

W. Blow

CONTRIBUTIONS
FROM THE
CUSHMAN FOUNDATION
FOR
FORAMINIFERAL RESEARCH

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204. SOME PRIMARY TYPES OF SPECIES BELONGING
TO THE SUPERFAMILY GLOBIGERINACEAE

F. T. BANNER and W. H. BLOW

The British Petroleum Company Limited, Exploration Division, BP Research Centre,
Chertsey Road, Sunbury-on-Thames, Middlesex

ABSTRACT

An attempt is made to clarify the taxonomy of those species of the superfamily Globigerinaceae which possess primary types deposited in London and Paris. The lectotypes of the following species are described: *Globigerina bilobata* d'Orbigny, *G. bulloides* d'Orb., *G. bulloides borealis* Brady, *G. conglobata* d'Orb., *G. cretacea* d'Orb., *G. cristata* Heron-Allen and Earland, *G. dutertrei* d'Orb., *G. eggeri* Rhumbler, *G. elongata* d'Orb., *G. helicina* d'Orb., *G. megastoma* Earland, *G. puncticulata* Deshayes, *G. punctulata* d'Orb., *G. quadrilobata* d'Orb., *G. rotundata* d'Orb., *G. rubra* d'Orb., *G. sacculifera* Brady, *Pullenia obliquiloculata* Parker and Jones, *Pulvinulina menardii fimbriata* Brady, *P. menardii tumida* Brady, *P. scitula* Brady, *Rotalia limbata* d'Orb., *R. menardii* Parker, Jones and Brady, *R. nitida* d'Orb., *Sphaeroidina bulloides* var. *dehiscens* Parker and Jones, and *Truncatulina humilis* Brady. Neotypes are proposed and described for *Globigerina conglomerata* Schwager, *G. seminulina* Schwager and *Rotalina cultrata* d'Orbigny. Descriptions of the morphology of the above species are emended, and their taxonomy, stratigraphy and phylogeny are discussed. The remaining syntypes of *Globigerina depressa* d'Orbigny, *Rosalina linnei-ana* d'Orb. and *Rotalina canariensis* d'Orb. are discussed. The taxon "*Rotalia menardii* d'Orbigny" is shown to be unavailable. *Globotruncana mariei* is proposed as a new name for the homonym *Globotruncana cretacea* Cushman non *Globotruncana cretacea* (d'Orbigny).

INTRODUCTION

In our studies of the various species of the superfamily Globigerinaceae (Banner and Blow 1959, 1960) it has become increasingly apparent that the original descriptions and illustrations of many famous species are inadequate. Although the names of these species have been frequently used, a review of the literature shows that there is often little similarity between the forms to which these popular names have been referred by different authors. For example, probably no two authors have used the name *Globigerina cretacea* d'Orbigny in the same sense and the name has been applied to forms which have widely differing stratigraphic ranges. Bolli (1954) has pointed out that certain names of planktonic Foraminifera have been used in too broad a sense and the resulting mis-identifications have led, in such cases, to a reduction in the value of these planktonic species as stratigraphic indices.

Because of the great inherent value of planktonic Foraminifera in stratigraphy it has become increasingly necessary to ascertain, as far as possible, the true nature of many of the species erected by the older workers, some of which have been used frequently by many subsequent authors in describing faunas of con-

siderable stratigraphic importance. It is emphasized that before the great stratigraphic value of the planktonic Foraminifera can be fully appreciated it is necessary to understand the true morphology and taxonomy of the species which are being used. It appears to us that much valuable stratigraphic information has been lost by the lax application of trivial names. In consequence we have endeavoured to isolate, redescribe and refigure as many of the more important species of the Globigerinaceae which have been available to us so that the morphology, inter-relationships and, subsequently, the stratigraphic record of these species can be more fully understood and evaluated.

We have examined the collections of Alcide d'Orbigny, in the Muséum National de l'Histoire Naturelle, Paris, France, and those of H. B. Brady, Heron-Allen and Earland and other workers in the British Museum (Natural History), South Kensington, London, England, and these re-investigations form the basis of this paper.

The Foraminifera collected and identified by Alcide d'Orbigny were originally contained loose in small glass vials and had small triangular-shaped brown paper labels inserted between the cork and the neck of the glass vial. Some of these small vials bearing d'Orbigny's original labels are still extant in the d'Orbigny collections in Paris. The insecurity of the labelling, and the inadequacy of the mounting method, led Terquem (at an unknown date) to remount the specimens; he gummed d'Orbigny's syntypes on to thin, narrow, rectangular strips of glass, which were placed above similar strips of blue card within cylindrical glass tubes. The tube was then corked, and glued to a strong cardboard base, which was labelled on the obverse in Terquem's handwriting, and, whenever possible, the original d'Orbigny label was gummed on to the back of the cardboard tube base. The lectotypes which we have isolated from the original syntypic series are now contained in single-celled cardboard slides with full details written on them, also with our names and the dates of isolation of the types. The transference of types was carried out with the full knowledge of Museum authorities (M. J. Sornay) and under the guidance and expert advice of M. Pierre Marie (B.R.G.G.M.) and with the approval of M. M. Lys (Institute du Petrole Francais).

In the British Museum (Natural History), London,

we examined the collections with the full help and assistance of Dr. C. G. Adams and Dr. R. H. Hedley. The Foraminifera were originally mounted in cardboard slides which were inscribed in the original author's own handwriting. The types now isolated into new single-celled cardboard slides have been re-registered in the British Museum (Natural History) official register. We were able to use the magnificent library facilities of the British Museum and to check much original literature, including Soldani (1791) and the various first editions of the works of d'Orbigny, Cuvier, etc.

We have endeavoured to keep this particular paper as objective in its treatment as possible. The species are listed under their authors' original generic assignments, and the subjective comment has been restricted to the "Remarks." In the subjective treatment of the species, the gender of each trivial name has been changed where necessary in accordance with Declaration 40 of the I.C.Z.N. (Opinions and Declarations, etc., vol. 19, 1958, pt. 14, pp. 19-28); e. g., *Globigerina rubra* d'Orbigny is subjectively referred to as *Globigerinoides ruber* (d'Orb.), and *Globigerinoides obliqua* Bolli is corrected to *Globigerinoides obliquus*. This paper forms a natural part of a series dealing with the various species of the Globigerinaceae. These papers are being published as separate parts in a variety of journals, and we hope that these publications will provoke discussion and interest amongst specialists on the planktonic Foraminifera. It is hoped eventually to gather all these works together into a single and concise monograph after having taken due note of the various views and criticism provoked by the prior publication of the individual parts. As in all our previous work the present authors' names are arranged alphabetically and this arrangement implies no seniority of authorship whatsoever.

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We wish to thank the Chairman and Directors of The British Petroleum Company Limited for permission to publish this work. We greatly appreciate the encouragement given to us by the Chief Geologist (Mr. N. L. Falcon) and Chief Palaeontologist (Dr. F. E. Eames) of The British Petroleum Company Limited who are fully aware of the stratigraphic importance of planktonic Foraminifera. We also thank our colleagues Dr. W. J. Clarke and Mr. F. R. Gnauck for stimulating discussions and critical advice. Our thanks are due in particular to MM. P. Marie, J. Sornay and M. Lys for their invaluable assistance, for they unreservedly placed their knowledge of the Alcide d'Orbigny collections at our disposal. We also wish to express our gratitude to M. G. J. Demaison (Chief Geologist) and Mlle. A. Benoit (Palaeontologist) of the Soci t  des Petroles de Valence for their help. In London we received much assistance and advice from Drs. R. Hedley and C. G. Adams and also from Miss C. Under-

wood (British Museum (Natural History)). All these workers were able to give us much advice, especially concerning the handwriting and idiosyncrasies of the original authors, which was necessary in order to interpret the status and validity of the material. We especially thank Mr. R. V. Melville (Assistant Secretary to the International Commission on Zoological Nomenclature) for his help in elucidating many difficult and involved taxonomic problems; he has read the manuscript and approved the taxonomy involved.

SYSTEMATIC PALAEOLOGY

Globigerina bilobata d'Orbigny, 1846

Plate 3, figure 9

Globigerina bilobata D'ORBIGNY, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 164, pl. 9, figs. 11-14, [lectotype here designated].

Globigerina ovoidea SEGUENZA, 1880, R. Accad. Lincei Roma, Mem., vol. 6, p. 334, pl. 17, fig. 39.

Orbulina gemina TERRIGI, 1891, Mem. Descr. Carta Geol. Ital., vol. 4, pt. 1, p. 103.

Candeina biloba JEDLITSCHKA, 1934, Naturf. Ver. Brunn, Verh., vol. 65, pp. 22, 24, text-figs. 8-12.

Candeina triloba JEDLITSCHKA, 1934 (part), *ibid.*, pp. 22, 24, text-figs. 14-18, 20.

Orbulina universa d'Orbigny var. *bisphaerica* LEROY, 1941, Colorado School of Mines Quart., vol. 36, no. 1, pt. 1, p. 44, pl. 1, fig. 3.

Orbulina bilobata (d'Orbigny), BRONNIMANN, 1951, Contr. Cushman Found. Foramin. Res., vol. 2, pt. 4, p. 135, text-fig. 3, nos. 1-2, 9-10, 17, 19; text-fig. 4, nos. 5-6, 17-18.

Biorbulina bilobata (d'Orbigny), BLOW, 1956, Micropaleontology, vol. 2, no. 1, pp. 69-70, text-fig. 3.

Taxonomic remarks.—D'Orbigny (1846) first described *Globigerina bilobata* from the Vindobonian marly clays near the village of Nussdorf, north of Vienna, Austria. For many years the gross morphology of this species was believed by many authors to be characteristic, even though its generic position was disputed. However, more recent work (Blow, 1956) has shown that superficially similar but actually distinct forms exist (e. g., *Porticulasphaera transitoria* (Blow, 1956)), and it proved necessary to be sure of the precise details of the type specimen of *G. bilobata*. The lectotype of *Globigerina bilobata* d'Orbigny, here designated, was selected from a named syntypic series present in the A. d'Orbigny collections, labelled "Tortonien, Nussdorf (Autriche)," probably in Terquem's handwriting. On the reverse of the mount, a subsequent hand had written the reference to d'Orbigny's first description of *G. bilobata* ("p. 164, pl. 9, Fig. 11-14").

Description of lectotype.—The large test is bilobate, consisting exteriorly of two sub-equal and partially embracing spheres, but without any external trace of any chambers earlier than the penultimate. The su-

ture between the penultimate and last chamber is distinct and depressed, and no apertural pores were observed in the suture. No external primary aperture exists, but a very few apertural pores are present, apparently randomly distributed over both the ultimate and penultimate chambers. The wall is calcareous, radial in structure, and is uniformly and coarsely perforate, but otherwise smooth, with little trace of the original hispidity. The surfaces of the ultimate and penultimate chambers are virtually identical, and the wall thicknesses appear to be the same. Maximum dimension of lectotype: 0.76 mm.

Remarks.—The origin and evolution of this species have been dealt with elsewhere (Blow, 1956), and it is considered to belong to the distinct genus *Biorbulina* Blow 1956. The species is known to occur from the highest Aquitanian to the Recent.

***Globigerina bulloides* d'Orbigny, 1826**

Plate 1, figures 1, 4

"*Polym. Tuberosa et Globuliferae*" SOLDANI, A., 1791 (partim), *Testaceographiae ac Zoophytographiae*, vol. 1, pt. 2, p. 117, pl. 123, fig. O only (not figs. H, I, and P).

Globigerina bulloides D'ORBIGNY, 1826, *Tableau Méthodique de la classe des Céphalopodes*, Ann. Sci. Nat., p. 277 (no figure), list No. 1, [lectotype here designated].

Globigerina bulloides D'ORBIGNY, CUVIER, (1834) 1837, "The Animal Kingdom," Atlas, (Transl.), London, G. Henderson, vol. 3, pl. 3, figs. 12a-b.

?*Globigerina bulloides* D'ORBIGNY, D'ORBIGNY, 1839, *Foraminifères des Îles Canaries* (in Barker-Webb and Berthelot, *Hist. Nat. Îles Canaries*) Paris, vol. 2, pt. 2, Zool., p. 132, pl. 2, figs. 1, 2, 3 (not fig. 28).

Globigerina bulloides D'ORBIGNY, PARKER, JONES and BRADY, 1871, *Ann. Mag. Nat. Hist.*, London, ser. 4, vol. 8, pl. 11, fig. 112 (after Soldani, 1791).

Globigerina bulloides D'ORBIGNY, BRADY, 1884, *Rept. Voy. Challenger*, Zool., vol. 9, p. 593, pl. 79, figs. 7a-c.

Globigerina bulloides D'ORBIGNY, CUSHMAN, 1941, *Contr. Cushman Lab. Foram. Res.*, vol. 17, pt. 2, pp. 38-39, pl. 10, figs. 1-13.

Globigerina bulloides D'ORBIGNY, BOLLI, LOEBLICH and TAPPAN, 1957, *U. S. Nat. Mus., Bull.* 215, p. 31, pl. 4, figs. 1a-c.

Globigerina bulloides D'ORBIGNY, BLOW, 1959, *Bull. Amer. Pal.*, vol. 39, no. 178, p. 175, pl. 9, figs. 38a-c.

Taxonomic remarks.—This species was listed by d'Orbigny in 1826, with no illustration or description; it is validated by the author's reference to the non-Linneian work of Soldani (1791). No holotype was designated by d'Orbigny, and no lectotype has been selected prior to this paper. The specimens available as syntypes theoretically include all those so labelled

or otherwise identified by d'Orbigny during or prior to 1826, as well as the specimens of Soldani which were referred to by d'Orbigny (Soldani, 1791, pl. 123, figs. H, I, O, and P), which specimens must have been included by d'Orbigny in his concept of the species at the time of the first publication (R. V. Melville, *verb.*). This species was designated as the type species of the genus *Globigerina* d'Orbigny 1826 by Parker, Jones and Brady (1865, p. 36). *G. bulloides* was subsequently referred to the genus *Pyloedexia* by Ehrenberg (1872), p. 276, but that genus was subsequent to *Globigerina*, being erected by Ehrenberg in 1858, and has not yet been validated (Cushman's designation in 1927 of the species *Pyloedexia? tetratrias* Ehrenberg 1858 as type species of *Pyloedexia* being invalidated by Art. 30, para. II, subpara. e (γ) of the International Rules of Taxonomy). The species name *G. bulloides* has been used extensively by zoologists and palaeontologists, and opinions as to its application have varied almost equally widely; it is consequently impossible to attempt a full synonymy here.

Although d'Orbigny (1826) published no illustration of the species, he issued to private subscribers two models in plaster; according to Heron-Allen (1917, pp. 14-15), the models numbered 1 to 25 were issued in 1823, and the remainder were issued in further instalments during that year. Model No. 17 was referred by d'Orbigny (1826) to a young individual of *Globigerina bulloides*, and Model No. 76 (in the fourth instalment) to an adult of that species. Only the latter is closely comparable with either the lectotype of the species here designated, or to any of the illustrations given by Soldani (1791), and referred to by d'Orbigny. Of the Soldani figures quoted by d'Orbigny, pl. 123, fig. I may be of a broken test, fig. H is bilocular and not conspecific, and fig. P is unrecognisable; only that specimen represented by fig. O is recognisably the same species as that modelled by d'Orbigny and now present in his collection. As the models were not available to the general public except on private and limited subscription they have no status in taxonomy, but should be used to understand d'Orbigny's concept of the species. We have attempted to do this in our selection of lectotype. Cuvier (1834, 1837) published two drawings of *G. bulloides* (dorsal and side views only) which are so like d'Orbigny's model no. 76 that there can be little doubt that they were actually copied from this model. D'Orbigny's first illustrations of *G. bulloides* (1839) showed two recent specimens, and the first (*op. cit.*, pl. 2, figs. 1, 2 and 3) showed the three standard views of a specimen, from the recent seas near the Canaries, which is probably conspecific with our lectotype (the other specimen (pl. 2, fig. 28) is not specifically determinable). Unfortunately, Ellis and Messina (1940 et seq.) omitted the umbilical view of the first specimen, i. e., pl. 2, fig. 2.

D'Orbigny (1826) stated that he obtained his speci-

mens of *G. bulloides* from the Adriatic Sea, close to Rimini. Two tubes of specimens, remounted from d'Orbigny's material by Terquem at an unknown date, and bearing the inscription *G. bulloides*, in Terquem's handwriting, are extant in the Muséum Nat. de l'Hist. Naturelle. One of these two tubes bears the original d'Orbigny label on the back of its mount but with no mention of locality of origin; this tube is now empty, and is marked "Type isolé." The single specimen which this tube apparently contained has obviously been removed, presumably by Dr. A. R. Loeblich during his visit to Europe in 1953 and 1954. The handwriting of the words "Type isolé" seems to correspond to that on other slides which are known to have been marked by Dr. Loeblich. Unfortunately, the present workers in Paris (MM. Marie, Sornay and Lys) were unable to throw any light on the whereabouts of this specimen, and, following a diligent search by all concerned, it must now be considered lost. We have written to Dr. Loeblich regarding this matter, but have received no reply. Since Dr. Loeblich has not yet published any information on this specimen, and as this species is of great importance in the understanding of the genus *Globigerina* and supra-generic taxa based upon it, we have isolated as lectotype (here figured, pl. 1, fig. 1) a further syntypic specimen from the second tube. The tube of origin of the lectotype was labelled "Subappenin, Rimini" on the obverse of the mount, and the number 12309 on the reverse.

Description of lectotype.—The test is coiled in a low trochospire with eight to nine chambers arranged in two to two and a half whorls, and with four chambers in the last whorl. The equatorial profile (i. e., in dorsal and ventral views) is sub-circular, with a lobulate periphery; the axial profile is slightly convex dorsally and possesses a smoothly rounded axial periphery. The chambers are inflated, subglobular, and only slightly embracing. The sutures are distinct dorsally, and depressed, and the intercameral sutures are nearly radial. The ventral sutures are depressed, radial, and lead into the deep, open umbilicus. The aperture is interiomarginal, umbilical, a symmetrical arch without a lip; the apertural face is convex and inflated uniformly with the remainder of the chamber wall. The earlier apertures of the last whorl can be seen opening into the deep open umbilicus. The wall of the test is calcareous, radial in structure, uniformly and finely perforate. The test surface is uniformly and finely cancellate. Maximum diameter of lectotype is 0.67 mm.

Remarks.—From comparison with recent specimens taken in life of *G. bulloides*, preserved in Canada-balsam mounts in the "Challenger" Collection of the British Museum (Natural History), this form possesses long, delicate spines distributed over its entire surface during life.

G. bulloides is known to us from topotype Tortonian of the Vienna Basin, and has been recorded by Blow

(1959) from beds in Venezuela as old as Lower Vindobonian. Records of older stratigraphical occurrences of this species are probably in error, since Blow (*op. cit.*) has demonstrated its evolution from *Globigerina praebulloides* in the middle to upper parts of the *Globorotalia menardii/Globigerina nepenthes* zone of the Caribbean area; this level is considered to be equivalent to part at least of the European Helvetian.

As Blow (1959, p. 175-176) has previously pointed out specimens of *Globigerina bulloides* which possess an aberrant final chamber appear similar to *Globigerina diplostoma* Reuss 1850 and to *Globigerina quadrilatera* Galloway and Wissler 1927. Topotype specimens of the former species have been seen and are believed to be fully conspecific with *Globigerina bulloides* d'Orbigny.

Near topotype specimens of *Globigerina concinna* Reuss 1850 (from Nussdorf, near Vienna, Austria), have also been examined and we consider that *G. concinna* should be regarded as a five-chambered subspecies of *G. bulloides*; unlike *G. bulloides sensu stricto*, *G. bulloides concinna* has not yet been correctly recorded from beds older than Tortonian, (see Bolli, 1954).

Globigerina bulloides d'Orbigny

var. *borealis* Brady, 1881

Plate 3, figures 4a-c

Globigerina bulloides d'Orbigny, arctic variety, BRADY, 1878, Ann. Mag. Nat. Hist. ser. 5, vol. 1, p. 435, pl. 21, figs. 10a-c.

Globigerina bulloides d'Orbigny variety *borealis* BRADY, 1881, Ann. Mag. Nat. Hist. ser. 5, vol. 8, no. 48, p. 412, (no figure) [lectotype here designated].

Globigerina bulloides d'Orbigny var. *borealis*, BRADY, 1882, Roy. Soc. Edinburgh, Proc. vol. 11, (1880-1882), no. 111, p. 716, (no figure).

Globigerina pachyderma (Ehrenberg), BRADY, 1884, Rept. Voy. Challenger, Zool. vol. 99, p. 600, pl. 114, figs. 19, 20. (?non *Aristerospira pachyderma* Ehrenberg 1861).

Taxonomic remarks.—This form was originally recognised by Brady in material collected by the Austro-Hungarian North-Polar Expedition during the years 1875-1876. He regarded it as a "thick-walled, cold-water, variety" of *Globigerina bulloides* d'Orbigny, and in 1882, named it "variety *borealis* nov." However, this proposal was, unfortunately, predated by his subsequently written but earlier published work which appeared in 1881 and the taxon "*borealis*" must date from this year. Subsequently, Brady (1884) considered that *G. bulloides* var. *borealis* was a synonym of *Globigerina pachyderma* (Ehrenberg), a species which was also recorded from northern latitudes, and which may be seen from Ehrenberg's original illustration (1873, pl. 1, fig. 4) to be tumid and thick walled. We would prefer to retain Brady's name "*borealis*" for this form since Ehrenberg's illustration does not wholly agree with Brady's species; a re-investigation of Ehren-

berg's material is necessary before this problem can be satisfactorily solved.

The lectotype of *Globigerina bulloides* d'Orbigny var. *borealis* Brady 1881 (here designated) came from a series of specimens mounted by Brady in a single-celled slide, labelled "North-Polar Expedition, 1875-1876; most northern sounding, latitude 83° 19' N, depth 72 fathoms," and registered in the British Museum (Natural History) as specimens numbers "1955:10:28:1008-20." The lectotype is now registered in the British Museum (Natural History) as number 1959.7.1.1.

Description of lectotype.—The small tumid trochoid test consists of a fairly rapidly enlarging series of about 14 chambers arranged in about 3 whorls. The trochospire is low and consequently the dorsal surface is only slightly convex. The chambers are uniformly inflated but partially embracing and considerably appressed. About 4 chambers are present in the last whorl with the earlier whorls having about 5 chambers. The equatorial profile is sub-circular to ovate and the equatorial periphery is weakly lobulate. The axial profile is sub-oval and the axial periphery smoothly rounded. The umbilicus is very small, almost closed, but depressed. The dorsal sutures are initially obscure but in the last whorl both the spiral and intercameral sutures are slightly depressed and fairly distinct. The later dorsal intercameral sutures are radial, meeting the spiral suture almost at right angles. The ventral sutures are distinct, slightly depressed and nearly radial. The aperture is a long low arch, interiomarginal, umbilical in position, not totally restricted to the deepest part of the umbilical depression. The aperture is bordered by a greatly thickened and broad rim. The test wall is uniformly and finely perforate and is characteristically thick. The test surface is practically smooth with only traces of an original fine hispidity. Maximum diameter of lectotype: 0.31 mm.

Remarks.—The syntypic specimens figured by Brady in 1878, and the other figured in 1884, all show an abnormally reduced terminal chamber, a feature which appears to be extremely common in specimens of this form. The terminal chamber is often very variable in size and sometimes may appear to be no more than a broad flap covering the aperture of the penultimate chamber. In other specimens the terminal chamber is often abortive both in position and shape and in these cases can superficially resemble a bulla (Bolli, Loeblich and Tappan, 1957). The last formed apertures in forms with abortive final chambers are as variable in extent, size and shape as are the abortive chambers themselves; in such a form the aperture may be umbilical-extraumbilical in position giving a *Turborotalia*-like appearance to the test. However a study of the ontogenetic development of a form with an abortive final chamber and associated extraumbilical aperture shows that the earlier chambers possess purely umbilical apertures and the feature is limited only to the

final stage of development. Consequently, this form is considered as belonging to the genus *Globigerina* and not to the genus *Globorotalia* (*Turborotalia*).

In this form, the embracing chambers, small umbilicus and the distinctive thickened apertural rim show a clear distinction from *Globigerina bulloides* d'Orbigny and it is considered here as a distinct species, *Globigerina borealis* Brady.

Globigerina borealis is known to occur in Pleistocene deposits and recent seas. It also occurs in sediments in Sicily which are probably of Pliocene age.

Globigerina bradyi Wiesner, 1931

Plate 3, figures 1, 2

Globigerina sp., BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 603, pl. 82, fig. 8 [lectotype, here designated], and fig. 9.

