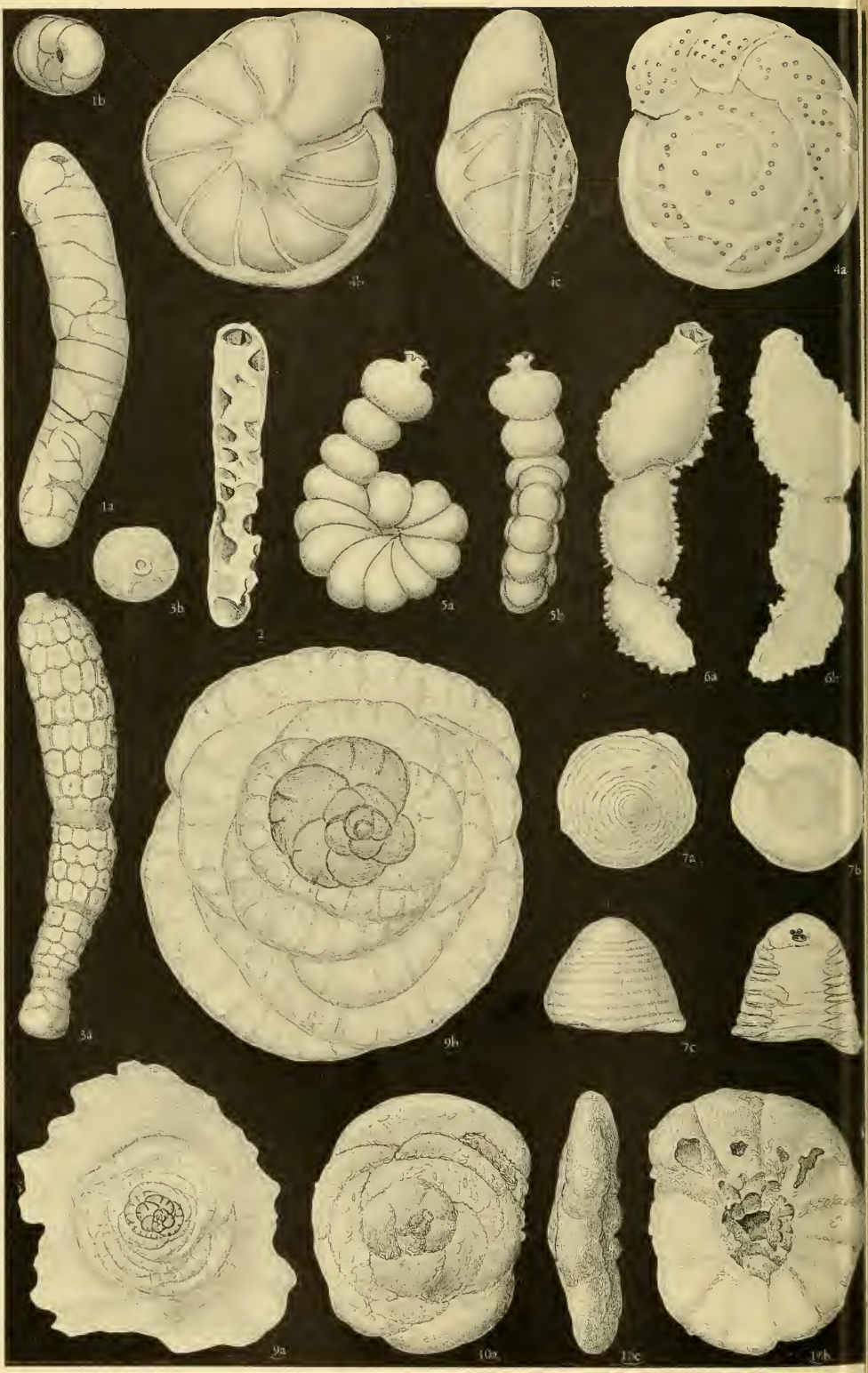


TRILOCULARENA, HAUERINA, AND INVOLVOHAUERINA

(SEE EXPLANATION OF PLATES AT END OF TEXT.)



POLYSEGMENTINA, ROTALIAMMINA, TRITAXIS, TROCHAMMINELLA, RIMULINA, BDELLOIDINA, AND TUBINELLA



ORTHOPLECTA, SCHUBERTIA, CIBICIDOIDES, MONALYSIDIUM,