Globigerina bradyi, WIESNER, 1931, "Die Foraminiferen der deutschen Südpolar-Expedition 1901-1903" (in Drygalski, "Deutsche Süd-Polar Expedition 1901-1903") de Gruyter, Berlin u. Leipzig, Bd. 20 (Zool. Bd. 12), p. 133, (no figure).

Globigerina bradyi Wiesner, BOLLI, 1957, U. S. Nat. Mus. Bull. 215, pp. 110-111, pl. 23, figs. 5a-c.

Globigerina bradyi Wiesner, BLOW, 1959, Bull. Amer. Pal., vol. 39, no. 178, pp. 173-4, pl. 7, fig. 36.

Taxonomic remarks.—Wiesner (1931) proposed the name *Globigerina bradyi* for a minute high spired species of *Globigerina*, first recorded and figured (but not named) by Brady (1884) from the "Challenger" Collections made in the Southern Ocean (Challenger Station 144), and subsequently found by himself also in the Southern Ocean in the vicinity of Crozet Island.

Both the specimens illustrated by Brady (1884), referred to by Wiesner, and the specimens actually seen by the latter worker must constitute the syntypic series upon which the concept of this species was based. At our request, Dr. Kurt Diebel, of the Geologisch-Paläontologisches Institut und Museum der Humboldt Universität zu Berlin, has kindly searched through the H. Wiesner collections in collaboration with Dr. Gruner, the Curator of the Zoologische Museum der Universität. He has informed us that all material of the species *G. bradyi* is missing (letter dated 29th July, 1959). Consequently we have selected as lectotype of *Globigerina bradyi* Wiesner that specimen illustrated by Brady in 1884, pl. 82, figure 8, and refigured here (pl. 3, fig. 1); this specimen was obtained from Challenger Station 144, depth 1570 fathoms, and is registered in the British Museum (Natural History) as specimen number 1959.5.11.738.

In 1861, Ehrenberg (pp. 276, 277, 308) described a minute elongate globigerine for which the name *Pylo-dexia uvula* was proposed; the specimens came from the Greenland Deep of the Northern Atlantic Ocean in the vicinity of Southern Greenland. Ehrenberg subsequently published illustrations of this form (1873,

pl. 2, figs. 24, 25); these specimens were evidently mounted in Canada Balsam (Ehrenberg's usual practice) and drawn using transmitted light. We illustrate here (pl. 3, fig. 2) a topotype specimen of *G. bradyi* similarly mounted in Canada Balsam and photographed in transmitted light.

Ehrenberg's (1873) figure 25 is reproduced here for comparison and it seems highly likely that *G. bradyi* Wiesner should be regarded as a junior synonym of *Pyloedexia uvula* Ehrenberg.

Description of lectotype.—The test is small, elongate, coiled in a high trochospire. The minute spherical proloculum is surrounded by a tightly embracing, comparatively low trochospiral whorl of 4 to 5 chambers; this is succeeded by about 3 whorls of slowly enlarging, subglobular, slightly embracing chambers arranged four to a whorl in a trochospire which becomes elongate along its axis. After the initial whorl, the spiral and intercameral sutures become increasingly deeply depressed and the equatorial and axial peripheries become increasingly lobulate. The umbilicus is small and usually completely closed. The primary aperture is a low interiomarginal, umbilical arch. The wall is thin, sometimes almost translucent, and is uniformly and finely perforate. The surface of the test is virtually smooth and with little trace of hispidity. Maximum dimension of lectotype: 0.25 mm.

Remarks.—The aperture of this form can vary considerably within its intraumbilical limits, sometimes being a fairly high arch without a distinct lip whilst in other specimens (especially in those from the Miocene) the aperture is low and with a distinct lip. Possibly the two different types may bear a subspecific relationship to one another. It is known to range from the Middle Aquitanian (Bolli 1957, Blow 1959) to Recent.

***Globigerina conglobata* Brady, 1879**

Plate 4, figure 4

Globigerina conglobata BRADY, 1879, Quart. Journ. Micr. Sci., n.s., vol. 19, p. 286, (no figures) [lectotype here designated].

Globigerina conglobata Brady, BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 603, pl. 80, figs. 1-5, pl. 82, fig. 5.

Globigerinoides conglobatus (Brady), A. G. I. P. MINERARIA auct., 1957, Foraminiferi Padani, Milan, Tav. 46, fig. 1.

Taxonomic remarks.—Brady (1879) first described this species from recent material collected by the Challenger Expedition; he did not illustrate the form nor did he give its precise provenance. When he subsequently wrote his more detailed account of the Foraminifera collected by H. M. S. Challenger (1884) he re-described and, for the first time, illustrated a syntypic series of specimens. Nuttall (1927, Ann. Mag. Nat. Hist., ser. 9, vol. 19, p. 233) was able to identify the Canada Balsam mounted specimen which had been

illustrated by Brady (1884, pl. 82, fig. 5), but was unable to locate any of the other illustrated specimens. With the assistance of Dr. C. G. Adams and Miss C. Underwood we have also searched for Brady's illustrated specimens and, like Nuttall, could only find the Canada Balsam mounted specimen. Two slides of *Globigerina conglobata* Brady are extant in the collections of the British Museum (Natural History); one slide contains 30 specimens obtained from Challenger Station 64, North Atlantic, depth 2750 fathoms, and is marked, in Brady's handwriting, on the back as "? pl. 80, fig. 2." The other slide contains 2 specimens obtained from Challenger Station 338, South Atlantic, depth 1990 fathoms, and is marked, again in Brady's handwriting, as "pl. 80, figs. 1, 3;" however, we do not believe that these were in fact the specimens so illustrated. Consequently, we have selected as lectotype one of the 2 specimens identified by Brady from the slide marked "pl. 80, figs. 1, 3" (Challenger Station 338). The lectotype, here designated, is illustrated here (pl. 4, fig. 4), and is registered in the British Museum (Natural History) as specimen no. 1959.4.13.7.

Description of lectotype.—The shape of the large test is subglobular to subquadrate. In axial profile the dorsal surface is convex and the axial periphery is broadly rounded. The equatorial periphery is weakly lobate. The chambers are coiled in a fairly low but tight trochospire consisting of approximately three whorls. The chambers are initially reniform but later becoming narrowly lunate in dorsal aspect. The later chambers are characteristically strongly depressed, slightly embracing but moderately inflated. There are about $4\frac{1}{2}$ chambers in the earlier whorls reducing to $3\frac{1}{2}$ chambers in the last whorl. The dorsal spiral and intercameral sutures are initially obscure but become distinctly and narrowly depressed during ontogeny, so much so that the later formed sutures appear deeply incised and the chambers "bevelled." Four chambers are visible ventrally and the sutures between them are distinct, narrowly depressed, slightly sinuous to radial. The umbilicus is small, almost closed, but deep. The apertures are multiple; the distinct primary interiomarginal-umbilical aperture is a fairly long, comparatively low, slightly asymmetric arch broadest posteriorly with respect to the direction of coiling. The dorsal supplementary apertures are sutural in position and are visible in the basal sutures of the chambers of the last whorl and the later part of the penultimate whorl. In the last chamber there are three such supplementary apertures. Both the primary and supplementary apertures of the last chamber are bordered by thickened rim-like lips. The wall is characteristically very thick, especially in the early whorls, and it is uniformly and fairly coarsely perforate. The surface of the test is cancellate and syntypes taken *in vivo* show it to have been originally finely, uniformly and densely spinose. Maximum diameter of lectotype: 0.85 mm.

Remarks.—This species is considered here to be properly assigned to the genus *Globigerinoides* Cushman 1927, as restricted by Bolli, Loeblich and Tappan 1957 (see also Banner and Blow, 1959); it possesses a distinct primary umbilical aperture and dorsal supplementary apertures which are sutural in position; these supplementary apertures are not confined to the last chamber only as they are in species of the genus *Globigerapsis* Bolli, Loeblich and Tappan 1957.

Records of this species in the Eocene (e. g., Subbotina, 1953) are in error and these Eocene forms belong to the genus *Globigerapsis* Bolli, Loeblich and Tappan. Forms recorded from the Miocene (e. g., Stainforth, 1948) are probably referable to *Globigerinoides bisphericus* Todd. The form figured by A. G. I. P. Mineraria (1957) is from the Lower Pliocene but the records of this species in the Miocene by A. G. I. P. Mineraria (*loc. cit.*) are probably in error. This species has only been observed by us in deposits of Pliocene and Pleistocene age as well as in collections from the recent seas. The species has probably evolved from *Globigerinoides gomitulus* (Seguenza) in the basal Pliocene.

Globigerina conglomerata Schwager, 1866

Plate 2, figure 3

Globigerina conglomerata SCHWAGER, 1866, "Fossile Foraminiferen von Kar Nikobar," Novara Exped. 1857-59, Vienna, Geol. Theil, Bd. 2, Abt. 2, p. 255, pl. 7, fig. 113. [neotype here proposed].

Taxonomic remarks.—This species was first described by C. Schwager from the Neogene deposits of Kar Nikobar, British India. He published an illustration of the ventral view only, and never amplified the original description.

H. B. Brady received identified topotypic (metatypic) specimens from Schwager. It is not known whether these specimens were determined by Schwager before or after the date of his publication of the species; if it were the former case the specimens would be available as syntypes, but otherwise they rank only as metatypes. 40 specimens were present in the slide, marked "*G. conglomerata* ex Schwager Colln., Kar Nikobar," and Brady (1884, p. 596) on comparing the material sent by Schwager with Schwager's illustration (Schwager, 1866, pl. 7, fig. 113), remarked that "the author's figure is not a very satisfactory rendering of their distinctive characters." However, we consider that all the specimens were conspecific and agreed with the ventral view illustrated by Schwager.

Professor M. Reichel (Basel) has informed us (personal letter, dated 14th July, 1959) that to his knowledge the Schwager collections in Munich are lost. We ourselves have made further enquiries without success and following the Copenhagen Decisions on Zoological Nomenclature (Hemming, 1957, p. 28-32) we designate Schwager's metatypic specimen, here illustrated

(pl. 2, fig. 3), as *neotype* of *Globigerina conglomerata* Schwager 1866. This specimen is deposited in the British Museum (Natural History), London, registered number P. 44031.

Description of neotype.—The large globose test consists of 10 chambers (including the proloculum) arranged in a low trochospire of about two whorls with four chambers in each whorl. The equatorial profile is sub-circular, with a weakly and broadly lobulate equatorial periphery. The axial profile is sub-elliptical, the dorsal side being weakly convex and the ventral side being also convex. The axial periphery is broadly and smoothly rounded. The chambers are appressed, not greatly inflated, but are moderately embracing; in dorsal view they are reniform, becoming much longer circumferentially than broader radially. The sutures are weakly depressed and initially not very distinct. The spiral suture is lobulate and the intercameral sutures are slightly curved to nearly radial, dorsally meeting the spiral suture nearly at right angles. The umbilicus is distinct, moderately broad, quadrate in outline and deep. The primary aperture is a low interiomarginal arch totally confined within the umbilicus. No apertural lip, rim or tooth is visible on the neotype. The apertural face is somewhat flattened; it directly faces the umbilicus and forms a distinct although rounded angle with the remainder of the chamber wall. The wall is coarsely and uniformly perforate. The surface of the test is rough and cancellate, furnished with strong short spines which are particularly well developed along the margins of the umbilicus. Maximum diameter of neotype: 0.75 mm.

Remarks.—The slide sent to Brady containing the metatypes is marked "Pliocene" although the age given by Schwager in his publication is merely "Younger Tertiary." We ourselves have observed this species in the Pliocene of Sicily and it probably ranges from this age to the Recent.

A number of other large globose globigerines with four chambers in the final whorl exist in Upper Eocene to Miocene deposits and these all seem to be very closely related to Schwager's species. The distinctions between these forms are very subtle although stratigraphically valuable. It seems highly likely that *Globigerina venezuelana* Hedberg 1937 and *Globigerina rotundata* var. *jacksonensis* Bandy 1949 should be considered as subspecies of *G. conglomerata* Schwager. However much more work on the morphology of these other forms is required before their relationships can be fully evaluated.

We have seen the holotype of *Globigerina bulloides* var. *quadripartita* Koch 1926 which was kindly lent to us by Dr. E. Gasche of the Naturhistorisches Museum, Basel, Switzerland; unfortunately, as the holotype of Koch's species is broken and its ventral side is largely destroyed, its specific characters cannot be ascertained. We will be discussing this species at greater length in a

further publication but it seems best to consider this taxon as *nomen dubium*.

We believe that *G. conglomerata* Schwager is distinguishable from *G. dutertrei* d'Orbigny and is a recognisably distinct species of the genus *Globigerina* d'Orbigny.

***Globigerina cretacea* d'Orbigny, 1840**

Plate 7, figure 1

Globigerina cretacea D'ORBIGNY, 1840, Soc. Géol. France, Mém., Paris, Tome 4, No. 1, p. 34, pl. 3, figures 12-14, [lectotype here designated].

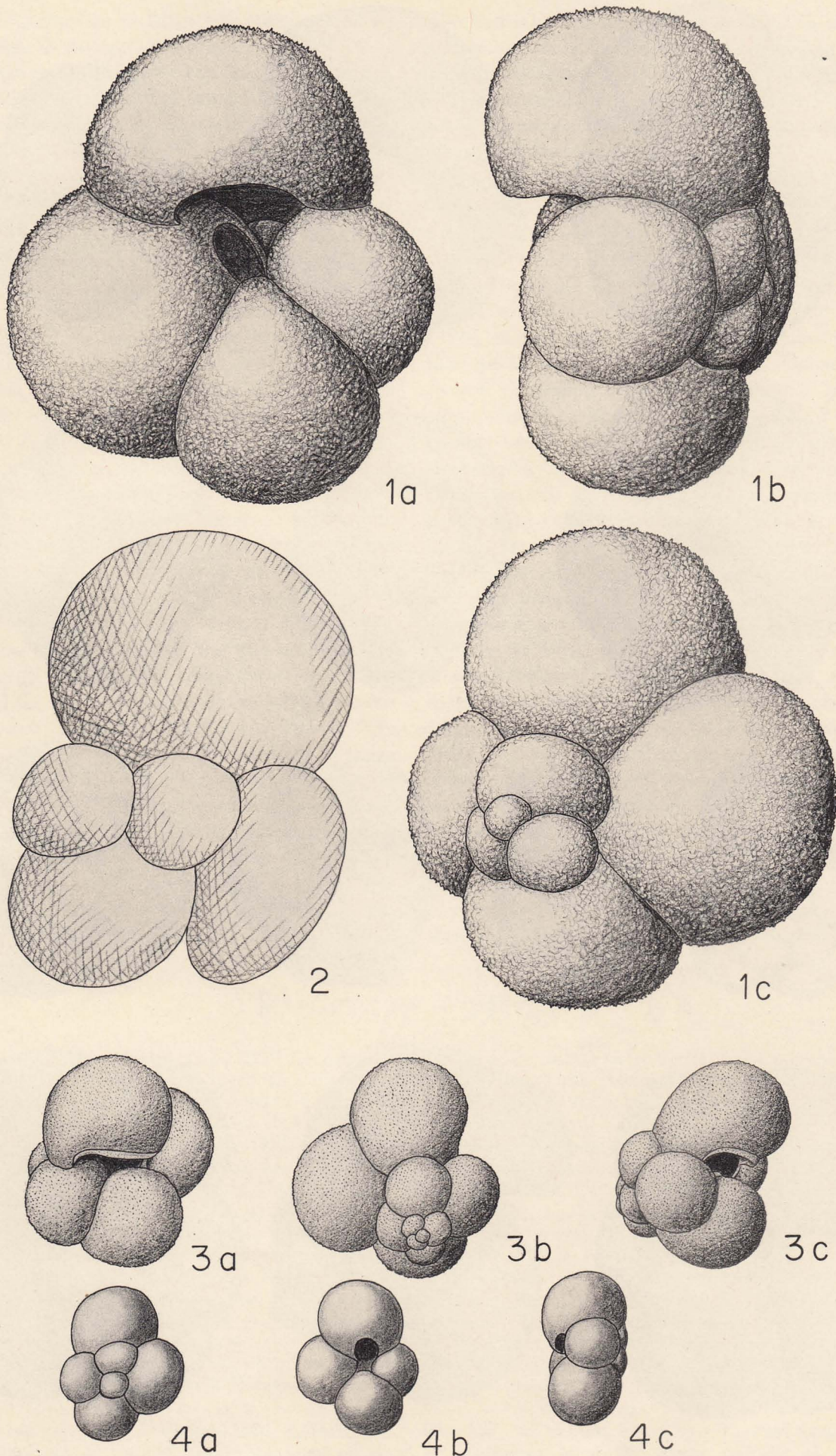
Taxonomic remarks.—D'Orbigny obtained this species from the Lower Campanian White Chalk of St. Germain, near Paris. In the material which is extant in the d'Orbigny collections deposited in the Muséum National de l'Histoire Naturelle, Paris, only one tube of specimens remains which has this locality marked upon it in Terquem's handwriting; these must constitute the only available syntypic series. Six specimens were present of which two were broken, three others had infilled umbilici and only one test was clean and empty and corresponded with the original d'Orbigny illustration. This specimen has been selected and isolated as lectotype (here figured, pl. 7, fig. 1); like the specimen illustrated by d'Orbigny (1840) it possesses five inflated chambers in the last whorl, a slightly compressed last chamber, nearly radial ventral sutures, a broad open ventral umbilicus, an interiomarginal, umbilical aperture and a hispid surface. The lectotype isolated is considered to be conspecific with that drawn by d'Orbigny and may possibly be the same specimen. As will be seen from our illustration the lectotype possesses two broadly spaced but weak carinae and is probably conspecific with the form described by Brotzen (1936, p. 177, pl. 12, figs. 3a-c, pl. 13, fig. 3) from the lower Senonian of Erikisdal, Sweden, as *Globotruncana globigerinoides* Brotzen. Brotzen (*op. cit.*, *loc. cit.*) has remarked that *Globotruncana globigerinoides* remarkably resembles *Globigerina cretacea* d'Orbigny but he considered them distinct because of the peripheral carinae present on his species. The carinae

are very weak on d'Orbigny's specimens (as they are also on Brotzen's specimens) and it is not surprising that d'Orbigny overlooked them, especially considering the optical instruments available in 1840. Seven other specimens in the d'Orbigny collections labelled "*G. cretacea* d'Orbigny" (probably in Terquem's handwriting), but with no locality recorded, were seen to be excellently preserved specimens of the genus *Globotruncana* Cushman 1927, and three of these specimens were mounted showing their ventral sides with perfectly preserved tegilla present. These specimens were clearly conspecific with the lectotype and showed a full range of variation from five to seven chambers in the last whorl.

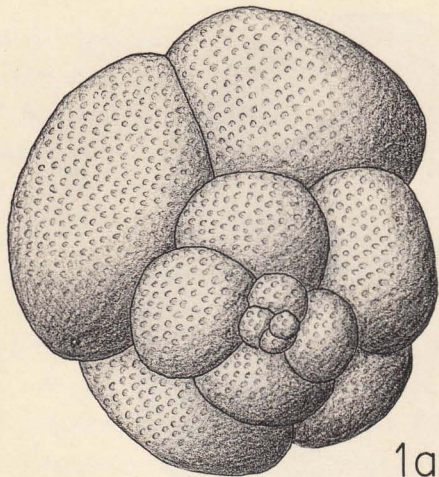
It is probable that the form described as *Globigerina cretacea* var. *saratogaensis* by Applin (*in* Applin, Ellisor and Kniker, 1925, p. 98, pl. 3, fig. 8) may be a full junior synonym of *Globigerina cretacea* d'Orbigny, as it appears to fall within the normal range of variation of d'Orbigny's species. However, it was probably a reworked specimen, being recorded originally from the Miocene Fleming Formation of Texas (see also Brönnimann and Brown, 1956 (1955), pp. 544-545) and strict topotype material is consequently impossible to obtain. Brönnimann and Brown's figured hypotype of *Globotruncana saratogaensis* (Applin) from the Taylor Marl (*op. cit.*, pl. 21, figs. 1-3) may also be referable to *Globotruncana cretacea* (d'Orbigny) 1840 *non* Cushman 1938. As a result of our recognition of *Globigerina cretacea* d'Orbigny 1840 as a species of the genus *Globotruncana* Cushman 1927, the subsequent species *Globotruncana cretacea* Cushman 1938 (not *Globotruncana cretacea* (d'Orbigny 1840)) becomes a junior homonym of d'Orbigny's species and the name *Globotruncana mariei* is hereby proposed as a new name for *Globotruncana cretacea* Cushman 1938, the holotype of which was obtained by Cushman from the Cretaceous Selma Chalk near Sardis, Tennessee, U. S. A., and which is deposited in the Cushman Collection, No. 15253. The new name *Globotruncana mariei* is in honour of M. Pierre Marie (B.R.G.G.M.) for his out-

EXPLANATION OF PLATE 1

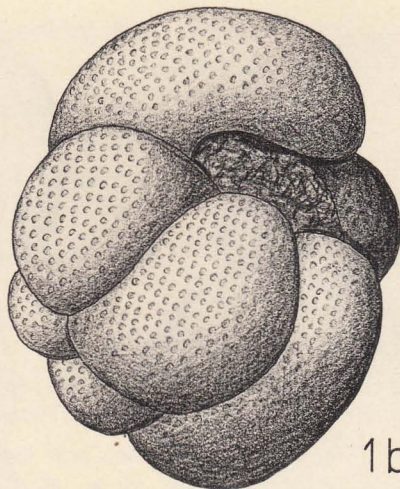
FIGS.	PAGE
1. <i>Globigerina bulloides</i> d'Orbigny 1826; lectotype, $\times 100$. Fig. 1a, ventral view; fig. 1b, axial peripheral view; fig. 1c, dorsal view. Specimen obtained by d'Orbigny from the recent deposits of the Adriatic near Rimini, now deposited in the Alcide d'Orbigny Collection, Muséum Nationale de l'Histoire Naturelle, Paris	3
2. "Polymorph. tuberosum et globuliferum," after Soldani, 1791, <i>Testaceographiae</i> , vol. 1, pt. 2, pl. 123, fig. O, enlarged to the same size as fig. 1c, to which it should be compared. This specimen was considered synonymous with <i>Globigerina bulloides</i> by d'Orbigny in 1826	3
3. <i>Globigerina megastoma</i> Earland 1934; lectotype, $\times 50$. Fig. 3a, ventral view; fig. 3b, dorsal view; fig. 3c, axial peripheral view. Specimen obtained by Earland from "Discovery" Station 385, Drake Straits at 3638 metres depth (Recent). Deposited in the British Museum (Natural History), registered No. 1959.5.11.740	14
4. <i>Globigerina bulloides</i> d'Orbigny 1826; A. d'Orbigny's model no. 76 ("adult individual") of the fourth instalment, 1823. Half natural size. Fig. 4a, dorsal view; fig. 4b, ventral view; fig. 4c, axial peripheral view	3



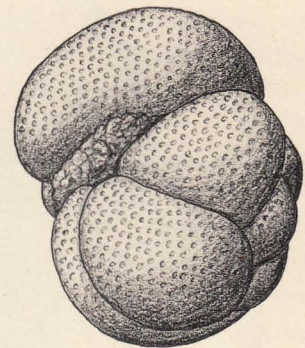
Banner and Blow: Primary Types, Globigerinaceae



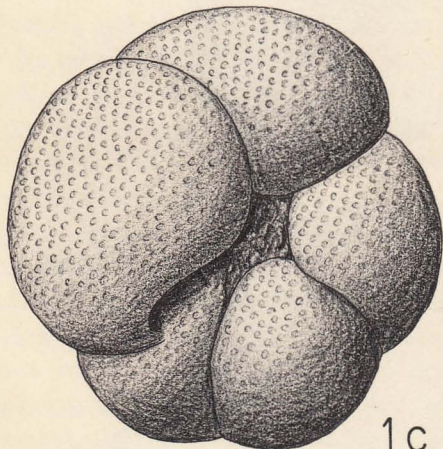
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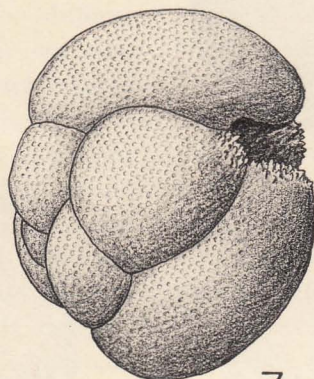
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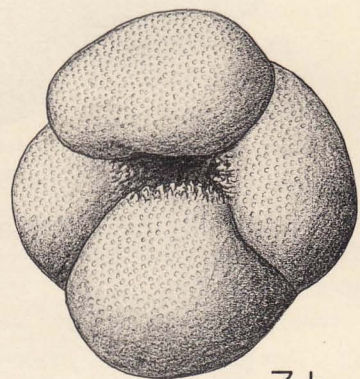
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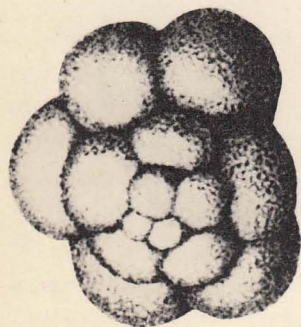
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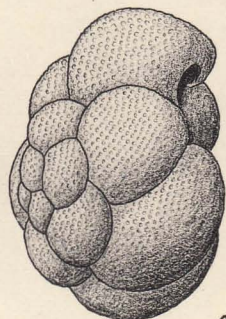
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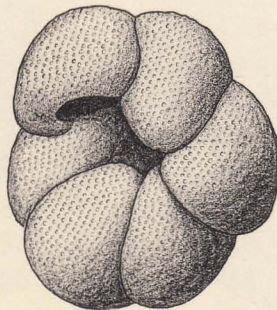
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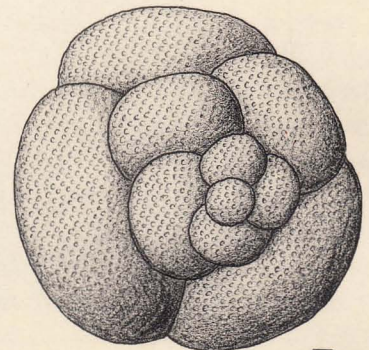
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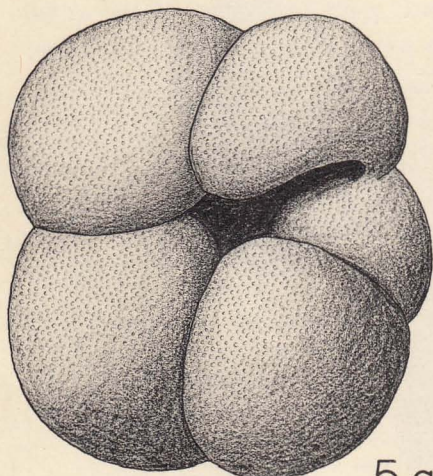
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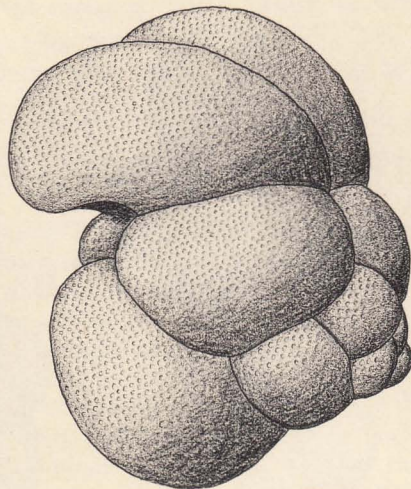
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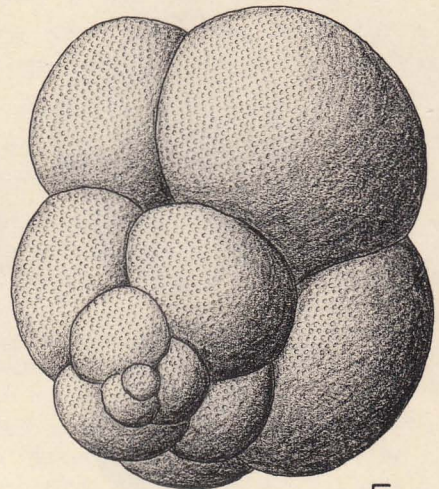
3c



5a



5b



5c

standing contributions to Micropalaeontology and his personal help to the present authors.

We would regretfully point out that, to the best of our knowledge, all the diverse forms hitherto recorded by authors as *Globigerina cretacea* d'Orbigny have been incorrectly assigned to the species (see Remarks below).

Description of lectotype.—The test is a low trochospire consisting of about 2½ whorls of inflated chambers. The dorsal surface is flattened and only slightly convex. The axial periphery is rounded and only very slightly if at all truncated. The equatorial profile is subcircular and the equatorial periphery is lobulate. The last whorl consists of five slowly and regularly enlarging, little embracing but inflated chambers, which are slightly compressed dorso-ventrally. The dorsal sutures are depressed, distinct, not thickened or limbate and the intercameral sutures are slightly curved. The ventral sutures are distinct, depressed and nearly radial; they are not thickened or limbate. The periphery of each chamber bears two weak, widely spaced carinae bordering the imperforate peripheral band. The dorsal carina does not appear to extend along the dorsal intercameral suture. The ventral carina on the last chamber is reflected along the apertural face but becomes weak and indistinct above the aperture; it is difficult to see the umbilical extension of the ventral carina on any chamber except the last formed. The umbilicus is broad and deep; the primary aperture opens into the umbilicus and is bordered by an asymmetric lip-like flap (porticus, see Banner and Blow, 1959). Relict parts of the primary apertures of the earlier chambers of the last whorl remain open into the umbilicus. The imperforate fragile tegillum, observed in the d'Orbigny collections as well as in our own topotypic specimens, is missing on the lectotype.

The wall is calcareous, apparently radial in structure, and is uniformly and finely perforate except for the imperforate area between the carinae. The surface of the test is hispid, the hispidity being greatest along the umbilical margins of the chambers. Maximum diameter of lectotype: 0.48 mm.

Remarks.—This species has been recorded by very many authors dating from Reuss in 1845 to the present day and our review of the literature shows that there is virtually no agreement between any of the authors as to the nature of the species. Over 100 references to this species are listed by Ellis and Messina (1940, et seq.) alone. Authors have ascribed forms to this species dating from the lowest Cretaceous to Recent (including forms taken *in vivo* from the recent seas, e. g., Brady 1884). Even within the Cretaceous faunas the identity of this species and its stratigraphic occurrence have been disputed; Weiss (1955, pp. 306-307) recorded a form which ranged Senonian to Danian; Brönnimann (1952, p. 14, text-fig. 3) recorded a totally different form from the Cenomanian to Senonian. Brönnimann (*op. cit.*, *loc. cit.*) lists many alleged American occurrences of this species with a variety of stratigraphic occurrences. As recently as 1959, Bolli (p. 270, pl. 22, figs. 8, 9) ascribed yet another species to *G. cretacea*, this time recording its range as Cenomanian to Coniacian. Examples such as this could be multiplied almost indefinitely and we believe that not one single record is correct; all these forms require new names and a clarification of their taxonomy is essential before their stratigraphic value can be ascertained. It is evident that much valuable stratigraphic information has already been lost by the lax usage of the name *G. cretacea* and the confused records that have resulted thereby. It is hoped that wherever possible present-

EXPLANATION OF PLATE 2

FIGS.	PAGE
1. <i>Globigerina dutertrei</i> d'Orbigny 1839; lectotype, × 100. Fig. 1a, dorsal view; fig. 1b, axial peripheral view; fig. 1c, ventral view. Specimen obtained by d'Orbigny from the recent beach sands of Cuba, and now deposited in the A. d'Orbigny Collection of the Muséum Nationale de l'Histoire Naturelle, Paris	11
2. <i>Globigerina rotundata</i> d'Orbigny 1898 [= <i>Globigerina dutertrei</i> d'Orbigny]; lectotype, × 100. Specimen obtained by d'Orbigny from the recent beach sands off St. Helena. Deposited in the A. d'Orbigny Collection of the Muséum Nationale de l'Histoire Naturelle, Paris	19
3. <i>Globigerina conglomerata</i> Schwager 1866; neotype, × 50. Fig. 3a, axial peripheral view; fig. 3b, ventral view, showing the spinosity of the umbilical parts of the chambers; fig. 3c, dorsal view. The specimen was obtained by Schwager from the Pliocene (?) of Kar Nikobar, and sent by him to Brady; it is now deposited in the British Museum (Natural History), and registered as no. P. 44031.	7
4. <i>Globigerina eggeri</i> Rhumbler 1901; lectotype, × 50. Fig. 4a, dorsal view, after Brady, 1884, pl. 79, fig. 17a, where it was described as " <i>Globigerina dubia</i> Egger"; fig. 4b, same specimen, axial peripheral view; fig. 4c, same specimen, ventral view. This is the specimen illustrated by Rhumbler, 1901, as text figure 20 (part). The specimen was obtained from "Challenger" station 300, north of Juan Fernandez, recent sea, at depth 1375 fathoms; now registered in the British Museum (Natural History) no. 1959.5.11.741	11
5. <i>Globigerina helicina</i> d'Orbigny 1826; lectotype, × 100. Fig. 5a, ventral view; fig. 5b, axial peripheral view; fig. 5c, dorsal view. Specimen obtained by d'Orbigny from the recent deposits of the Adriatic Sea, near Rimini, and now deposited in the A. d'Orbigny Collection, Muséum Nationale de l'Histoire Naturelle, Paris (cf. pl. 3, figs. 6 and 7)	13

day workers will reconsider their records of *G. cretacea* d'Orbigny 1840 and will rename their forms which are now obviously not referable to d'Orbigny's species.

With the evidence available to us we consider that *Globotruncana cretacea* (d'Orbigny) is limited in range from the Coniacian to Campanian, with the possibility of its occurrence in the highest Turonian. It is also possible that typical forms with the weak carinae do not occur above the Lower Campanian.

***Globigerina cristata* Heron-Allen and Earland, 1929**
Plate 7, figure 5

Globigerina cristata HERON-ALLEN and EARLAND, 1929 (part), Roy. Micr. Soc. Jour., London, Ser. 3, vol. 49, pt. 4, art. 27, p. 331, pl. 4, figs. 37-39, ?33-36. [Lectotype here designated].

Taxonomic remarks.—This species was first described from recent material dredged off Possession Island, S. W. Africa, (latitude 26° 17' 40" S, longitude 14° 26' 28" E) by the "Discovery" Expedition of 1925-1927. The lectotype of *Globigerina cristata*, here designated, came from a slide registered in the British Museum (Natural History) as ZF.3276; this slide was marked with full details of the locality mentioned above. The lectotype is deposited in the British Museum (Natural History), registered number 1959.7.1.3. It is possible that two minute but distinct species were included under this name by Heron-Allen and Earland, but it appears that neither has been recorded by any subsequent author.

Description of lectotype.—The minute test consists of about two whorls of slowly enlarging chambers, arranged six to a whorl in a very low trochospire. The chambers are globular to subovoid with a tendency to be slightly radially elongate. The chambers are equally inflated dorsally and ventrally and are but slightly embracing. The equatorial profile is subcircular, and the equatorial periphery is lobulate. The axial periphery is smoothly rounded and the test appears nearly parallel sided. The final chamber is bulla-like and extends from its normal position to cover the umbilicus, and it possesses simple tube-like prolongations extending along the intercameral sutures of the ventral side. The apertures of the final chamber open at the distal ends of the tube-like prolongations and are in line with the intercameral sutures of the final whorl. The intercameral sutures are distinctly and equally depressed both dorsally and ventrally; they are sinuous, slightly curved or nearly radial, and are not thickened or limbate. The wall is finely perforate. On all the chambers, except the last, the surface is finely hispid, but the hispidity becomes markedly stronger at the distal ends of the more elongate chambers. The final chamber is smooth. Maximum diameter of lectotype: 0.145 mm.

Remarks.—A great many specimens were present in

the Heron-Allen and Earland collection and it was observed that the peculiar form of the last chamber described for the lectotype appeared to be a normal character for adult specimens of this species. In what appeared to be immature or damaged specimens the primary aperture of the last present chamber was seen to be a low, elongate, interiomarginal, umbilical-extra-umbilical, slit-like opening. The peculiar final chamber seems remarkably constant in general shape and position and is similar to that described by Loeblich and Tappan (1957) for the distinct species *Globigerinita parkerae*. The species *cristata* may be referable to the genus *Globigerinita* Brönnimann 1951, as emended by Loeblich and Tappan 1957, but we discuss this further below (p. 37). This species has only been observed so far in collections from the recent seas.

***Globigerina depressa* d'Orbigny, 1903**
Plate 5, figures 6a-c

- Globigerina depressa* d'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat. vol. 7, p. 277, list No. 9 [*nomen nudum*].
not *Globigerina depressa* EHRENBURG, 1844, K. Preuss. Akad. Wiss. Berlin, Ber. Berlin, p. 92, (no figures).
not *Globigerina depressa* Ehrenberg, EHRENBURG, 1854, Mikrogeologie, Leopold Voss, Leipzig, pl. 19, fig. 92.
not *Globigerina cretacea* d'Orbigny var. *depressa* SILVESTRI, 1898, Accad. Pont. Nuovi Lincei, Mem., Rome, vol. 15, p. 259, pl. 5, fig. 3a-c.
Globigerina depressa d'ORBIGNY, in FORNASINI (given as *Globigerina? depressa*), 1903, R. Accad. Sci. Ist., Bologna, Rend., Bologna, vol. 17, n. s., p. 140, pl. 1, figs. 3, 3a-b, (after d'Orbigny, "disegni inediti").

Taxonomic remarks.—As the species *Globigerina depressa* d'Orbigny was without any taxonomic status in 1826, the first valid use of the name "*Globigerina depressa*" was that by Ehrenberg (1844) for a species he described from the chalk of Greece. No reference was made by Ehrenberg to the work of d'Orbigny and the species *G. depressa* Ehrenberg 1844 was clearly new and is nominally valid. We are informed by Mr. R. V. Melville (Assistant Secretary to the I.C.Z.N.) that d'Orbigny's name had no status, even under the rules of homonymy. In 1903, Fornasini published a copy of d'Orbigny's previously unpublished drawing of *G. depressa* d'Orbigny and d'Orbigny's species dates from this year. *G. depressa* d'Orbigny 1903 is therefore clearly a junior homonym of *Globigerina depressa* Ehrenberg 1844.

In 1826, d'Orbigny stated nothing about the geographical provenance of his form but a single remaining specimen labelled "*Globigerina depressa* d'Orbigny, (vivante), Ste. Hélène" is extant in the Alcide d'Orbigny collections in Paris. It is here illustrated (pl. 5, figs. 6a-c) for the sake of general interest and

completeness of the record. It is considered that the form here illustrated is conspecific with *Globorotalia scitula* (Brady) (see p. 27, pl. 5, figs. 5a-c) but may be subspecifically distinct from Brady's type. This can only be fully decided when the range of variation of the form becomes better known and more specimens are found. Accordingly no new name is proposed for d'Orbigny's homonym.

***Globigerina dutertrei* d'Orbigny, 1839**

Plate 2, figure 1

Globigerina dutertrei d'ORBIGNY, 1839, in de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, Bertrand, Paris, p. 84, (plates published separately, vol. 8, pl. 4, figs. 19-21) [lectotype here designated].

?*Globigerina dutertrei* d'Orbigny, BRADY, 1884, Rept., Voy. Challenger, Zool., vol. 9, pt. 22, p. 601, pl. 81, figs. 1a-c.

Taxonomic remarks.—This species was first described by d'Orbigny from recent marine sands of Cuba, Martinique and Guadeloupe. A tube originally containing eight specimens was found in the d'Orbigny collection. This tube had d'Orbigny's original label pasted on the back of the mount and bore the following inscription in d'Orbigny's handwriting:

IV
19-21
Globigerina
Dutertrei

The locality and bibliographic numerals (probably in Terquem's handwriting) were inscribed on the front of the mount:

Cuba: TYPE
84. IV. 19. 21

Of the eight specimens originally present, one was completely lost, five were merely fragmentary, and one was broken but still recognisable; the single remaining undamaged specimen, here figured, was therefore isolated and is designated here as lectotype.

The specimen illustrated by Brady (1884) probably belongs to this species but the last chamber is misshapen and is misplaced in the progression of the spire. However, except for this abortive last chamber, Brady's form agrees in general characters with the lectotype.

The form ascribed by Ovey (*in* Wiseman and Ovey, 1950, p. 65, pl. 2, figs. 1a-c) to this species is referable to a *Globorotalia* (*Turborotalia*) and is probably conspecific with the form described by Blow (1959) as *G. (T.) acostaensis*.

Description of lectotype.—The globose test consists of about 13 chambers arranged in a fairly high, tightly coiled trochospire of about three whorls. There are about four chambers in the early whorls increasing to five chambers in the ultimate whorl. The equatorial profile is subcircular and the equatorial periphery

weakly lobulate. The axial profile is broadly rounded, with the dorsal side moderately convex. The axial periphery is smoothly rounded. The chambers are appressed, inflated, moderately embracing, reniform in dorsal aspect and ovoid in axial view. All the dorsal and ventral sutures are distinct and moderately depressed. The intercameral sutures are slightly curved to nearly radial both ventrally and dorsally, and the spiral suture is lobulate. The umbilicus is well marked, moderately broad and probably deep (infilled in the lectotype). The aperture is an interiomarginal, umbilical arch leading directly into the umbilicus. No apertural lip or rim is visible on the lectotype. The wall is moderately and uniformly perforate and has a practically smooth surface. Maximum diameter of lectotype: 0.48 mm.

Remarks.—This species is referable to the genus *Globigerina* d'Orbigny as restricted by Banner and Blow (1959). No supplementary apertures are present and the aperture is purely umbilical, notwithstanding the slightly abortive nature of the final chamber in the lectotype. This species has been observed by us in the Pleistocene of S. E. Sicily and in the sub-recent deposits off the coast of Nigeria as well as in recent material collected by the "Discovery" and the "Challenger" Expeditions.

***Globigerina eggeri* Rhumbler, 1901**

Plate 2, figure 4

Globigerina dubia Egger, BRADY, 1879, Quart. Jour. Micr. Sci., vol. 19, (n. s.) p. 285 (*not* Egger 1847, *teste* Rhumbler 1901).

Globigerina dubia Egger, BRADY, 1884, Rept. Voy. Challenger, Zool. vol. 9, pt. 22, p. 595, pl. 79, figs. 17a-c (*not* Egger 1857, *teste* Rhumbler 1901).

Globigerina dubia Egger, FLINT, 1899, U. S. Nat. Mus., Ann. Rept., 1897, Washington, D. C., pt. 1, p. 322, pl. 69, fig. 4, (*not* Egger 1857, *teste* Rhumbler 1901).

Globigerina eggeri RHUMBLER, 1901, in Brandt, Nordisches Plankton, Lipsius und Tischer, Kiel, Lief. 1, Nr. 14, p. 19-20, text-fig. 20, (after Brady 1884, pl. 79, figs. 17a-c) [lectotype here designated].

Globigerina dubia Egger, OVEY, in WISEMAN and OVEY, 1950, Proc. Geol. Assoc., vol. 61, pp. 67-68, pl. 3, figs. 10a-b, (*not* Egger 1857).

Globigerina eggeri Rhumbler, PHLEGER, PARKER and PEIRSON, 1953, Rept., Swedish Deep-Sea Exped., vol. 7, no. 1, p. 12, pl. 1, figs. 11-12.

Taxonomic remarks.—Egger, in 1857, described *Globigerina dubia* from the Miocene of Germany; this species appears to be a moderately high spired form with a small and almost closed umbilicus. In 1901, Rhumbler realised that forms obtained from recent seas and referred to "*dubia*" by Brady (1884) and Flint (1899) were distinct from Egger's species; as Rhumbler stated, they are larger, with thicker and

rougher walls and with a broader umbilicus in which the relict parts of many of the primary apertures of the last whorl can be observed. In consequence, he proposed as new the species *Globigerina eggeri* putting Brady's "Challenger" specimens in full synonymy and illustrating his description with a reproduction of Brady's illustrations.

Although Brady referred to his illustrations (1884, pl. 79, figs. 17a-c) as being of "a bottom specimen" (note the use of the singular) our studies of Brady's material have disclosed that actually three separate and different specimens were drawn by Brady's artist, A. T. Hollick. The slide (Challenger Collection B. M. (N. H.) Registered No. ZF.1482 from Challenger Station 300, depth 1375 fathoms, North of Juan Fernandez) contained six specimens; it was marked in Brady's handwriting as "fig. 17." Amongst these specimens, one had a broken dorsal side but its umbilical view agreed with that illustrated by Brady (1884) as fig. 17b. The specimen illustrated as fig. 17a is characterised by an irregular series of chambers in the penultimate whorl and was also present in this slide ZF.1482. No specimen could be found which clearly matched Brady's figure 17c. Dr. C. G. Adams and Miss C. Underwood agreed with us in these identifications; consequently, the specimen illustrated by Brady (1884) as figure 17a (not figures 17b and 17c) has been isolated and re-registered in the British Museum (Natural History) as specimen number 1959.5.11.741.

The three specimens illustrated by Brady and referred to by Rhumbler (1901) stand as syntypes of the species *Globigerina eggeri* Rhumbler. Rhumbler designated no type locality for his species, stating that it occurred in the North and South Atlantic and also in the North and South Pacific oceans from 56° N. to 46° S. latitude. Brady (1884) mentioned no specific locality for his specimens, but the specimen we have isolated falls within the geographical limits recorded by Rhumbler. This isolated specimen (1959.5.11.741) is hereby designated the lectotype of *Globigerina eggeri* Rhumbler 1901.

Description of lectotype.—The fairly large test is composed of about 14 chambers arranged in about 2½ whorls in a moderately high and fairly loosely coiled trochospire. There are about five chambers in the initial whorl increasing to six in the ultimate whorl. The equatorial profile is subcircular and the equatorial periphery is moderately lobulate. The axial profile is broadly rounded with the dorsal side being distinctly convex. The axial periphery is smoothly and broadly rounded. The chambers are inflated, moderately embracing, reniform to hemispherical in dorsal aspect and rounded ovoid in axial view. The chambers are not greatly appressed. The dorsal and ventral intercameral sutures are distinctly depressed and nearly radial. The spiral suture is also depressed, and

is broadly and evenly lobulate. The umbilicus is moderately broad, probably very deep (the umbilicus is infilled in the lectotype). The aperture is an interiomarginal, umbilical, fairly high arch leading directly into the umbilicus; no apertural lip or rim is visible on the lectotype. The wall is fairly thick, distinctly, fairly coarsely and uniformly perforate. The surface of the test is cancellate and was apparently uniformly and finely hispid. Maximum diameter of lectotype: 0.67 mm.

Remarks.—This species is distinguished from *Globigerina dutertrei* d'Orbigny by its consistently larger test in the adult with more numerous and less appressed chambers in the last whorl. In dorsal aspect the chambers of *G. eggeri* are circumferentially shorter relative to their radial breadth than are the dorsal sides of the chambers in *G. dutertrei*. The surface of the test in *G. eggeri* is more distinctly cancellate, more coarsely perforate and rougher than in d'Orbigny's species. The dorso-peripheral shoulder is less marked in *G. eggeri* than in *G. dutertrei*. This form is known to us in collections from the recent seas and from sub-recent deposits off the coast of Nigeria. It may occur in the Pleistocene but there are no definite records of this form in the Pliocene.

Globigerina elongata d'Orbigny, 1826

Plate 3, figures 10a-c

[?] "*Polymorphium tuberosum et globiferum*" (teste d'Orbigny, recte "*polym. Tuberosa* & *Globuliferae*") SOLDANI, 1791, Testaceographiae ac Zoophytographiae, vol. 1, pt. 2, p. 117, tab. 123, fig. K (not figs. H, I, J, L, M, N, O, P).

Globigerina elongata d'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., ser. 1, vol. 7, p. 277, list no. 4 (no figures) [lectotype here designated].

Globigerina elongata d'ORBIGNY, in FORNASINI, 1899, Palaeontogr. Italica, vol. 4, p. 207, fig. 1, (after d'Orbigny, "disegno inedito").

Globigerinoides elongata (d'Orbigny), CUSHMAN, 1941, Contr. Cushman Lab. Foram. Res., vol. 17, p. 40, pl. 10, figs. 20-23, pl. 11, fig. 3.

?*Globigerinoides elongatus* (d'Orbigny), A. G. I. P. MINERARIA Auct., 1957, Foraminiferi Padani, Milan, pl. 46, figs. 2d, 2v.

Taxonomic remarks.—D'Orbigny, in 1826, named as new *Globigerina elongata*, giving no description or illustration but merely referring to a figure in the non-Linneian work of Soldani (1791). We consider that this figure (copied here) is not recognisable with certainty but may be referable to the genus *Bulimina*. However, as all the specimens determined by d'Orbigny as *Globigerina elongata* up to the time of first publication of this name can be regarded as syntypic (R. V. Melville, *verb.*), we were able to select, from the series of 14 specimens obtained by d'Orbigny from the vicin-

ity of Rimini (a syntypic locality) and preserved in the Muséum National de l'Histoire Naturelle, Paris, a specimen which is here illustrated and designated as lectotype of *Globigerina elongata* d'Orbigny 1826 (pl. 3, figs. 10a-c).

We have been careful to ascertain from the Assistant Secretary to the International Commission on Zoological Nomenclature (Mr. R. V. Melville) that, although the publication of the name *G. elongata* in 1826 is valid only insofar as it refers to a Soldani specimen, as no type specimen was selected by d'Orbigny, the Soldani specimen is merely syntypic and has a rank no greater than d'Orbigny's own identified specimens of that time. Whether or not the forms involved are actually conspecific (or even congeneric) matters only to the extent that d'Orbigny considered them so. Consequently, we selected from d'Orbigny's syntypic series the specimen which matched as closely as possible that drawn under this name in the "Planches Inédites" of d'Orbigny which were actually drawn prior to 1826 (*vide* M. Lys, 1950) but not published until 1899 by Fornasini.

The lectotype is now isolated in a single-celled slide and remains in the A. d'Orbigny collections in Paris.

Description of lectotype.—The sub-tetrahedroid test consists of about ten chambers arranged in a high, tightly coiled trochospire of about three whorls. There are three chambers visible in each of the whorls. The equatorial profile is sub-triangular to subquadrate; the equatorial periphery is weakly lobate. The axial profile resembles a rounded and truncated cone; the axial periphery is rounded. In dorsal view, the chambers are reniform to sub-rectangular and are distinctly longer tangentially than they are broad radially. In ventral (umbilical) view the chambers are ovoid to sub-rectangular. The chambers are both laterally compressed and depressed, and are weakly inflated and moderately embracing. The sutures are distinct but only slightly depressed. The umbilicus is virtually closed and is very shallow. The apertures are multiple; the primary aperture is a large, almost completely circular opening, with an indistinct and slightly thickened rim, situated immediately above the penultimate intercameral suture. The dorsal supplementary apertures are small but strongly arched openings and are situated in the spiral suture at its junction with the intercameral sutures. Only one supplementary aperture is visible in each chamber. The wall is thick and is uniformly and coarsely perforate. The surface of the test is strongly cancellate and rough. Maximum diameter of lectotype: 0.36 mm.

Remarks.—This species is referable to the genus *Globigerinoides* Cushman 1927 as restricted by Bolli, Loeblich and Tappan 1957 (see also Banner and Blow, 1959). The species *G. elongatus* d'Orbigny is considered here to be quite distinct from *Globigerinoides ruber* both in morphology and stratigraphic

occurrence. The distinctions between this form and *G. ruber* are discussed under the latter species.

It is considered that the height of the spire can vary considerably in *G. elongatus* and this feature does not seem to be of either taxonomic or stratigraphic value. The biocharacters of importance are believed to be the high but equidimensional primary aperture, the shape and position of the supplementary apertures, the tightly coiled and relatively uninflated chambers and the characteristically thick and rough wall.

G. elongatus shows some resemblances to the form described by Bolli as *Globigerinoides diminutus* (Bolli, 1957) but the latter has more embracing chambers and a more circular axial and equatorial profile, as well as a smaller, more semicircular primary aperture. *G. diminutus* Bolli has a very restricted range within the Aquitanian (Lower Miocene). Forms which have been referred to this species have been recorded from the Burdigalian (Todd, 1957) but it is doubtful whether Todd's form is strictly synonymous.

A. G. I. P. Mineraria (1957) have recorded *G. elongatus* from the Tortonian to Quaternary and their illustrated specimen from the Pliocene is agreed to belong to this species. We ourselves have observed this species throughout the Pliocene and Pleistocene of Sicily as well as in the Recent. It is possible that some of the stratigraphically older records may refer either to *Globigerinoides ruber* d'Orbigny or *Globigerinoides subquadratus* Brönnimann 1954.

Globigerina helicina d'Orbigny, 1826

Plate 2, figure 5

? "*Polymorphium globuliferum*" (*teste* d'Orbigny 1826; *recte* "*Testas globiferas*") SOLDANI, 1791, *Testaceographiae ac Zoophytographiae*, vol. 1, pt. 2, p. 119, (? *not* p. 118), pl. 130, figs. qq, rr, ? pp.

Globigerina helicina D'ORBIGNY, 1826, *Tableau Méthodique de la classe des Céphalopodes*, *Ann. Sci. Nat.*, vol. 7, p. 277, list no. 5 (no figures) [lectotype here designated].

Globigerina helicina D'ORBIGNY, *in* FORNASINI, 1898, *Pal. Italica*, Mem., Pal., vol. 4, p. 209, Text-fig. 4, (after d'Orbigny, "disegno inedito").

? *Globigerina adriatica* FORNASINI, 1899, (part), *R. Accad. Sci. Inst., Bologna*, ser. 5, vol. 7, p. 582, pl. 3, ? fig. 7, (*not* fig. 6).

Taxonomic remarks.—In 1826, d'Orbigny proposed the name *Globigerina helicina* for specimens he had obtained from the Adriatic Sea near Rimini. He neither described nor illustrated his species but merely referred to three forms illustrated by Soldani (1791). Of the three Soldani drawings only two (*qq* and *rr*) were unequivocally referred by d'Orbigny to his species; Soldani's figure "*rr*" is completely unrecognisable but his figure "*qq*" (here copied) has a recognisable affinity to a form, here considered abortive, which is related to *Globigerinoides ruber* (see p. 19). Brady

was well aware of this Soldani illustration since he, together with Parker and Jones, reproduced it in 1871 (Ann. Mag. Nat. Hist., ser. 4, vol. 8, pl. 11, figure 113). Brady (1884) subsequently referred specimens from the Challenger Collection to *Globigerina helicina* d'Orbigny having based his determinations upon Soldani's figure "qq" (*op. cit.*, p. 605). Brady also believed it to be a "monstrous or abnormal development," most resembling "an ordinary small Globigerine shell of the "rubra" type, with the addition of an inflated chamber at two opposite points of its periphery." We fully agree with this having seen Brady's specimens (which he illustrated) and having ourselves noted that the early whorls have the identical and typical red-colouration of *G. rubra* (Brady's (1884) illustration, pl. 81, fig. 4, is reproduced; and the other view of this specimen is figured here for the first time (see pl. 3, figs. 7a-c)).

When Fornasini (1898) published d'Orbigny's original (circa 1823-5) drawing of *G. helicina*, he pointed out that d'Orbigny's specimen did not match either the Soldani illustration or Brady's subsequent determination. Fornasini considered it preferable to retain the name "*helicina*" for the form illustrated by Soldani and Brady; subsequently, in 1899, he proposed the new species *Globigerina adriatica* for specimens which he believed matched d'Orbigny's drawing. In the Alcide d'Orbigny collections deposited in the Muséum National de l'Histoire Naturelle, Paris, one single specimen only exists bearing the name *Globigerina helicina* d'Orbigny. It was obtained from a locality (recorded on the mount) as "Subapennin, Rimini," and it may be seen from our illustration of this single remaining specimen that it agrees quite well with d'Orbigny's drawing of the species. The specimen illustrated here is clearly syntypic, having been mounted by Terquem from d'Orbigny's Rimini material. As far as is known, d'Orbigny never subsequently altered his determined Rimini material after 1826; indeed it is highly likely that the d'Orbigny material lay undisturbed until re-examined by Terquem.

This specimen, here illustrated, is therefore here designated as the lectotype of *Globigerina helicina* d'Orbigny.

The abortive form figured by Soldani (*op. cit.*, *loc. cit.*) had, prior to this designation of lectotype, syntypic status equal to, but not greater than, that of the syntypes collected by d'Orbigny. All these specimens were nominally available for lectotypic selection (see also the taxonomic remarks under *Globigerina elongata*, p. 12).

Although Fornasini (1899) placed the specimen illustrated by d'Orbigny (Planches Inédites) in full synonymy with *Globigerina adriatica* we believe the d'Orbigny specimen to have been conspecific with our lectotype and distinct from Fornasini's specimen illustrated as "plate 3, figure 6" (*loc. cit.*). However, the

illustration by Fornasini of his species "*adriatica*" on pl. 3, figure 7, is possibly conspecific with the lectotype of *Globigerina helicina* d'Orbigny.

Description of lectotype.—The fairly large test consists of about 13 chambers arranged in a high, fairly tightly coiled trochospire of about three whorls. There are about four chambers in the initial whorl and about 4½ in the final whorl, the final chamber being much reduced in size and misshapen, although it follows the normal progression of chambers in the spire. The equatorial profile is subcircular and the equatorial periphery is moderately lobulate. The axial profile is subconical with a broadly and smoothly rounded axial periphery. The chambers are inflated, sub-globular, moderately embracing, and are broadly reniform in dorsal aspect. The dorsal and ventral intercameral sutures are distinctly depressed and are nearly radial in ventral and dorsal aspects. The spiral suture is equally depressed and is broadly lobulate. The umbilicus is small relative to the size of the test. The primary aperture of the penultimate chamber (the last normal chamber) appears to be a moderately low interiomarginal umbilical arch leading directly into the umbilicus; no apertural rim or lip is visible on the lectotype. The primary aperture of the abnormal final chamber is a fairly long low arch, mainly umbilical in position.

The wall is distinctly, fairly finely and uniformly perforate. The surface of the test is faintly hispid. Maximum diameter of lectotype: 0.52 mm.

Remarks.—In the d'Orbigny drawing, which was first published by Fornasini in 1898, the final aperture in axial peripheral view is clearly umbilical and is now seen to be correct. However, in the umbilical (ventral) view the aperture is shown to be extraumbilical; this may have been occasioned by the fact that an abnormal final chamber was present (but not clearly indicated) in d'Orbigny's original specimen. Indeed it is possible that the lectotype, here figured, pl. 2, fig. 5, is actually the same specimen as that sketched by d'Orbigny. It should be remembered that some of these "Planches Inédites" were merely preliminary sketches by d'Orbigny. There is a considerable difference in standard between what are obviously d'Orbigny's preliminary sketches and his finished drawings, which were of a very high standard (see Lys, 1950, pls. 1, 2 and 3). No supplementary dorsal sutural apertures are present and the species is therefore correctly referred to the genus *Globigerina* d'Orbigny.

The species is only known to us in collections from the recent seas and we have not observed it fossil.

Globigerina megastoma Earland, 1934

Plate 1, figure 3

Globigerina megastoma EARLAND, 1934, Foraminifera; Pt. III — The Falklands sector of the Antarctic (excluding South Georgia); in: "Discovery" Re-

ports, issued by the "Discovery" Committee, Colonial Office, London. Cambridge University Press. Vol. 10, (1935), p. 177, pl. 8, fig. 9 [lectotype here designated], figs. 10-12.

Taxonomic remarks.—In addition to very many small specimens of this species present in the Heron-Allen and Earland collections in the British Museum (Natural History), London, the four syntypes which were illustrated by Earland are also preserved. The four illustrated syntypes came from "Discovery" Station 385 (Drake Straits) from 3638 metres depth and were preserved on a slide registered as ZF.3279 in the British Museum (Natural History). The lectotype, here designated and illustrated (pl. 1, fig. 3), was removed from this slide and is now registered as number 1959.5.11.740 in the British Museum (Natural History) records.

Description of lectotype.—The fairly large test is composed of about eleven chambers arranged in about 2½ whorls comprising a high and loosely coiled trochospire. There are four rapidly and uniformly enlarging, inflated chambers in each whorl. The equatorial profile is sub-circular and the test has a very strongly lobulate equatorial periphery. The axial profile is sub-conical with a smoothly lobulate axial periphery. The chambers are sub-globular, well separated, and only slightly embracing. The last chamber especially shows slight elongation in a direction oblique to the axis of coiling. All the sutures are strongly depressed and deeply and broadly incised. The umbilicus is moderately broad and very deep and the relict parts of the earlier primary apertures are clearly visible within it. The primary aperture of the last chamber is interiomarginal, umbilical, extending the full width of the umbilicus, but it is only half as high as the smoothly convex apertural face. The aperture possesses a well developed, apparently perforate, symmetrical lip along its length. The wall is thin, uniformly and finely perforate. The surface is smooth and the test often appears translucent. Maximum diameter of lectotype: 0.63 mm.

Remarks.—Earland's specimens varied considerably in size and the lectotype was chosen from the four largest specimens present in the collection which was illustrated by Earland (*loc. cit.*). Earland's illustrations tend to make the species appear far more hispid and coarsely perforate than is actually the case. Smaller and probably immature specimens tend to show the oblique elongation of the chambers more noticeably, and the form illustrated by Bé (1959, pl. 1, figs. 15-17) is very similar to those in the Earland collection. We are of the opinion that Bé's *Globigerina bulloides* (*op. cit.*, *loc. cit.*) is in fact *Globigerina megastoma*. However, the possibility also exists that the model no. 17 ("young form") of *Globigerina bulloides* issued in 1823 by d'Orbigny may also be referable to this species.

G. megastoma, although congeneric with *G. bulloides*, differs from the latter by possessing a very thin wall, a smaller umbilicus, a higher spire, more elongate and better separated chambers and an exceedingly well developed apertural lip.

This species has only been seen by us in collections from the recent seas and we have not observed it fossil.

Globigerina punctulata Deshayes, 1832

Plate 5, figures 7a-c

Globigerina punctulata D'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., vol. 7, p. 277, list no. 8, [*nomen nudum*].

Globigerina punctulata "d'Orbigny," nobis, DESHAYES, 1832, Encyclopédie Méthodique; Histoire naturelle des vers, Mme. v. Agasse, vol. 2, pt. 2, p. 170, (no figures) [lectotype here designated].

Globigerina punctulata D'ORBIGNY (*sic.*), in FORNASINI, 1898 (1899), Pal. Italica, vol. 4, p. 210, text-fig. 5 (after d'Orbigny, "figure inédite"), [lectotype here designated].

Taxonomic remarks.—When d'Orbigny (1826) published the name *Globigerina punctulata* he gave no indication of the nature of the species nor did he give any definition or description. Consequently, that publication of the name has no taxonomic status whatsoever. By Art. 21 of the "Règles Internationales de la Nomenclature Zoologique," 1905 (1953), the first author of a species name is that person who first publishes the name in connection with such an indication, definition or description provided that these indications are clearly the work of the author in question. The first description applicable to the species here described was that given by Deshayes in 1832 who considered it new and used the term "*nobis*." We have carefully checked as much as possible of the original first editions of the literature of the period concerned in order to confirm this. Although Deshayes (1832, p. 170) was clearly referring to d'Orbigny's species (he referred to "no. 8" of the list given in d'Orbigny 1826 under the heading *Globigerina*), his spelling of the name *Globigerina punctulata* is the first and only valid spelling, and it must supplant the version "*punctulata*" invalidly proposed by d'Orbigny in 1826.

Deshayes (*loc. cit.*) obtained his specimens from Rimini and the d'Orbigny specimens must also be considered syntypic because of the reference by Deshayes to d'Orbigny's list number (i. e., *G. punctulata*) (R. V. Melville *verb.*).

A slide which originally contained seven specimens, all labelled "*Globigerina punctulata* d'Orbigny (Subapennin) Rimini," is preserved in the Alcide d'Orbigny collections, Paris; only two of these seven specimens are well preserved and one of these (here illustrated and described, pl. 5, fig. 7) is here designated the lectotype of *Globigerina punctulata* Deshayes 1832.

As the name *Globigerina punctulata* d'Orbigny be-

came nominally valid with the first publication of d'Orbigny's drawing by Fornasini in 1899 and in order to avoid further taxonomic confusion we hereby designate that specimen which is here designated the lectotype of *G. puncticulata* Deshayes 1832 to be also the lectotype of *Globigerina punctulata* d'Orbigny 1899. Therefore *Globigerina punctulata* d'Orbigny 1899 becomes an absolute and objective junior synonym of *Globigerina puncticulata* Deshayes 1832.

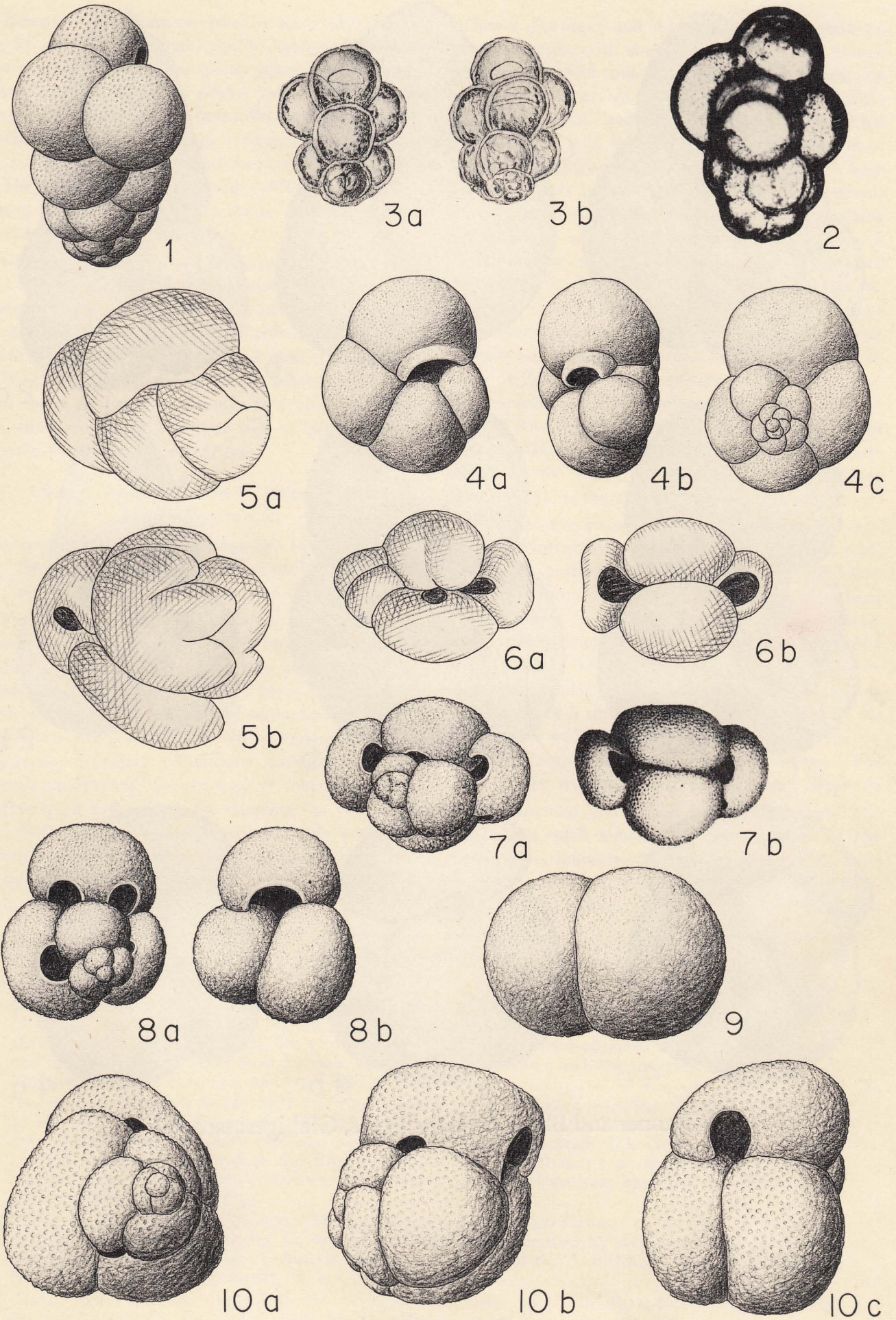
We would like to especially thank Mr. R. V. Melville (Assistant Secretary to the I.C.Z.N.) for his verbal help in clarifying the complicated taxonomy involved in this particular case.

Description of lectotype.—The test is composed of about 12 chambers comprising about 2½ whorls arranged in a fairly tightly coiled and low trochospire. There are about four slowly enlarging chambers in each whorl and those in the last whorl increase somewhat irregularly in size. The equatorial profile is sub-circular and the test has a slightly lobulate equatorial periphery. The axial profile is sub-ovate with the ventral side only slightly more convex than the dorsal side; the axial periphery is smoothly but narrowly

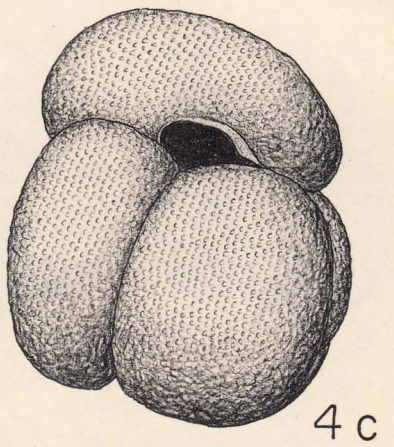
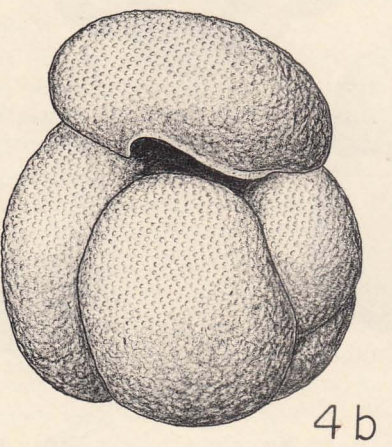
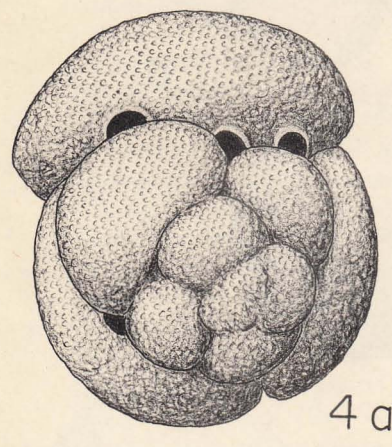
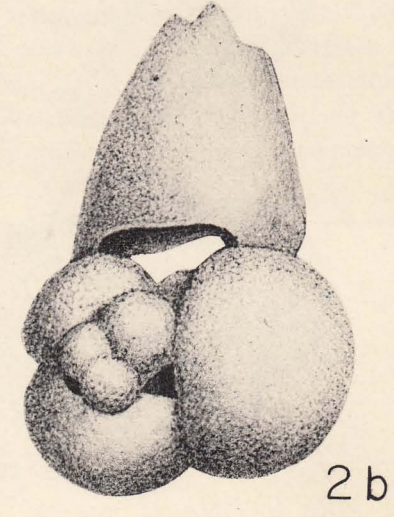
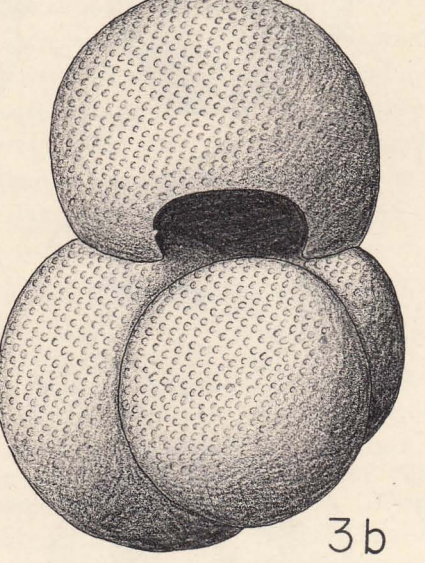
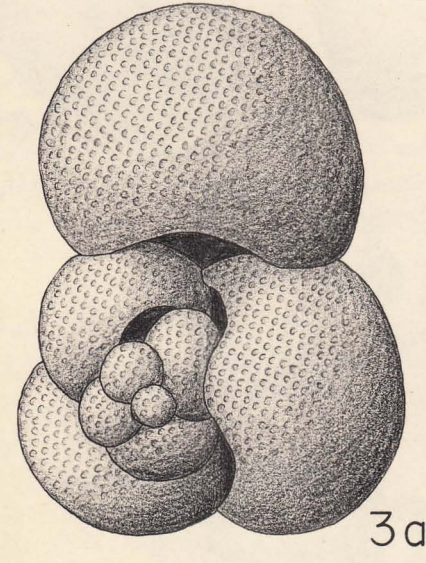
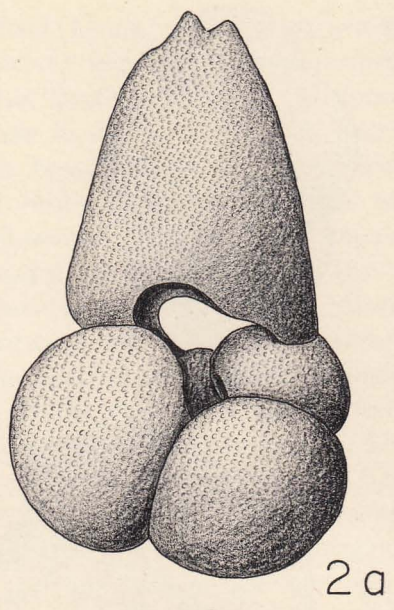
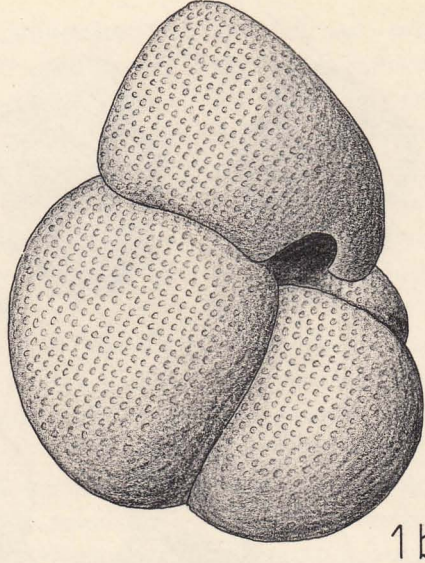
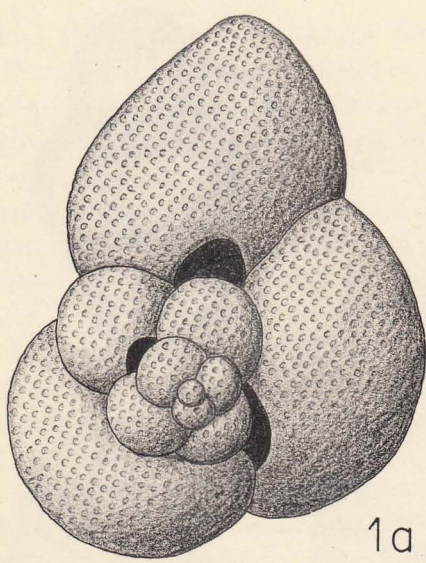
rounded; no peripheral carina nor any peripheral thickening (pseudocarina) is present. The chambers are little inflated and partly embracing; in dorsal aspect they are lunate in shape, being much longer circumferentially than broad radially, a feature which becomes accentuated during ontogeny. The dorsal sutures are slightly and narrowly depressed, the amount of depression increasing in ontogeny; the spiral suture is only slightly lobulate, almost a smooth curve, whilst the dorsal intercameral sutures are strongly recurved, meeting the spiral suture at an acute angle. The ventral sutures of the final whorl are narrowly and very weakly depressed and nearly radial. The umbilicus is closed with no marked depression. The primary aperture is interiomarginal, umbilical-extra-umbilical, a fairly high arch which is set into a slightly concave part of the apertural face; no apertural lip or rim is visible on the lectotype. The wall is fairly thick, finely and uniformly perforate. The ventral surface of the first chamber of the last whorl, facing the terminal aperture, is heavily pustulose; the remainder of the surface of the test is smooth. Maximum diameter of lectotype: 0.44 mm.

EXPLANATION OF PLATE 3

FIGS.	PAGE
1. <i>Globigerina bradyi</i> Wiesner, 1931; lectotype, × 160. The specimen from "Challenger" station No. 144, depth 1570 fathoms (Southern Ocean), figured by Brady, 1884, pl. 82, fig. 8, as <i>Globigerina</i> sp., and named by Wiesner, 1931. British Museum (Natural History) registered no. 1959.5.11.738	5
2. <i>Globigerina bradyi</i> Wiesner 1931; topotype, × 168. The specimen, from "Challenger" station no. 144, depth 1570 fathoms, has been mounted in Canada Balsam, and this photograph was taken in transmitted light. Specimen registered in the British Museum (Natural History) as no. 1959.5.5.359	5
3. <i>Pyloedxia uvula</i> Ehrenberg 1861; after Ehrenberg 1873, pl. 2, figs. 24 (3a) and 25 (3b), × 150. Ehrenberg's specimens were probably mounted in Canada Balsam and drawn when viewed in transmitted light; comparison with fig. 2, shows that <i>Globigerina uvula</i> (Ehrenberg) may prove to be a prior synonym of <i>Globigerina bradyi</i> Wiesner.	5
4. <i>Globigerina bulloides</i> var. <i>borealis</i> Brady 1881 [= <i>Globigerina borealis</i> Brady]; lectotype, × 50. Fig. 4a, ventral view; fig. 4b, axial peripheral view; fig. 4c, dorsal view. Specimen collected by the North Polar Expedition of 1875-76, from the most northern sounding, 83° 19' N., depth 72 fathoms and identified by Brady; now registered in the British Museum (Natural History) no. 1959.7.1.1	4
5. "Polymorphium tuberosum et globiferum," after Soldani, 1791, <i>Testaceographiae</i> , vol. 1, pt. 2, pl. 123, fig. K; placed in the synonymy of <i>Globigerina elongata</i> nob. by d'Orbigny, 1826, p. 277. Note the <i>Bulimina</i> -like aperture illustrated in the axial-apertural view, fig. 5b	12
6. "Polymorphium globuliferum," after Soldani, 1791, <i>Testaceographiae</i> , vol. 1, pt. 2, pl. 130, fig. qq; placed in the synonymy of <i>Globigerina helicina</i> nob. by d'Orbigny, 1826, p. 277	13
7. " <i>Globigerina helicina</i> d'Orbigny" of Brady, 1884; × 50. Fig. 7a, dorsal view; fig. 7b, ventral view, after Brady, 1884, pl. 81, fig. 4. Specimen obtained by Brady from "Challenger" station 85, off Palma, Canaries, depth 1125 fathoms, and considered by him to be conspecific with the form illustrated by Soldani (fig. 6). Specimen deposited in the British Museum (Natural History).	14
8. <i>Globigerina rubra</i> d'Orbigny 1839 [= <i>Globigerinoides ruber</i> (d'Orbigny)]; lectotype, × 50. Specimen obtained by d'Orbigny from recent deposits of Cuba, and now deposited in the A. d'Orbigny collection in the Muséum Nationale de l'Histoire Naturelle, Paris. This specimen is the type of the genus <i>Globigerinoides</i> Cushman 1927. Fig. 8a, dorsal view, showing supplementary sutural apertures present in all chambers of the last whorl; fig. 8b, ventral view	19
9. <i>Globigerina bilobata</i> d'Orbigny 1846 [= <i>Biorbulina bilobata</i> (d'Orbigny)]; lectotype, × 50. Specimen obtained by d'Orbigny from the Tortonian marly clays, near Nussdorf, Austria, and now deposited in the A. d'Orbigny collection, Muséum Nationale de l'Histoire Naturelle, Paris. This specimen is the type of the genus <i>Biorbulina</i> Blow 1956	2
10. <i>Globigerina elongata</i> d'Orbigny 1826 [= <i>Globigerinoides elongatus</i> (d'Orbigny)]; lectotype, × 100. Specimen obtained by d'Orbigny from recent deposits of the Adriatic Sea near Rimini, and now deposited in the A. d'Orbigny Collection, Muséum Nationale de l'Histoire Naturelle, Paris. Fig. 10a, dorsal view, showing supplementary sutural apertures present in the chambers of the last whorl; fig. 10b, axial peripheral view; fig. 10c, ventral view	12



Banner and Blow: Primary Types, Globigerinaceae



Banner and Blow: Primary Types, Globigerinaceae

Remarks.—The form recorded by Kane (1953, pl. 1, fig. 9) as this species is not clearly illustrated but does not seem to belong to the species *puncticulata*; Kane's specimens may belong to *Globorotalia crassula* Cushman and Stewart, and the forms illustrated by Phleger, Parker and Peirson (1953, pl. 4, figures 8-12) may also be referable to Cushman and Stewart's species.

The form illustrated by Brady (1884, pl. CIV, figs. 17a-c) belongs to the Discorbinæ and not to the Globorotaliinae.

Globigerina puncticulata Deshayes 1832 appears to be consubgeneric with *Globorotalia* (*Turborotalia*) *centralis* Cushman and Bermúdez and therefore should be referred to as *Globorotalia* (*Turborotalia*) *puncticulata* (Deshayes) (see Banner and Blow, 1959).

We have observed this species in deposits of Pleistocene age in Sicily and in deposits from the same locality which may be Pliocene, as well as having seen it in collections from the recent seas.

Globigerina quadrilobata d'Orbigny, 1846

Plate 4, figures 3a-b

Globigerina quadrilobata D'ORBIGNY, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 164, pl. 9, ?figs. 7-10, [lectotype here designated].

Taxonomic remarks.—D'Orbigny first described this species as having been obtained from marly plastic clays (of Vindobonian age) from the environs of Nussdorf, Austria. In the A. d'Orbigny collections in Paris a single mounted tube of specimens is extant, which bears the label "*Globigerina quadrilobata* d'Orb., Tortonien, Nussdorf (Autriche)" probably in Terquem's handwriting. On the back of tube mounting a further hand had written the reference "p. 164, pl. 9, figs. 7-10." This tube apparently originally contained eleven specimens; of these three have been lost, but of the remainder one was referable to *Globigerina bilobata* d'Orbigny, two were referable to *Globigerina*

bulloides d'Orbigny and the remaining five specimens were conspecific with the lectotype which was chosen from among them and which is here designated, described and illustrated. No specimens present in the collection agreed well with d'Orbigny's illustrated specimen and it is probable that the specimen illustrated by d'Orbigny was among those which have been lost. So long as any of d'Orbigny's syntypic specimens exist the name *G. quadrilobata* must remain available for them and no neotype can be proposed. As it is clearly illogical to presuppose that d'Orbigny erected the new name *G. quadrilobata* for a species (*G. bulloides*) which he had previously named or that he deliberately included his new and distinctive species *Globigerina bilobata* (described at the same time in 1846) in his quadrilobate species, we were forced to select a lectotype which belonged to a species which had not been described before 1846 and which was of fundamental quadrilobate form. This species, represented by the lectotype, was also the predominant form present in the syntypic series.

Description of lectotype.—The fairly large test consists of about nine chambers arranged in a low, loose trochospire of about two whorls, each whorl, following the proloculum, consisting of about four chambers. The chambers are rapidly and uniformly enlarging, much inflated and little embracing. The equatorial profile is ovoid and the test has a strongly lobulate equatorial periphery. The axial profile is ovate and the axial periphery is smoothly rounded. The chambers are sub-globular and the intercameral sutures become increasingly deeply depressed during ontogeny. The spiral suture is initially slightly depressed becoming deeply depressed and incised in the last whorl. The umbilicus is small, almost closed, and is shallow. The apertures are multiple; the primary aperture is interiomarginal, umbilical, a low, symmetrical, sub-rectangular arch-like opening with no lip or rim. The dorsal

EXPLANATION OF PLATE 4

FIGS.	PAGE
1. <i>Globigerina sacculifera</i> Brady 1877 [= <i>Globigerinoides quadrilobatus</i> (d'Orbigny) subsp. <i>sacculifer</i> (Brady)]; lectotype, × 100. Fig. 1a, dorsal view, showing supplementary sutural apertures in the chambers of the last whorl; fig. 1b, ventral view. The specimen was obtained by Brady from an exotic block (of Upper Miocene or Pliocene age?) from New Ireland, and now is deposited in the British Museum (Natural History), and registered as no. P. 44033	21
2. <i>Globigerina sacculifera</i> Brady 1877 [= <i>Globigerinoides quadrilobatus sacculifer</i> (Brady)]; ideotype, × 50. Fig. 2a, ventral view; fig. 2b, slightly oblique dorsal view after Brady, 1884, pl. 80, fig. 11. Specimen obtained by Brady from the recent sea, "Challenger" station 224, North Pacific, at 1850 fathoms, and now registered in the British Museum (Natural History) as no. 1959.4.13.8. Showing the looser coiling, wider umbilicus, larger primary and supplementary apertures, and higher final chamber than in the lectotype	21
3. <i>Globigerina quadrilobata</i> d'Orbigny 1846 [= <i>Globigerinoides quadrilobatus</i> (d'Orbigny)]; lectotype, × 100. Fig. 3a, dorsal view; fig. 3b, ventral view. Specimen obtained by d'Orbigny from the Tortonian marly clays near Nussdorf, Austria, and now deposited in the A. d'Orbigny collection, Muséum Nationale de l'Histoire Naturelle, Paris	17
4. <i>Globigerina conglobata</i> Brady 1879 [= <i>Globigerinoides conglobatus</i> (Brady)]; lectotype, × 50. Fig. 4a, dorsal view; fig. 4b, ventral view; fig. 4c, oblique ventral view, showing the asymmetry of the primary aperture. Specimen obtained by Brady from the recent sea, "Challenger" station 338, S. Atlantic, at 1990 fathoms, now registered in the British Museum (Natural History) as no. 1959.4.13.7	6

supplementary apertures open in the spiral suture; each is an elongate, rather slit-like opening present at the base of each chamber in the last whorl at least

and they may be present in the earlier whorls. The supplementary apertures do not possess lips or well marked rims. The wall is thick, and is coarsely and

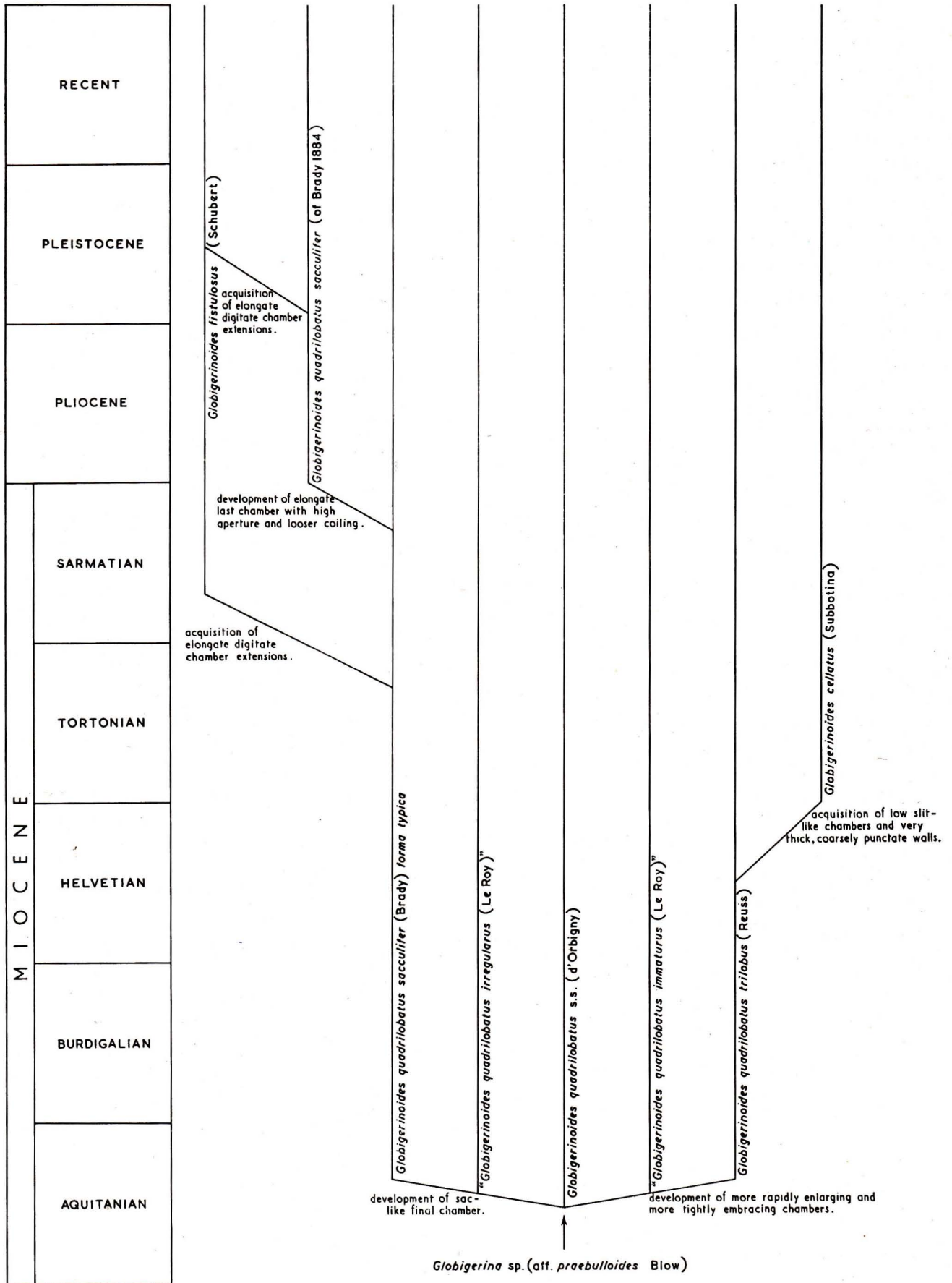


FIGURE 1

Simplified phylogeny of the species-plexus centred on the form *Globigerinoides quadrilobatus* (d'Orbigny).

uniformly perforate. The surface of the test is markedly cancellate and punctate. Maximum diameter of lectotype: 0.57 mm.

Remarks.—This species is congeneric with *Globigerina rubra* d'Orbigny and is consequently referable to the genus *Globigerinoides* Cushman 1927, as restricted by Bolli, Loeblich and Tappan 1957 (see also Banner and Blow, 1959).

This species is very closely related to the forms described as *Globigerina triloba* Reuss 1850, *Globigerinoides sacculiferus* (Brady) var. *immatura* LeRoy 1939, *Sphaeroidinella cellata* Subbotina 1958, as well as *Globigerina sacculifera* Brady 1879, and these forms seem to comprise a complicated evolving plexus in which further taxonomic differentiation is difficult, although certain groupings can be recognised which may be stratigraphically useful when recognised at subspecific level. If *Globigerina quadrilobata* d'Orbigny 1846 is recognised as the "central morphological type" then two extremes, exemplified by *Globigerina triloba* Reuss 1850 and *Globigerina sacculifera* Brady 1877 (or *G. fistulosa* Schubert), can be recognised. Thus the form described as *Globigerinoides sacculiferus* (Brady) var. *irregularus* LeRoy is intermediate in the plexus between *G. quadrilobatus* (d'Orbigny) and *G. sacculifer* (Brady). The full stratigraphic value of these Miocene to recent forms still has to be fully evaluated (see text-figure 1).

We are of the opinion that *Sphaeroidinella cellata* described by Subbotina (1958) is not referable to the genus *Sphaeroidinella*, but seems to be a particularly thick walled form lacking a cortex (see Blow 1959, Banner and Blow 1959), and which is closely related to the plexus group discussed above. We have seen similarly thick walled forms ourselves especially in deposits of probable Upper Vindobonian age.

Globigerinoides trilobus altiapertura Bolli 1957, which is believed to be confined to the Middle Aquitanian (Blow, 1959), is distinguished at subspecific level from *Globigerinoides quadrilobatus* (d'Orbigny) by its much larger, more rounded primary aperture and much more highly arched supplementary apertures (see also Remarks under *Globigerina sacculifera*).

We consider *Globigerinoides obliquus* Bolli 1957, and *Globigerinoides bollii* Blow 1959 to be specifically distinct from *G. quadrilobatus* (d'Orbigny) and reference should be made to the respective authors' works (Bolli 1957, Blow 1959).

Globigerina rotundata d'Orbigny, 1898

Plate 2, figure 2

Globigerina rotundata D'ORBIGNY, 1826. Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., vol. 7, p. 277, list no. 6 (*nomen nudum*).

Globigerina rotundata D'ORBIGNY, in FORNASINI, 1898, Pal. Italica, vol. 4, p. 208, text-fig. 3 (after

d'Orbigny, "figure inédite"), [lectotype here designated].

not *Globigerina rotundata* d'Orbigny, FORNASINI, 1899, Mem. R. Accad. Sci. Ist. Bologna, ser. 5, vol. 7, pl. 1, figs. 4-5, pl. 4, fig. 1.

Taxonomic remarks.—When d'Orbigny, in 1826, proposed the name *Globigerina rotundata* for forms obtained by him from the Island of Ste. Hélène, he omitted to describe or figure the species or to give any other indication as to its nature. Consequently, the name *G. rotundata* d'Orbigny did not become taxonomically available until 1898 when Fornasini published for the first time copies of d'Orbigny's preliminary drawings of this species. In the A. d'Orbigny collections in Paris, one single specimen exists which was labelled "*Globigerina rotundata* d'Orbigny (Viv^{te}) Ste. Hélène" and the tube bearing the specimen was numbered "12313" on the reverse of its mount. This single specimen is here illustrated and designated as lectotype. Unfortunately the specimen is not well preserved and is very fragile and it did not prove possible to illustrate it in detail. It did not appear to be conspecific with the specimens obtained from Ravenna by Fornasini in 1899 which were referred by him to *G. rotundata*. The Fornasini specimens have no taxonomic availability except as potential neotypes (as they were obviously never seen by d'Orbigny) and so long as the d'Orbigny specimen exists they have no taxonomic status.

Description of lectotype.—The fairly small and globose test consists of about two whorls of chambers arranged in a fairly high and tightly coiled trochospire with five chambers present in the last whorl. The equatorial and axial profiles are subcircular and the equatorial periphery is weakly lobulate. The chambers are appressed, inflated, moderately embracing, reniform in dorsal aspect and ovoid in axial view. The sutures are moderately depressed. The umbilicus, although infilled, appears to be moderately broad. The primary aperture is obscured by the extraneous material present in the umbilicus but no indication exists that it is other than interiomarginal and umbilical. The wall is fairly thick, moderately and uniformly perforate and the surface of the test is practically smooth. Maximum diameter of lectotype: 0.34 mm.

Remarks.—The lectotype of *G. rotundata* is smaller than *G. dutertrei* d'Orbigny, and it appears to have fewer whorls of chambers. All its other morphological characters seem to agree with those of *G. dutertrei* and we consider the two forms synonymous.

Globigerina rubra d'Orbigny, 1839

Plate 3, figures 8a, b

Globigerina rubra D'ORBIGNY, 1839, (*in de la Sagra*, Histoire physique, politique et naturelle de l'île de Cuba, Bertrand, Paris, pp. 82-83, (plates published

separately, vol. 8, pl. 4, figs. 12-14) [lectotype here designated].

Globigerinoides rubra d'Orbigny, CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 87 (but not pl. 19, fig. 6, (after Brady 1884)).

Globigerinoides rubra d'Orbigny, BOLLI 1957, (part) U. S. Nat. Mus. Bull. 215, pp. 113-114, pl. 25, figs. 12a-c (not fig. 13).

Taxonomic remarks.—D'Orbigny first described *Globigerina rubra* in 1839, basing his description on specimens obtained from recent marine sands from Cuba, Jamaica, Guadeloupe and Martinique.

In the A. d'Orbigny collections in Paris, there exists a mounted tube which originally contained eight specimens; the front of the mount of this tube is inscribed "*Globigerina rubra* d'Orbigny, Cuba," probably in Terquem's handwriting, with an additional note in another handwriting reading "Type Isolé." On the reverse of the tube mount is affixed d'Orbigny's original label which reads as follows:

IV
12 - 14

Globigerina rubra.

One specimen is obviously missing from the original tube and we believe that this specimen is now present in a modern single-celled slide which is also present in the A. d'Orbigny collection. Following discussions with the present authorities of the Muséum National de l'Histoire Naturelle, Paris, we presume that the isolation of the specimen was made by Dr. A. R. Loeblich during his visit to Europe in the years 1953-1954. We mentioned this to Dr. Loeblich in a letter written to him, mainly concerning *G. bulloides*, but we have received no reply appertaining to his work in Europe. As it is absolutely essential to establish whether or not the specimen of *G. rubra* isolated into the new modern single-celled slide actually came from, and was a part of, the original syntypic series, it is necessary to be reasonably sure who isolated the specimen and when it was done. First of all, the inscription as to locality and name on the new slide agrees with that written on the original tube mount. Secondly, the handwriting of the words "Type Isolé" on the original tube mount agrees with the handwriting on the new slide. Unfortunately, none of the present authorities in Paris can vouch that the handwriting is that of Dr. Loeblich but we have seen slides used by Dr. Loeblich for the isolation of types in the British Museum which are not only of the same modern type as that containing the isolated specimen of *G. rubra* in Paris but are also inscribed in a handwriting which is known to be that of Dr. Loeblich and vouched for by Miss C. Underwood (British Museum). The handwriting seen on these slides agrees well with that under discussion and we are now confident that Dr. Loeblich carried out the isolation of the specimen and that it was taken from the original tube mount. Con-

sequently, we believe the isolated specimen to be syntypic. Furthermore, in view of the considerable lapse of time following Dr. Loeblich's visit to Europe we feel justified (especially considering the great importance of this species) in proceeding to describe this specimen as lectotype of *Globigerina rubra* d'Orbigny 1839, (pl. 3, figs. 8a-b).

The specimen here designated lectotype was by far the best preserved of all the remaining syntypes and shows all the morphological characters of the species to the best advantage; this is an additional reason for establishing the validity of the specimen in question.

No attempt here is made to give a complete list of synonymous references but a reference to the work of Bolli (1957) has been included so as to demonstrate the stratigraphic range of the species (see Remarks below).

Globigerina rubra d'Orbigny 1839 was designated the type species of the new genus *Globigerinoides* Cushman 1927 by Cushman, 1927. Since this designation, the genus *Globigerinoides* was restricted by Bolli, Loeblich and Tappan (1957) in order to separate and clearly distinguish forms which are now referred to the genera *Porticulasphaera* and *Globigerapsis*. Banner and Blow (1959) further discussed these genera.

Description of lectotype.—The fairly large test consists of slightly more than two whorls of strongly inflated chambers arranged three to a whorl in a moderately high trochospire. The equatorial profile is subovate, but the equatorial periphery is strong lobulate. The dorsal surface is distinctly convex and the earlier whorls are clearly visible. The chambers are subglobular to sub-ovoid and are broadly reniform in dorsal aspect, well separated one from the other and are but little embracing. The sutures are distinctly and broadly depressed both dorsally and ventrally; they are strongly curved dorsally, but also radial ventrally. The apertures are multiple. The primary aperture is interiomarginal umbilical, a moderately high, semi-circular arch bordered by a distinct, uniformly narrow, rim; the primary aperture is placed and shaped symmetrically with respect to the intercameral suture between the penultimate and antepenultimate chambers. The supplementary apertures are dorsal in position and are situated at the basal suture of each chamber at its junction with the adjacent intercameral suture of the preceding whorl. One or two such supplementary apertures are present in each chamber of the last whorl. The supplementary apertures are high, semi-circular arches, with very thin rims. The umbilicus is small, almost closed and very shallow. The wall is calcareous, apparently radial in structure, uniformly and fairly finely perforate and moderately thin. The surface of the test is slightly rough, but little trace of any original hispidity exists in the lectotype. The earlier part of the test is red coloured, not with the red tint of ferric compounds, but with a deeper and more

crimson hue, probably of an organic origin. Maximum diameter of lectotype: 0.62 mm.

Remarks.—In life, *G. rubra* possesses abundant, uniformly distributed, fine spines (see Brady, 1884, pl. 79, fig. 16). D'Orbigny's name "*rubra*" was clearly intended to refer to the characteristic red colouration which is possessed by living specimens of this species, and which often seems to persist even in specimens from sub-recent deposits. However, a red-colouration is not only confined to *G. rubra*, but has been observed by us (also recorded by Brady, 1884, *et. al.* for other forms, e. g., *Rotalia rosea* d'Orbigny 1826) on other planktonic and benthonic Foraminifera from the recent seas. The red colouration is quite distinct from that due to secondary staining by iron oxides.

Globigerina rubra d'Orbigny shows a considerable range of variation both in the separation of the later chambers and in the height of the spire (compare Ovey, in Wiseman and Ovey, 1950, pl. 3, figs. 12a-b, and Bradshaw, 1959, pl. 7, figs. 12, 13). However, the very high spired forms figured by Brady (1884, pl. 79, figs. 13, 14, 15) and by Cushman ("Foraminifera, their classification and economic use," 1940 to 1955 editions, Key plate 34, figures 8a-b) are believed by us to be referable to *Globigerina pyramidalis* (Van den Broeck) (= *Globigerina bulloides* var. *rubra* subvar. *pyramidalis* Van den Broeck 1876) because this form is much more tightly coiled and possesses more slowly enlarging chambers, with smaller but more numerous dorsal sutural supplementary apertures. The stratigraphic occurrence of *G. pyramidalis* is not fully known but we have observed it only in collections from the recent seas and know of no fossil records. On the other hand, *G. rubra* is known to have existed from Miocene times.

In 1954, Brönnimann (in Brönnimann and Todd, 1954, p. 680, pl. 1, figs. 5, 8a-c) erected the name *Globigerinoides subquadratus* for forms from the "Upper Oligocene" (here believed to be Aquitanian) of Saipan and from the Middle Cipro formation of Trinidad (here believed to be also Aquitanian). The holotype is not well preserved but forms sent by one of us to Miss R. Todd in 1955, from the *Globigerinatella insueta* Zone, Pozón formation, eastern Falcón, Venezuela, were found by her to be conspecific with *Globigerinoides subquadratus*. These forms differed from the typical *G. ruber* by being more tightly coiled, more quadrate in outline, and in possessing more embracing chambers with a thicker and more coarsely punctate wall. Also, the apertures of these forms seem to be smaller than in recent *G. ruber*. Although Bolli (1957, p. 113) placed *G. subquadratus* in full synonymy with *Globigerinoides ruber* we consider them to be subspecifically distinct and that *G. subquadratus* is an earlier and probably ancestral form. Bolli (1957, pl. 25, fig. 12) illustrated a form from the "*Globorotalia fohsi robusta*" Zone of the Cipro formation (considered here to be Upper Burdigalian), which appears to be fully

synonymous with the true *Globigerinoides ruber*. Bolli (*loc. cit.*, pl. 25, fig. 13) also illustrated a form from the *Globigerinatella insueta* Zone, Cipro formation, Trinidad (here believed to be Upper Aquitanian) under the name *Globigerinoides ruber*, but we consider this to be referable to *G. ruber subquadratus* (Brönnimann). The evolution from "*subquadratus*" to "*ruber*" *sensu stricto* appears to occur in the Burdigalian. Accordingly we consider the range of *G. ruber subquadratus* to be Middle Aquitanian to Burdigalian, and that of *G. ruber ruber* to be Burdigalian to Recent.

The forms described by Brady (1884, pl. 81, figs. 4, 5, here re-illustrated, pl. 3, figs. 7a-b) as *Globigerina helicina* d'Orbigny are probably conspecific with that illustrated by Soldani (1791, pl. 130, fig. qq) and *G. rubra* d'Orbigny 1839. However, as discussed above, they are not conspecific with the lectotype of *G. helicina* d'Orbigny 1826 (see p. 13, pl. 2, figs. 5a-c).

Globigerina elongata d'Orbigny 1826 may be related to *G. rubra*, but it is considered to be specifically distinct because of the thicker, more coarsely perforate and cancellate wall, the more tightly coiled, less inflated, chambers, the rounder, more laterally restricted primary aperture and the smaller supplementary apertures in the former species. It is possible that *G. elongata*, which does not seem to appear before the Pliocene, may have descended from *G. rubra*, or it may be a completely independent near-pseudomorph with a separate ancestry.

Globigerina cyclostoma Galloway and Wissler 1927 may be related to *G. rubra* but a re-examination of the types is necessary, in light of the above comments, before its position can be adequately discussed.

Hofker (1959, pp. 1-9) proposed the name *Globigerina rubra foraminata* for specimens of *G. rubra* which possess "sutural openings." Although he did not further describe or illustrate the form, it appears that his newly proposed subspecific taxon is fully synonymous with *G. rubra sensu stricto*. As our writing above demonstrates, we are not in agreement with either Hofker's taxonomic system or his views on the evolution of this form.

***Globigerina sacculifera* Brady, 1877**

Plate 4, figures 1, 2

Globigerina helicina d'Orbigny, CARPENTER, 1862, (*not* d'Orbigny) Introduction to the study of the Foraminifera, Ray Soc., London, pl. 12, fig. 11 (*teste* Brady).

Globigerina sacculifera BRADY, 1877, Geol. Mag., London, n. s., decade 2, vol. 4, no. 12, p. 535 (no figure) [lectotype here designated].

Globigerina sacculifera Brady, BRADY, 1879, Quart. Jour. Micr. Sci., London, n. s., vol. 19, p. 287, (no figures).

Globigerina sacculifera Brady, BRADY, 1884, Rept. Voy.

Challenger, Zool., vol. 9, pt. 22, p. 604, pl. 80, figs. 11-17, pl. 82, fig. 4.

Globigerinoides sacculiferus Brady, LEROY, 1941, Colorado School of Mines, Quart., vol. 36, no. 1, p. 44, pl. 2, figs. 68-70, p. 87, pl. 4, figs. 25-27.

Globigerinoides triloba sacculifera (Brady), BOLLI, 1957, U. S. Nat. Mus. Bull. 215, p. 113, pl. 25, figs. 5a-6.

Taxonomic remarks.—Very many references to this species have been made in the literature and it is impossible for us to attempt a complete list of synonymous references here. Those given above merely trace a historical outline of the usage of Brady's name "*sacculifera*." Further points concerning this are discussed below the Remarks.

Brady first validly described this species in 1877 when he discussed material obtained from a fragment of "?Chalk" (a soft white calcareous rock) which had been found on a beach by Liversidge in New Ireland (Territory of New Guinea) after an earthquake. He believed that the rock was "a compact fragment from a recent sea bottom," but it is more likely to have been of Upper Miocene or Pliocene age. It is from this material that Brady's original syntypic series of specimens was obtained. They are extant in the collections of the British Museum (Natural History) and slide registered as number P. 43317 contains them. It is marked "White Chalk; New Britain (Liversidge)" in Brady's handwriting and "Post Tertiary, New Ireland, Geol. Mag., Dec. 1877, p. 535" in another handwriting. New Britain and New Ireland are in the same group of Islands (Bismarck Archipelago) and seem to have been confused by Brady in his notes though not in his publications.

The lectotype, here designated, of *Globigerina sacculifera* Brady 1877 has been isolated from this slide and is now registered in the collections of the British Museum (Natural History) as registered number P. 44033.

Brady first illustrated this species in 1884 when he described recent material collected by the "Challenger" Expedition from the North Pacific, Atlantic Ocean and the Caribbean area. The specimen figured by him (*op. cit.*) on pl. 80, figure 11, is ideotypic (not syntypic) and its ventral view is illustrated for the first time (pl. 4, fig. 2). This specimen is now registered in the British Museum (Natural History) as number 1959.4.13.8. It was obtained from slide no. 85.10.5.482., which contained 49 specimens from Challenger Station 224, 1850 fathoms, North Pacific.

Description of lectotype.—The large, sub-tetrahdroid test consists of about 2½ whorls of ovoid, inflated chambers arranged 3½ to 4 in each convolution of a low trochospire. The equatorial profile is sub-triangular and the equatorial periphery is lobulate. The axial profile is also sub-triangular but approaches an oval shape. The axial periphery is broadly rounded on the

earlier chambers, becoming narrowly rounded over the last chamber. All chambers except the last are constant in shape and are regularly enlarging; the last chamber is "sac-like," and slightly radially elongate. The volume of the last chamber differs but little from the volume of the penultimate chamber although it is of distinctly different shape. The sutures are slightly and broadly depressed, the intercameral sutures are distinctly curved dorsally, meeting the lobulate spiral suture almost at right angles. The ventral intercameral sutures are slightly sinuous to nearly radial. The umbilicus is small, almost but not totally closed, and is shallow. The apertures are multiple; the primary aperture is interiomarginal, intraumbilical, a moderately low, almost semicircular, slightly asymmetrical arch, with no rim or lip visible. The dorsal supplementary apertures are situated at the base of the chambers, opening in the spiral suture; they are low, virtually semicircular arches with no lips or rims and appear to be present from at least the beginning of the last whorl. Only one supplementary aperture is present in each chamber. The wall is fairly thick and is uniformly and coarsely perforate. The surface of the test is cancellate but with little trace of any original hispidity. Maximum diameter of lectotype: 0.56 mm.

Remarks.—As Brady (1884, p. 604) has pointed out, this species is spinose during life. His specimens, taken *in vivo* and now preserved in Canada balsam (*op. cit.*, pl. 80, figs. 15-16), show the presence of fine, abundant long spines distributed uniformly over the test. Brady (*op. cit.*, *loc. cit.*) also noted a certain amount of "pink colouration" in some rare specimens from Challenger Station 24; we have examined these specimens and consider that the colouration is due to secondary staining by iron oxides.

Brady's syntypic series of specimens from a probable Uppermost Miocene horizon all show the same characters relating to the final chamber as here illustrated for the lectotype. The constancy of the "sac-like" nature of the final chamber for any particular stratigraphic horizon is quite distinctive, although its detailed form appears to vary in time. Thus, the recent populations noted in the Brady Collection (from widely separated geographical localities) all appear to possess a broadly similar final chamber which is more radially elongate than those from Tertiary horizons. Furthermore, the later chambers of the recent specimens are much less embracing and the primary and supplementary apertures on the later chambers are considerably both higher and broader than those of their fossil counterparts. These characters can be of stratigraphic use. In Upper Miocene to recent times, the distal end of the final chamber (occasionally that of the penultimate as well) often becomes pointed, forming a narrow digitate extension; these narrow digitate extensions may become multiple on the final

chamber during the Upper Sarmatian (see Hamilton and Rex, 1959, pl. 254, fig. 14) to Recent, and show a passage to forms described by Schubert (1910, 1911) as *Globigerina fistulosa*. In this latter form these digitate extensions may be present on all chambers of the last whorl and become long "finger-like" processes highly reminiscent of the chamber extensions seen in some Cretaceous genera (see Cushman, Todd and Post, 1954, p. 369, pl. 91, fig. 13).

Forms similar to the figured lectotype (pl. 4, figs. 1a, b) have been recorded by Bolli (1957, p. 113, pl. 25, figs. 5a-c), and by Blow (1959, p. 188, pl. 11, figs. 63a-b) in Miocene sediments and probably range from the Middle or Upper Aquitanian. Similar forms to these also occur in the type Tortonian of Nussdorf (Austria) and are known to range to the recent. However, forms similar to Brady's ideotype, here figured, (pl. 4, figs. 2a-b) do not seem to occur before the Pliocene at least, and probably do not appear until the upper part of this interval. The fistulose forms may be restricted to Sarmatian to recent times.

The earlier part of the test, up to and including much of the last whorl, is virtually identical to the species *Globigerina quadrilobata* d'Orbigny (see pl. 4, figs. 3a, b). The morphological type represented by *Globigerinoides sacculiferus* (Brady) var. *irregularus* LeRoy 1944 seems to form a "connecting link" between *Globigerinoides quadrilobatus* (d'Orbigny) and *Globigerinoides sacculifer* (Brady) but this form of LeRoy does not appear to have any great stratigraphic significance. Although Bolli (1957, p. 99, range chart) implies that "*G. triloba immatura*" (recte, *G. quadrilobatus*) and "*G. triloba sacculifera*" appear simultaneously within the *Globorotalia kugleri* Zone, Cipro formation (= Middle Aquitanian) there is, in fact, an interval of time between the appearances of these two forms, *G. quadrilobatus* appearing earlier, and this is implied by Blow (1959, p. 105, text-fig. 5), and indicated in text-figure 1.

It has been suggested (e. g., Hofker, 1959) that certain morphological characters used in the taxonomic differentiation of the Globigerinaceae are reproductive structures of no fundamental taxonomic importance. The "sac-like" nature of the later chambers of *Globigerina sacculifera* Brady might be considered in this light. However, we are firmly of the opinion that, whether or not this is the case, the "sac-like" final chamber is constant in form for any particular population and given instant of time, and, moreover, it is a developing character (as shown above) which is recognisably modified during evolution and thus must be an inheritable character with a genetic significance. Even if this character is associated with a reproductive phase its development and modification in time indicate that the organism is achieving a greater capacity to produce the "sac-like" final chamber with time, and thus it must be sensitive to the mechanics of natural

selection and genetics and be of some taxonomic importance. Further, a new stock (the fistulose forms) appears to develop in the Mio-Pliocene from *G. sacculifera*, illustrating the new genetic potentialities of this form. However, we are not yet satisfied that characters such as these are wholly connected with a reproductive phase, for no direct biological evidence exists to support this point of view; these characters may be of an iterative nature and be connected with an environmentally adaptive process (see Banner and Blow 1959, 1960). As noticed above, "*Globigerinoides triloba altiapertura*" Bolli differs from *Globigerinoides quadrilobatus* (d'Orbigny) in possessing distinctly larger apertures. The early parts of the test of typical *Globigerinoides sacculifer* (Brady) also possess larger apertures than does *G. quadrilobatus*. However, forms which are referable to primitive *G. sacculifer* and which occur contemporaneously with "*G. triloba altiapertura*" have smaller apertures, which are similar to those of *G. quadrilobatus*, than those seen in the recent specimens of *G. sacculifer*. It appears that, during the evolution and range of *G. sacculifer*, both the primary and supplementary apertures increase in size with time, so that it is the later forms (from younger horizons) that show the similarity of apertural shape to the Aquitanian "*G. triloba altiapertura*." Consequently, we regard the evolution of *G. sacculifer* to be independent of "*G. triloba altiapertura*," because those apertural characters which they possess in common have been clearly acquired independently at two different periods of time; this is an example of iterative development of a morphological character within a closely related group of forms (compare Banner and Blow 1959, 1960). Also, as the gradual acquisition of larger apertures takes place in the *G. sacculifer* stock, but does not occur over the same stratigraphic interval in *G. quadrilobatus sensu stricto*, we consider that these two forms have followed separate lines of evolution since their first appearance in the middle part of the Aquitanian. Therefore, as *G. sacculifer* has evolved separately from *G. quadrilobatus* since its initial origin from the latter form, we believe that it is unlikely that one should represent a reproductive form of the other, and that they may be distinguished subspecifically. Preferred bathymetric habitats (see Emiliani, 1954) may account in part for their thanatocoenetic co-existence.

The two *nomina nuda*, *Globigerina sacculifera* Brady variante *recumbens* and *G. sacculifera* Brady variante *galeata*, both illustrated by Rhumbler 1911 (pl. 31, figs. 11-13 and 14-15 respectively) but not named until 1949 (in Wetzels, p. 39), are probably fully synonymous with *G. sacculifera* Brady 1877. It is perhaps noteworthy, in view of the above remarks, that the biologist Rhumbler, who examined these forms taken *in vivo* and who made cytological studies of his specimens whenever they were of interest, noticed no asso-

ciation between the "sac-like" chambers of this species and any part of a reproductive cycle.

***Globigerina seminulina* Schwager, 1866**

Plate 7, figures 2a, b

Globigerina seminulina SCHWAGER, 1866, "Fossile Foraminiferen von Kar Nikobar," Novara Exped., 1857-59, Vienna, Geol., Theil, Bd. 2, Abt. 2, p. 256, pl. 7, fig. 112 (neotype here proposed).

Sphaeroidinella seminulina (Schwager), A. G. I. P. MINERARIA *Auct.*, 1957, Foraminiferi Padani, Milan, pl. 47, figs. 6, 6v, 6p, 6d.

Sphaeroidinella seminulina seminulina (Schwager), BLOW, 1959, Bull. Amer. Pal., vol. 39, no. 178, pp. 196-198, pl. 12, figs. 74-77.

Taxonomic remarks.—Schwager first described this species in 1866 using specimens obtained from the Neogene of Kar Nikobar, British India. Metatypic specimens were sent by Schwager to H. B. Brady and these are deposited in the British Museum (Natural History). As we have been informed by Prof. M. Reichel (personal letter dated 14th July, 1959) that the Schwager Collections in Munich have been lost, we have re-investigated this metatypic material (see also taxonomic remarks under *Globigerina conglomerata*). A slide present in the British Museum (Natural History) collections is labelled "Pliocene? Kar Nikobar, ex Dr. Schwager, *Globigerina seminulina* Schwager," on the reverse of this slide a label is pasted, and this reads, "*Globigerina zeminulina* [*sic*] Schwager, Pliocaen, Kar Nicobar, KI." This latter label is probably in Schwager's handwriting. From among the specimens it contains, one metatype has been isolated and this is now registered in the British Museum (Natural History) as specimen number P. 44035. This specimen is here described, illustrated and proposed as *neotype* of *Globigerina seminulina* Schwager.

Description of neotype.—The fairly large test consists of about two whorls of rapidly enlarging, inflated chambers arranged in a low trochospire, with four chambers present in the last whorl. The chambers are initially obscure but probably embracing; they become increasingly well separated, slightly radially elongate and ovoid during the last whorl. The equatorial profile is sub-oval, somewhat elongate in the direction of the last chamber; the equatorial periphery is strongly lobulate. The axial profile is a compressed oval, and the dorsal surface is only very slightly convex. The axial periphery is evenly rounded, tending to become subacute over the last chamber. The dorsal sutures are initially obscure. In the last whorl, the intercameral sutures are slightly but broadly depressed on the ventral and dorsal surfaces and are much more deeply depressed over the periphery. The dorsal intercameral sutures are slightly curved to nearly radial, whilst the ventral intercameral sutures are virtually radial. The

umbilicus is broad and probably very deep (infilled in the neotype) and is bordered by broad, clear, hyaline, thickened, crenulate and corrugated flanges, which are the strongly developed lips of the relict parts of the primary apertures of the chambers in the last whorl. The primary aperture is believed to be a low interior-marginal, intraumbilical arch, but it is obscured in the neotype. There are no supplementary apertures present, either dorsally or ventrally. The wall is very thick and coarsely perforate. The surface of the test is covered by a layer of clear shell material which is thickest near the umbilicus; this cortex partially or wholly covers the coarse but sparsely distributed punctations. Maximum diameter of neotype: 0.56 mm.

Remarks.—We refer this species to the genus *Sphaeroidinellopsis* Banner and Blow 1959 because of its external cortex, secondarily thickened flange-like lips and the absence of supplementary apertures (see Banner and Blow, 1959). The taxonomic importance of the presence or absence of supplementary sutural apertures is confirmed by a study of this species. No comparable form is known which does possess such sutural supplementary apertures; *Sphaeroidinella dehiscens*, for example, is distinct both in morphology and stratigraphic range. It is therefore unlikely that the contention that supplementary apertures are merely reproductive features is tenable (compare Hofker, 1959).

No specimens which could be referred to *Sphaeroidinellopsis subdehiscens* (Blow) were present in Schwager's metatypic series; one specimen appeared similar to the form described as *Globigerina kochi* Caudri 1934, but the type of Caudri's species needs re-examination. The age given by Schwager on the slide sent to Brady is doubtful and the specimens are, in our opinion, much more likely to have come from the Middle or Upper Miocene. However, A. G. I. P. Mineraria have illustrated specimens from the Lower Pliocene of Italy but this uppermost part of its range needs further investigation. It may be found that it does not occur above the Sarmatian; the stratigraphic evidence given by A. G. I. P. Mineraria is not documented. It has been recorded by Blow (1959, p. 198), from beds as old as the "*Globigerinatella insueta*/*Globigerinoides triloba*" Subzone, Tocuyo formation, which is here considered to be Middle to Upper Aquitanian.

Blow (*op. cit.*, *loc. cit.*) has already discussed the evolutionary trends seen in this species and he refers to a plexus of evolving forms which may be shown by future work to be taxonomically distinguishable at subspecific level. Forms described as *Sphaeroidinella disjuncta* by Finlay (1940) are particularly closely related to *Sphaeroidinellopsis seminulina* and may prove to be fully synonymous. Other forms which have close affinity are *Globigerina kochi* Caudri 1934; *Sphaeroidinella rutschi* Cushman and Renz 1941 (holotype only) and *Globigerina grimsdalei* Keijzer 1945. These may, in part, prove synonymous amongst themselves

but they are at least subspecifically distinct from *S. seminulina* (Schwager).

Pullenia sphaeroides* (d'Orbigny) var. *obliquiloculata
Parker and Jones, 1865

Plate 7, figures 4a-c

Pullenia obliquiloculata PARKER and JONES, 1862, in Carpenter, "Introduction to the study of the foraminifera," Ray Soc., London, p. 183 [nomen nudum] (teste Parker and Jones 1865).

Pullenia sphaeroides (d'Orbigny) var. *obliquiloculata*, PARKER and JONES, 1865, Roy. Soc., London, Philos. trans., London, vol. 155, pp. 365, 368, pl. 19, figs. 4a-b.

Pullenia obliquiloculata PARKER and JONES, BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 618, pl. 84, figs. 16-20.

Pulleniatina obliquiloculata [sic] (Parker and Jones), CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, no. 39, p. 90, pl. 19, fig. 5 (after Brady).

Pulleniatina obliquiloculata [sic] (Parker and Jones), BOLLI, LOEBLICH and TAPPAN, 1957, U. S. Nat. Mus. Bull. 215, p. 33, pl. 4, figs. 3a-5.

Taxonomic remarks.—Dr. A. R. Loeblich, during his visit to Europe in the years 1953/1954, selected and isolated a specimen from a slide registered in the British Museum (Natural History) as number 94.4.3.1045 which contained specimens of Foraminifera obtained from the Abrohlos Bank (latitude 22° 54' S., long. 40° 37' W.) at depth 260 fathoms, South Atlantic. This specimen, now contained in a slide registered number B.M. (N.H.) ZF.3583, was designated by Bolli, Loeblich and Tappan (1957, p. 33) as lectotype of *Pulleniatina obliquiloculata*. They neither figured nor described the actual lectotype, but published illustrations of a syntypic (paratypic-sic) specimen (now deposited in the U. S. National Museum number P. 4228) together with a general description of the monotypic genus *Pulleniatina* Cushman 1927 for which *P. obliquiloculata* is the type species. The description of the genus fits the lectotype, here figured for the first time (pl. 7, figs. 4a-c), but it will be noticed that the lectotype has a polychaete worm-tube attached to its dorsal peripheral surface and is apparently less well preserved than the syntype which is now in the United States. No further description of the lectotype is given here.

Remarks.—The typical form of this species appears only to range from Pliocene to Recent, but some primitive forms have been observed in sediments of Fiji and Papua which may be of Uppermost Miocene age. These primitive forms show a relationship with *Globigerina inflata* d'Orbigny auct. and it may be that the latter form is ancestral to *P. obliquiloculata* (Parker and Jones). The form figured by Stainforth (1948, p. 125, pl. 26, figs. 21-23) from the supposed Upper Miocene of Ecuador appears similar to the forms seen by

us from Papua and Fiji. These early forms are not so strongly streptospiral in late ontogeny as are the typical forms of the species. The form recorded by Germeraad in 1946 as *Pulleniatina? semi-involuta* is of unknown taxonomic position and needs further study.

Pulvinulina menardii* (d'Orbigny) var. *fimbriata
Brady, 1884

Plate 5, figures 2a, b

Pulvinulina menardii (d'Orbigny) var. *fimbriata* BRADY, 1884, Rept. Voy. Challenger, Zool. vol. 9, pt. 22, p. 691, pl. 103, figs. 3a-b [which is lectotype, here designated].

Globorotalia menardii (d'Orbigny) var. *fimbriata* (Brady), OVEY, in WISEMAN and OVEY, 1950, Proc. Geol. Assoc., vol. 61, p. 69, pl. 3, fig. 3.

Globorotalia fimbriata (Brady), HOFKER, 1956, Spolia Zoologica Musei Hauniensis, Copenhagen, vol. 15, pp. 194-199, pl. 30, figs. 7-12, ?13-14.

Taxonomic remarks.—In 1884, Brady illustrated and described this form; his original specimens are present in a slide registered in the British Museum (Natural History) as number ZF. 2227. These specimens, four in number, came from Challenger Station 24, depth 390 fathoms, off Culebra Island, West Indies. Brady's handwriting on the reverse of the slide confirmed that his illustrated specimen was present and this specimen has now been isolated and re-registered as British Museum (Natural History) number 1959.7.1.2. The work by Brady's illustrator, A. T. Hollick, was very accurate and we consider no useful purpose would be served in redrawing the specimen. The original illustration is reproduced here (pl. 5, fig. 2).

Description of lectotype.—The fairly large test (approaching one millimeter in diameter) consists of about 10 chambers arranged in a very low trochospire of about 2 whorls, with 5 chambers present in the last whorl. The chambers are little, if at all, inflated; they are strongly compressed dorso-ventrally and uniformly enlarging. The equatorial profile is subcircular and the equatorial periphery is lobulate. In axial profile, the dorsal and ventral surfaces are only very slightly convex and the axial periphery is sharply acute. The dorsal intercameral and spiral sutures are weakly depressed but are limbate, being thickened by clear shell material which bears short blunt spines. The dorsal intercameral sutures are smoothly re-curved, meeting the spiral suture almost at right angles. The chambers do not embrace on their dorsal sides and the clear shell material present in the sutures appears to be continuous with the imperforate peripheral carina. The ventral intercameral sutures are depressed and nearly radial. The peripheral carina is characteristically furnished with an abundance of strongly developed spines arranged in nearly radial directions.

The umbilicus is small but open, with the relict parts of the primary apertures of some of the later cham-

bers visible within it. The primary aperture is interior-marginal, umbilical-extraumbilical, a low elongate opening furnished with a distinct lip. A trace of the lip of the penultimate chamber can be seen within the umbilicus. The wall is uniformly and fairly finely perforate, except for the imperforate peripheral carina and the dorsal sutural thickenings. The surfaces of the chambers are smooth except where these thickenings occur and no secondary deposits are apparent on the ventral side.

Remarks.—This form is regarded here as a subspecies of *Globorotalia* (*Globorotalia*) *menardii* (Parker, Jones and Brady). (Our comments concerning the taxonomic validity of *Rotalia menardii* d'Orbigny should be referred to, p. 32).

This subspecies is only known from the recent seas and appears to be the latest offshoot from the virile *Globorotalia menardii* stock (see also p. 27). As pointed out by Brady (1884), the illustrated (lectotypic) specimen is exceptionally large, but smaller, more commonly occurring, specimens possess the sub-specific characters almost equally well developed.

Pulvinulina menardii* (d'Orbigny) var. *tumida
Brady, 1877

Plate 5, figure 1

Pulvinulina menardii (d'Orbigny) var. *tumida* BRADY, 1877, Geol. Mag., London, n. s., dec. 2, vol. 4, p. 535, (*in* Liversidge, "On the occurrence of Chalk in the New Britain Group," *loc. cit.*, pp. 529 et seq.) (no figures) [lectotype here designated].

Pulvinulina menardii (d'Orbigny) var. *tumida* Brady, BRADY, 1879, Quart. Jour. Micr. Soc., London, vol. 19, n. s., p. 80 (no figure).

Pulvinulina tumida Brady, BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, pt. 22, p. 692, pl. 103, figs. 4-6.

Globorotalia tumida (Brady), CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, p. 91, pl. 19, fig. 12 (after Brady).

Globorotalia tumida (Brady), LEROY, 1941, Colorado School of Mines, Quart., vol. 36, no. 1, p. 45, pl. 3, figs. 101-103.

Globorotalia tumida (Brady), BOLLI, LOEBLICH and TAPPAN, 1957, U. S. Nat. Mus., Bull. 215, pp. 41-42, pl. 10, figs. 2a-c.

Taxonomic remarks.—Brady first described this form from a fragment of soft, white calcareous rock which had been found by Liversidge on a beach on the east side of New Ireland (Territory of New Guinea), Bismarck Archipelago. Brady (1877, p. 535) also noted that he was aware of the presence of the same form in deep-sea dredgings collected during the voyage of H.M.S. Challenger, 1873-1876. However, we have selected the lectotype (here designated, described and illustrated, pl. 5, figs. 1a-c) from Brady's syntypic series obtained from the white "Chalk" of New Ire-

land. The slide containing the syntypes is registered in the British Museum (Natural History) as number P. 43322 and was labelled in Brady's handwriting as follows: "White Chalk, New Britain, Prof. Liversidge, Geol. Mag., Dec. 1877, p. 535;" it is also labelled "*Pulvinulina menardii* var. *tumida*, Post Tertiary, New Ireland" with the same bibliographic reference. As in the case of *Globigerina sacculifera* Brady, there appears to have been some confusion in Brady's MS. as to the precise geographic origin of Liversidge's material, but this seems to have been corrected in Brady's published work.

The lectotype is now registered in the British Museum (Natural History) as specimen number P. 44034.

Bolli, Loeblich and Tappan (1957, p. 42, pl. 10, fig. 2) illustrated a "syntype" which they stated to be from the "Post Tertiary" of New Ireland; this specimen is now deposited in the U. S. National Museum as number P. 3143. If it be presumed that this specimen is actually a syntype, as stated by the authors, then it must have originated from Brady's original syntypic series which was deposited in the British Museum. Unfortunately, we have not been able to trace any record of a syntypic specimen having left the British Museum. The preservation of Brady's remaining syntypic specimens seems to be less good than that illustrated for Bolli, Loeblich and Tappan's specimen, although we have no doubt that the two forms are conspecific.

This species, *Pulvinulina tumida* Brady, was designated the type species of the genus *Globorotalia* Cushman 1927, by Cushman (1927) and used by him as the basis of his family Globorotaliidae (1927 and 1928).

Description of lectotype.—The large tumid test consists of about 17 chambers comprising 3 whorls of a moderately low trochospiral with 6 chambers in the last whorl. The number of chambers in each whorl increases slightly during ontogeny and they enlarge regularly but fairly slowly. As seen in dorsal aspect the chambers are initially reniform, becoming sub-quadrangle in outline; they are little, if at all, inflated and are not embracing. In ventral aspect the chambers are sub-triangular, slightly inflated and partially embracing. The test is completely evolute dorsally but ventrally highly involute with a small but fairly deep umbilicus (which is partially infilled in lectotype). The equatorial profile is sub-circular and the equatorial periphery is smooth to weakly lobulate but becoming angular and sharply truncate in the terminal face. The axial profile is rhomboid, the test being almost equally biconvex. The axial periphery is acute and is furnished with an imperforate carina which is extremely massive on the early part of the last whorl becoming less strongly developed (although still well marked) on the terminal face. The dorsal sutures are slightly depressed but are distinctly thickened with clear shell material; these sutural deposits are continuous with, but appear

thinner than, the material of the carina. The spiral suture is weakly lobulate; the dorsal intercameral sutures are initially smoothly curved but later become more sharply curved, their proximal ends being almost straight and nearly radial whilst their distal ends are re-curved almost tangentially to the periphery. The ventral sutures are not thickened but are depressed, and are weakly sinuous to nearly radial throughout. The primary aperture is interiomarginal, umbilical-extraumbilical, extending for about two thirds of the length of the basal suture; it is a low arch, partially covered by a distinct, uniformly broad, thick lip which appears to be a direct continuation of the chamber wall. The lip extends from the part of the aperture nearest the periphery almost to, but not quite reaching, the umbilicus, so that the inner part of the aperture is uncovered. The apertural face is, in apertural view, trapezoid in general outline; it is somewhat flattened and meets the ventral surface of the last chamber in a distinct but rounded angle. The apertural face is limited dorsally by an extension of the carina and is slightly concave near it. The ventral surface of the last chamber is slightly concave near the periphery but becomes strongly convex towards the umbilicus thus forming a broadly rounded umbilical shoulder. It is, in part at least, this feature which gives the "swollen," tumid appearance to the ventral surface of the test. The wall is calcareous, radial in structure, and uniformly and finely perforate except in the thickened dorsal sutures, the massive carina, and (possibly) in the pustulose areas. The surface of the test is smooth except for the ventral surface of the early chambers of the last whorl and the umbilical margins of the later chambers; these areas are heavily pustulose. Maximum diameter of lectotype: 0.75 mm.

Remarks.—The development of pustules on the ventral surface of the test varies greatly between individuals; the pustules of the lectotype are particularly strong (compare the specimen illustrated by Bolli, Loeblich and Tappan, 1957). The pustules are developed on that part of the ventral surface which faces the primary aperture and which surrounds the umbilicus. This distribution of pustules is common to many rotaliform Foraminifera and is well known to occur in species of *Amphistegina* for example. Owing to the restricted distribution of these pustules it is considered here that they are secondarily formed on the walls of early chambers by protoplasmic flow from the aperture of the last formed chamber and possibly by similar protoplasmic flow, *via* the umbilicus, from relict parts of the primary apertures of earlier chambers. It is probable that this secondary deposition of calcareous material was responsible for the greatly thickened nature of the apertural lip and of the early parts of the carina, which is characteristic of the species. It is therefore possible that these pustules are due to a genetically inherited tendency to secrete more calcar-

eous material than is structurally necessary for test growth. This exceptionally high secretion of skeletal material is usually present in phylogenetic end-forms (possibly associated with the phenomenon known as phylogerontism). Evolutionary links leading to these end forms usually reveal trends towards a greatly increased overall test size during phylogeny and this appears to have happened within the evolution of forms comprising the "*G. menardii*" stock (compare Blow, 1959), reaching an apparent climax of development in *Globorotalia tumida*. This latter form is believed to have originated and separated from "*Globorotalia menardii*" *sensu stricto* in the Upper Tortonian and/or Lower Sarmatian. A parallel case is that seen in the *Globorotalia fohsi* - *Globorotalia lobata* lineage (Bolli 1950, Banner and Blow 1959) within the Lower Miocene. Here, a small unkeeled form gave rise to a larger carinate form which, in turn, became more strongly carinate and robust until the lineage ended with *Globorotalia lobata robusta* (Bolli), which is a gross pseudomorph of *Globorotalia tumida* (Brady). However, *Globorotalia lobata robusta* (Bolli) differs from *Globorotalia tumida* (Brady) in possessing typically more chambers in the last whorl, these chambers being more narrowly triangular in ventral view and more sub-rectangular throughout in dorsal aspect; the dorsal intercameral sutures of *G. lobata robusta* are straighter and more nearly radially directed throughout. *G. tumida* is much more nearly equally biconvex possessing a greater dorsal convexity and a relatively less ventral convexity than is seen in *G. lobata robusta*.

Although *G. tumida* (Brady) and "*G. menardii*" are now clearly morphologically distinct and can be considered as separate species, in the Upper Tortonian and Sarmatian populations exist in which it is difficult to clearly separate the two forms. Many morphologically intermediate forms are present at this level indicating that during Upper Miocene times a gradual dichotomy took place leading to the separation of the two species (see text figure 2, and compare pp. 31 and 34-35).

Pulvinulina scitula Brady, 1882

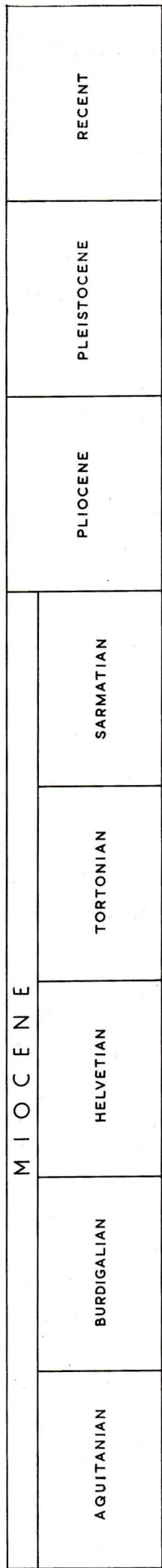
Plate 5, figures 5a-c

Pulvinulina scitula BRADY, 1882, Roy. Soc. Edinburgh, Proc., Edinburgh, vol. 11, (1880-1882), no. 111, pp. 716-717, (no figure) [lectotype here designated].

Pulvinulina patagonica (d'Orbigny), BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, pt. 22, p. 693, pl. 103, figs. 7a-c (*non Rotalina patagonica* d'Orbigny 1839).

Globorotalia scitula (Brady), CUSHMAN and HENBEST, 1940, U. S. Geol. Survey, Prof. Paper 196-A, pt. 2, p. 36, pl. 8, figs. 5a-c.

Globorotalia scitula scitula (Brady), BLOW, 1959, Bull.



Globorotalia (T.) scitula praescitula Blow To *Globorotalia (T.) scitula* (Brady) group (see Blow 1959)

acquisition of an imperforate "keel" (= carina)

Globorotalia cultrata archeomenardii (Bolli)

Globorotalia cultrata praemenardii (Cushman & Stainforth)

trend towards carina becoming more massive.

Globorotalia cultrata multicamerata (Cushman)

trend towards more chambers in last whorl.

strong development of carinal spines.

Globorotalia cultrata fimbriata (Brady)

Globorotalia cultrata menardii (Parker, Jones & Brady) and *Globorotalia cultrata* s.s. (d'Orbigny).

trend to more tumid test with higher trochospire and thicker walls and carina.

[G. cf. *tumida*]

[G. cf. *tumida*]

Globorotalia tumida (Brady)

trend towards more tumid test.

Globorotalia miocenica Palmer

FIGURE 2

Simplified phylogeny of the species-plexus centred on *Globorotalia (Globorotalia) cultrata* (d'Orbigny).

Amer. Pal., vol. 39, no. 178, p. 219, pl. 19, figs. 126a-c.

Taxonomic remarks.—Brady (1882) first described, but did not figure, this species from samples collected by the "Knight Errant" expedition to the Farøe Channel in 1880. The samples taken during this expedition are deposited in the British Museum (Natural History) and two slides labelled "*Pulvinulina patagonica* d'Orbigny sp. = *P. scitula* Brady" and "Knight Errant, S.7, 530 fathoms," the latter in Brady's handwriting, are present in the "Knight Errant" collection. From this syntypic series a lectotype, here designated, described and figured (pl. 5, figs. 5a-c), has been isolated and it is now registered as specimen no. 1959.6.25.1. in the British Museum (Natural History) records.

In 1884, Brady redescribed this species from samples collected by the "Challenger" Expedition; in this subsequent work he doubted the novelty of his species and referred the specimens to *Pulvinulina patagonica* (d'Orbigny) (= *Rotalina patagonica* d'Orbigny 1839). However, we do not believe that *Rotalina patagonica* d'Orbigny is even congeneric with *Pulvinulina scitula* Brady and consequently regard the latter as a separate and distinct species.

Description of lectotype.—The fairly small test consists of about 14 chambers arranged in nearly three whorls, which comprise a low trochospire with 5-6 chambers in a whorl. The chambers are slightly embracing and uniformly and slowly enlarging; they are little, if at all, inflated dorsally but are slightly inflated ventrally. The equatorial profile of the test is sub-circular and possesses a periphery which becomes increasingly, although still weakly, lobulate in ontogeny. The axial profile shows that the test is compressed dorso-ventrally; the peripheral margin is acutely rounded but it is not carinate or secondarily thickened (i. e., no pseudocarina is present). The sutures are slightly depressed, not limbate or thickened, and the spiral suture is weakly lobulate. The dorsal intercameral sutures are strongly recurved and vorticiform; the distal ends of these sutures are smoothly tangential to the periphery. In the earlier ontogenetic stages the proximal ends of the intercameral dorsal sutures meet the spiral suture at a broadly acute angle, but later in ontogeny these sutures meet the spiral suture almost at right angles. The chambers of the last whorl show a decrease in the amount of embrace dorsally and simultaneously become even less inflated on that side of the test than they were earlier; this is associated with a step-like appearance which develops between successive chambers on the dorsal surface of the last whorl. The ventral sutures are nearly radial; initially they are smoothly curved, but later they become slightly sigmoidal. The umbilicus is small and it is almost closed by an umbilical lobe of the last chamber. The primary aperture is interiomarginal, umbilical-extraumbilical; it is a low arch extend-

ing from the umbilicus for about three quarters of the length of the terminal basal suture. The aperture possesses a uniformly very narrow and thin lip. The apertural face is slightly concave in its distal region but is smoothly convex near the umbilicus; it is not clearly delimited from the ventral surface of the last chamber. The wall of the test is thin and is uniformly and very finely perforate except for a weakly pustulose area on the ventral surface of the first chamber of the last whorl (facing the terminal aperture). The surface of the test is fairly smooth and shows little trace of any original hispidity; it possesses a characteristic glistening and a somewhat translucent appearance. Maximum diameter of lectotype: 0.31 mm.

Remarks.—The lectotype is distinctly larger than any of the remaining syntypes in the Brady collection although we believe it to be fully conspecific with them. Blow (1959, p. 220, pl. 16, figs. 127a-c) proposed the name *Globorotalia scitula gigantea* for populations characterised by individuals of distinctly greater dimensions and which were, in fact, almost double the size of co-existing typical specimens in the Lower Miocene. Brady (1884, p. 693) also commented on the much greater size of specimens of this species found in the South Pacific deeps compared to those in the Farøe Channel. The smaller specimens (similar to our lectotype) appear earlier in time in the highest Aquitanian whereas *G. scitula gigantea* occurs after the extinction of the index species *Globorotalia fohsi barisanensis* (i. e., within the Lower Burdigalian). As the origin of *G. scitula* appears to be from the yet smaller form *G. scitula praescitula* (see Blow, 1959) this lineage may also demonstrate the increase in size of its members during evolution. Although the relationships of *G. scitula scitula* and *G. scitula gigantea* are not yet clear, there may be a geographic and/or bathymetric relationship in the distributions of these two forms and the ecological factors involved may be affecting incipient speciation.

Akers (1955) described *Globorotalia canariensis* (d'Orbigny) var. *minima* from the "Middle" and "Upper" Miocene of Louisiana. Blow (1959) has shown that this form actually ranges from the Upper Aquitanian to Upper Burdigalian and that it is better considered as the separate species *Globorotalia minima* Akers. It appears to have arisen directly from *G. scitula praescitula* and is distinguishable from *G. scitula scitula* (Brady) by its greater number of chambers per whorl, less re-curved, more radial intercameral sutures, more strongly convex ventral side and closed umbilicus.

Pulvinulina scitula Brady 1882 is referable to the subgenus *Turborotalia* Cushman and Bermúdez 1949.

Rosalina linneiana d'Orbigny, 1839

Rosalina linneiana D'ORBIGNY, 1839, in de la Sagra, Histoire physique, politique et naturelle de l'île

de Cuba, Bertrand, Paris, p. 101; (as *Rosalina linnei* d'Orbigny), vol. 8, pl. 5, figs. 10-12.

General remarks.—In 1839, d'Orbigny described *Rosalina linneiana* from the shore sand of Cuba. As has been pointed out by Brönnimann and Brown (1956, pp. 540-542), it was most probably derived from adjacent Cretaceous strata. In the d'Orbigny collections in Paris there exists a tube containing a single broken specimen. The front of the mount is labelled "*Rosalina linneiana*, Cuba" in Terquem's handwriting, and d'Orbigny's original label inscribed as follows:

Cuba
Rosalina
Linnei
V - 10 - 12

is pasted on to the reverse of the mount. We agree with Brönnimann and Brown (*op. cit.*, *loc. cit.*) that d'Orbigny's textual reference to "*linneiana*" gives the correct spelling of the patronymic.

The single remaining syntype is very badly damaged but sufficient remains of the final chambers still exist to show that d'Orbigny's illustration was an accurate representation, and may even have been based on this particular specimen before the damage occurred.

Brönnimann and Brown (*op. cit.*, *loc. cit.*) proposed a "topotypic" neotype for this species. However, the existence of a d'Orbigny syntype makes the status of the neotype doubtful, especially as Brönnimann and Brown gave no indication as to where this neotype is deposited. Therefore, we are not able to judge the validity of the neotypic specimen in accordance with the "conditions for the establishment of neotypes" given in the Copenhagen Decisions on Zoological Nomenclature (Hemming, 1957). If the neotype can be fully validated by Brönnimann and Brown, we consider that it would be preferable to suppress the syntype in favour of the neotype under Section 1, Subsection B, para. 40, of the Copenhagen Decisions. However, this is a matter for the original authors of the proposed neotype to consider further.

One of the later chambers of d'Orbigny's syntype is broken, disclosing the axial section. This section is very closely similar to that figured by Quereau (1893, pl. 5, fig. 3a) for his species *Pulvinulina tricarinata*. This particular illustration was taken by Bolli (1945, p. 232) as the basis of *Globotruncana lapparenti tricarinata* (Quereau) in his subdivision of the species *Globotruncana lapparenti* Brotzen 1936. However, Vogler (1941, p. 287) was at least nominally correct when he referred "*tricarinata*" to the older species "*linneiana*" and we consider that, as there is no known morphological distinction between *Pulvinulina tricarinata* Quereau (as restricted by Vogler, 1941, and Bolli, 1944) and *Rosalina linneiana* d'Orbigny, the two forms should be considered synonymous.

Rotalia limbata d'Orbigny, 1902

Plate 5, figures 3a-c

Rotalia limbata D'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., vol. 7, p. 274, list no. 30, [*nomen nudum*].

Rotalia limbata D'ORBIGNY, in FORNASINI, 1902, R. Acad. Sci. Ist. Bologna, Mem. Sci. Nat., Bologna, ser. 5, vol. 10, p. 56, text-fig. 55, ("disegno inedito") [lectotype here designated].

Taxonomic remarks.—When d'Orbigny (1826) proposed the name *Rotalia limbata* for specimens he had obtained from the Adriatic sea near to Rimini, he neither described nor illustrated the species. As not even a synonymous reference was given in 1826 the species was *nomen nudum* and it did not become taxonomically available until Fornasini published d'Orbigny's drawings in 1902.

In the A. d'Orbigny collections in Paris a tube labelled "*Rotalia limbata* d'Orb. (Subapennin) Rimini," contains the only surviving syntypic specimen of this species. This specimen is here designated, illustrated and described as lectotype of *Rotalia limbata* d'Orbigny.

Description of lectotype.—The test consists of 14 chambers arranged in about 2½ whorls comprising a low trochospire with 6 chambers present in the last whorl. The equatorial profile is sub-circular and the equatorial periphery is moderately lobulate. The axial profile is rhomboidal with an acute carinate periphery. The test is somewhat compressed dorso-ventrally and is almost equally biconvex. The chambers are uniformly and regularly enlarging (with the exception of the abnormally reduced final chamber); in dorsal aspect they are semi-circular, little inflated and do not embrace. In ventral view the chambers are sub-triangular, slightly inflated and partially embracing. The dorsal sutures are slightly depressed and are limbate, being thickened by a deposit of clear shell material which is continuous with the imperforate peripheral carina. The dorsal intercameral sutures are, for the most part, smoothly curved but in the last few chambers they become angular. These sutures meet the spiral suture at right angles and recurve to become almost tangential to the periphery. The ventral intercameral sutures are depressed, not thickened or limbate, but are slightly curved or slightly sinuous and become nearly radial. The umbilicus is small, open and fairly deep. The primary aperture is a low interiomarginal arch, extending from the umbilicus almost to the periphery; it possesses a thin and narrow lip along its length. The apertural face is sub-triangular in apertural view and is only slightly flattened, not being clearly delimited from the ventral face of the last chamber. The umbilical shoulders of the ventral surfaces of the chambers are weakly developed. The wall is finely and uniformly perforate, except for the areas of the imperforate peripheral carina and the

dorsal sutural limbations. The surface of the test is smooth except for a weakly developed pustulose area on the ventral side of the first chamber of the last whorl, facing the primary aperture. Maximum diameter of lectotype: 0.44 mm. The lectotype has suffered slight damage and parts of the periphery of the last two chambers have been lost.

Remarks.—This species has not been recorded in the literature as far as we are aware. Most authors appear to have followed Fornasini (1902, p. 56) in considering it difficult to separate from *Globorotalia menardii* (d'Orbigny) *auct.* We believe it to be a junior synonym of *Rotalina cultrata* d'Orbigny 1839, (see p. 34).

***Rotalia menardii* Parker, Jones and Brady, 1865**

Plate 6, figures 2a-c

Rotalia (Rotalie) menardii, d'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., Paris, ser. 1, vol. 7, p. 273, list no. 26, [*nomen nudum*] (*teste* Parker, Jones and Brady, 1865).

Rotalia menardii PARKER, JONES and BRADY, 1865, Ann. Mag. Nat. Hist., vol. 16, ser. 3, p. 20, pl. 3, fig. 81, [lectotype here designated].

Taxonomic remarks.—The name *Rotalia (Rotalie) menardii* was first proposed by d'Orbigny in 1826 for material seen by him from the Adriatic Sea near to Rimini. He gave no description, illustration, reference to prior synonymous name or any other valid indication of the nature of the species; he merely referred to model number 10 (1^e livraison) which had been issued to private subscribers in 1823. As the model cannot count as a published indication or description (*vide* R. V. Melville) the name *Rotalia (Rotalie) menardii* was *nomen nudum* and had no taxonomic availability whatsoever, not even under the rules of homonymy.

In 1865, Parker, Jones and Brady published the first valid indication for this species; they published a drawing of d'Orbigny's model no. 10 and this constitutes the first published indication. It should be noted that d'Orbigny's model was only available to private subscribers whereas the drawing by Parker, Jones and Brady was contained in a recognised scientific work which was for public sale. Although the model was made by d'Orbigny, the publication and illustration were made by Parker, Jones and Brady and we are informed by the Assistant Secretary of the International Commission on Zoological Nomenclature (R. V. Melville) that the binomen *Rotalia menardii* belongs to Parker, Jones and Brady and dates from their work in 1865. This case contrasts to those where d'Orbigny's species were subsequently validated by the later publication (by Fornasini) of d'Orbigny's own drawings.

Parker, Jones and Brady (*op. cit.*, p. 20) recorded that they had observed some specimens of *Rotalia menardii* in "sands dredged from deep-water off the Isle of Man." These specimens, together with any

material labelled by d'Orbigny in or prior to 1826 (because the d'Orbigny 1826 reference was placed in full synonymy by Parker, Jones and Brady), would constitute the syntypic specimens of the species *Rotalia menardii*. With the assistance of MM. Marie, Lys and Sornay, we searched through the A. d'Orbigny collections in Paris for d'Orbigny's syntypic specimens of *R. menardii* and, together with the French authorities, we are confident that no such syntypic specimens exist. However, H. B. Brady and his brother, G. S. Brady, collected many samples of recent material from off the coast of the Isle of Man (Irish Sea) in June 1863. These samples are still extant in the collections deposited in the British Museum (Natural History), London. Also present in the H. B. Brady collections is a slide labelled in Brady's handwriting "*Pulvin. menardii*, off Laxey, Isle of Man, 15 fathoms." This slide contained three specimens, and, because no other specimens are recorded or exist which came from this locality and which were labelled "*menardii*" by Parker, Jones or Brady prior to 1865, these specimens constitute the only available syntypic series for the species *Rotalia menardii* Parker, Jones and Brady 1865.

Parker, Jones and Brady (1865, p. 20) considered that this species was subspecifically related to *Pulvinulina repanda* and it is probably for this reason that Brady's slide was inscribed "*Pulvin. menardii*." However, Parker, Jones and Brady originally described this form under the heading "*Rotalia menardii*" for it is this name which clearly refers to their illustration. Hence, *Rotalia menardii* is the correct original name for this species.

All the three syntypic specimens had undergone (damage. The best preserved of the three has been isolated, and is now registered in the British Museum (Natural History) as specimen no. 1959.7.27.3. This specimen is here designated lectotype of *Rotalia menardii* Parker, Jones and Brady 1865 and is here illustrated (pl. 6, figs. 2a-c) and described.

Description of lectotype.—The fairly large test consists of about 3 whorls of fairly rapidly enlarging chambers arranged in a moderately low trochospire. There are about 5½ chambers present in the last whorl (the final chamber being damaged peripherally). The equatorial profile of the test is subcircular and its equatorial periphery is moderately lobulate. In axial profile the test is moderately compressed, being almost equally biconvex and the axial periphery is acute and strongly carinate. In dorsal aspect the chambers are weakly inflated and are little, if at all, embracing; the chambers are nearly as long circumferentially as they are broad radially. The dorsal sutures are slightly depressed and are thickened with a deposit of clear shell material which appears to be continuous with the peripheral imperforate carina. The inner (proximal) ends of the dorsal intercameral sutures meet the mod-

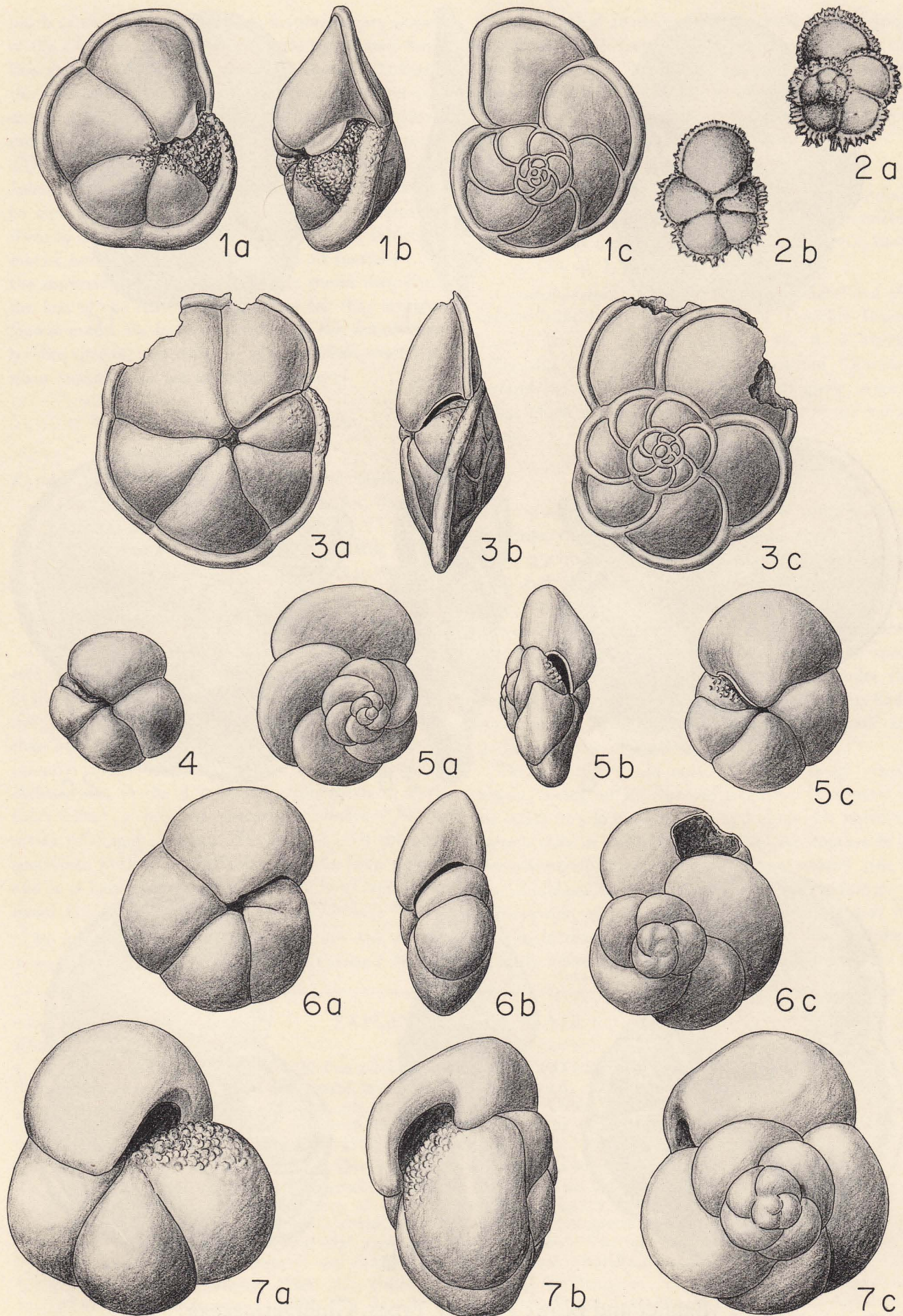
erately lobulate spiral suture almost at right angles, while they become smoothly recurved distally to meet the periphery almost tangentially. In ventral aspect the chambers are sub-triangular and moderately inflated. The ventral intercameral sutures are depressed, not thickened or limbate, and are nearly radial being slightly curved to sinuous. The umbilicus is small (compared to overall test size), but it is open and deep. The inner parts of the ventral chamber sides form inconspicuous umbilical shoulders. The primary aperture is interiomarginal, umbilical-extraumbilical, a moderately high arch extending for the full length of the ventral basal suture of the final chamber. The primary aperture is furnished, along its length, with a uniformly developed thin, but hispid, lip. Relict parts of the apertures of the later chambers of the last whorl, together with their lips, may be seen within the umbilicus. The apertural face of the terminal chamber is slightly flattened although there is no angular delimitation between it and the adjacent ventral face; the apertural face is limited peripherally by a slender continuation of the carina and the face becomes slightly concave in the vicinity of it. The wall is finely perforate except in the imperforate regions of the dorsal sutures and the peripheral carina. The surface of the test is smooth except for weakly hispid areas on the

ventral faces of the first two chambers of the last whorl and the adjacent parts of the carina. Maximum diameter of lectotype: 0.76 mm.

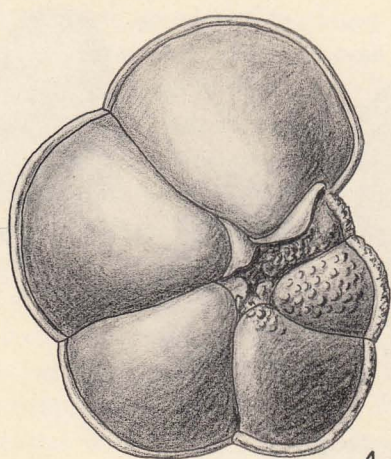
Remarks.—This form appears to have been referred to by very many authors as *Globorotalia menardii* (d'Orbigny); because the taxon *Rotalia menardii* d'Orbigny has never existed, the concept of the species maintained by these authors (e. g., Cushman and Henbest 1940, Coryell and Rivero 1940, LeRoy 1941, Stainforth 1948, Wiseman and Ovey 1950, Phleger, Parker and Peirson 1953, Weiss 1955, Hofker 1956, Bolli 1957, Blow 1959, etc.) has been without real foundation. The species "*Globorotalia menardii* d'Orbigny" has been extensively used by authors during the last three decades, fortunately basing their concepts on the later work of Brady (1884). In consequence we consider that the authors cited above have correctly used the name "*menardii*" although it was not realised that the species belonged to Parker, Jones and Brady (1865) and not to d'Orbigny (1826). Owing to the extensive usage of the taxon "*G. menardii* d'Orbigny," it is unfortunate that it is impossible to maintain that species; it has never been validated, and is even predated by the well described and illustrated *Rotalina cultrata* d'Orbigny 1839 which is clearly conspecific (see p. 34, pl. 6, figs. 1a-c). As

EXPLANATION OF PLATE 5

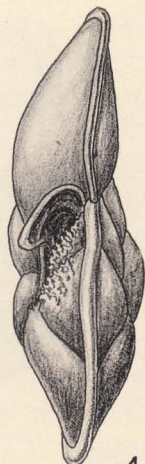
- | FIGS. | PAGE |
|--|------|
| 1. <i>Pulvinulina menardii</i> var. <i>tumida</i> Brady 1877 [= <i>Globorotalia tumida</i> (Brady)]; lectotype, $\times 50$. Fig. 1a, ventral view; fig. 1b, axial peripheral view; fig. 1c, dorsal view. This is the type of the genus <i>Globorotalia</i> Cushman 1927. The specimen was obtained by Brady from an exotic block (of Upper Miocene or Pliocene age?) from New Ireland, and is now deposited in the British Museum (Natural History), and registered as specimen no. P. 44034 | 26 |
| 2. <i>Pulvinulina menardii</i> var. <i>fimbriata</i> Brady 1884 [= <i>Globorotalia cultrata</i> (d'Orbigny) subsp. <i>fimbriata</i> (Brady)]; lectotype, $\times 25$. Fig. 2a, dorsal view, after Brady, 1884, pl. 103, fig. 3a; fig. 2b, ventral view, after Brady, <i>loc. cit.</i> , fig. 3b. The specimen was obtained by Brady from the recent sea, "Challenger" station 24, off Culebra Island (W. Indies), at 390 fathoms; it is now deposited in the British Museum (Natural History), and registered as no. 1959.7.1.2 | 25 |
| 3. <i>Rotalia limbata</i> d'Orbigny 1902 [= <i>Globorotalia limbata</i> (d'Orbigny) = <i>Globorotalia cultrata</i> (d'Orbigny 1839)]; lectotype, $\times 100$. Specimen obtained by d'Orbigny from the recent deposits of the Adriatic near Rimini, now deposited in the A. d'Orbigny collection, Muséum Nationale de l'Histoire Naturelle, Paris. Fig. 3a, ventral view; fig. 3b, axial peripheral view; fig. 3c, dorsal view. The specimen is damaged peripherally in the last two chambers | 30 |
| 4. <i>Rotalina canariensis</i> d'Orbigny 1839 [= <i>Globorotalia</i> (<i>Turborotalia</i> ?) <i>canariensis</i> (d'Orbigny)]; syntype, $\times 50$. Ventral view. The specimen is extremely fragile, and is distorted, partly by dorsal fractures; it was obtained by d'Orbigny from recent marine sediments off the Canary Islands, and is deposited in the A. d'Orbigny collection of the Muséum Nationale de l'Histoire Naturelle, Paris | 33 |
| 5. <i>Pulvinulina scitula</i> Brady 1882 [= <i>Globorotalia</i> (<i>Turborotalia</i>) <i>scitula</i> (Brady)]; lectotype, $\times 100$. Fig. 5a, dorsal view; fig. 5b, axial peripheral view; fig. 5c, ventral view. The specimen was obtained by Brady from the "Knight Errant" sample taken at Station 7, 530 fathoms depth, in the Farøe Channel; it is deposited in the British Museum (Natural History), registered as no. 1959.6.25.1 | 27 |
| 6. <i>Globigerina depressa</i> d'Orbigny 1903 [= <i>Globorotalia</i> (<i>Turborotalia</i>) <i>depressa</i> (d'Orbigny) = ? <i>G. (T.) scitula</i> (Brady)] (<i>non Globigerina depressa</i> Ehrenberg 1844); only remaining syntype, $\times 100$. Fig. 6a, ventral view; fig. 6b, axial peripheral view; fig. 6c, dorsal view, showing damage to the last chamber. The specimen was obtained by d'Orbigny from recent marine deposits off St. Helena, and it is now deposited in the A. d'Orbigny collection, Muséum Nationale de l'Histoire Naturelle, Paris | 10 |
| 7. <i>Globigerina puncticulata</i> Deshayes 1832 [= <i>Globorotalia</i> (<i>Turborotalia</i>) <i>puncticulata</i> (Deshayes)]; lectotype, $\times 100$. This specimen is also the lectotype of <i>Globigerina punctulata</i> d'Orbigny (1826) (1898) 1899. Fig. 7a, ventral view; fig. 7b, axial peripheral view; fig. 7c, dorsal view. This specimen was obtained by d'Orbigny from recent sediments of the Adriatic near to Rimini, and is now deposited in the A. d'Orbigny collection, Muséum Nationale de l'Histoire Naturelle, Paris | 15 |



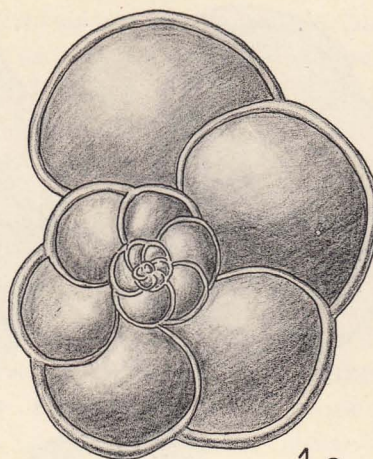
Banner and Blow: Primary Types, Globigerinaceae



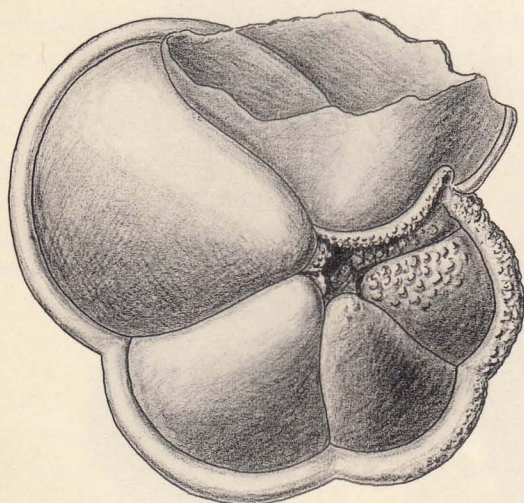
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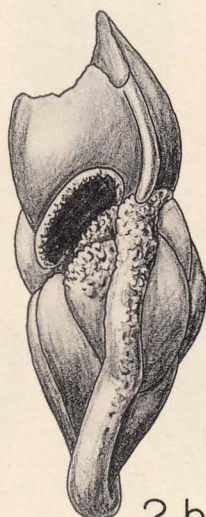
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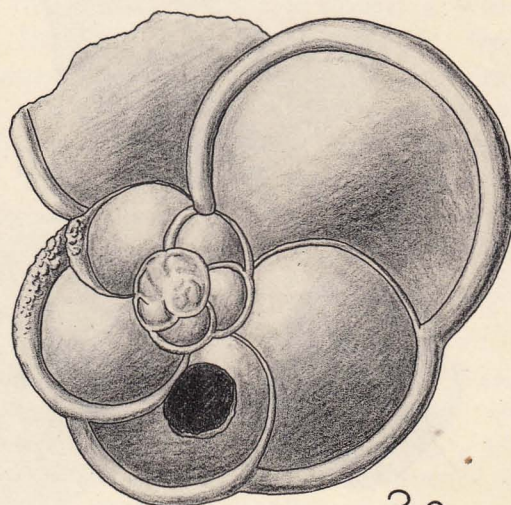
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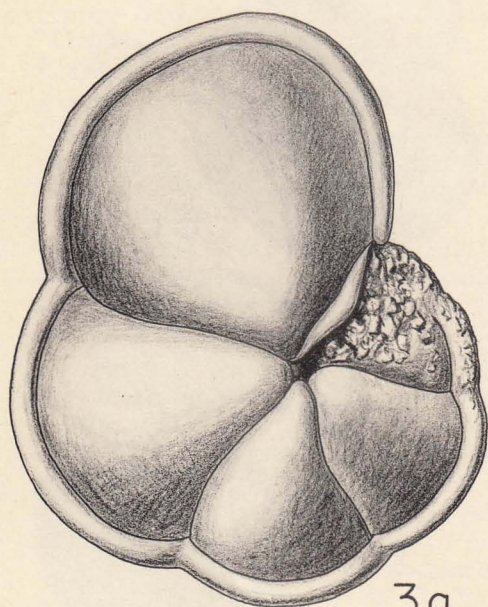
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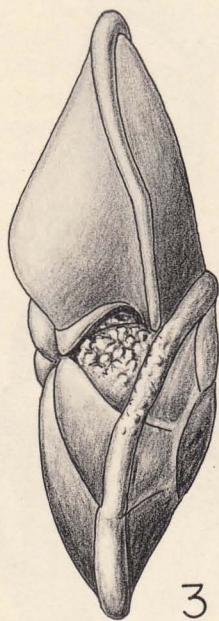
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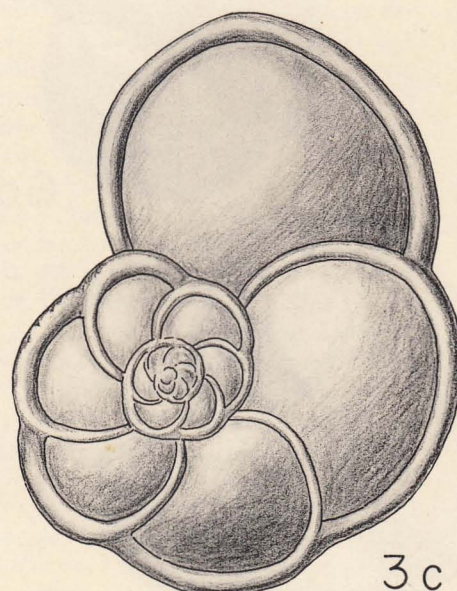
2c



3a



3b



3c

much as we would have liked to invoke plenary powers of the I.C.Z.N. to suppress the little used name *Rotalina cultrata* in favour of *Rotalia menardii* d'Orbigny, this cannot be done as the latter name has never possessed taxonomic availability. It may be considered preferable to suppress the name *Rotalina cultrata* d'Orbigny 1839 in favour of *Rotalina menardii* Parker, Jones and Brady 1865, but, while we believe them to be conspecific, there are still grounds for considering them to be subspecifically distinct. This is a subjective matter and should be considered by all specialists. As the suppression of *Rotalina cultrata* would then entail the loss of the only available name for that morphological group, we have retained it as the senior name for the species, and consider that *menardii* should remain available for use at subspecific level.

Rotalia nitida d'Orbigny, 1906

Plate 6, figures 3a-c

Rotalia nitida d'ORBIGNY, 1826, Tableau Méthodique de la classe des Céphalopodes, Ann. Sci. Nat., vol. 7, p. 274, list no. 31, [*nomen nudum*].

Rotalia nitida d'ORBIGNY, in FORNASINI, 1906, R. Acad. Sci. Ist., Bologna, Mem. Sci. Nat. Bologna, Ser. 6, vol. 3, p. 66, pl. 3, figs. 4, 4a, 4b, [lectotype here designated].

General remarks.—Although the name *Rotalia nitida* d'Orbigny was *nomen nudum* in 1826, it became available in 1906 when d'Orbigny's drawing of this species was published. In 1826, d'Orbigny had noted that his specimens of this species came from recent material collected from the coasts of the island of Ste. Hélène, and, in the A. d'Orbigny collections in Paris, there exists a tube of specimens labelled "*Rotalia nitida* d'Orbigny., vivante, Ste. Hélène." Of the eight specimens present in this tube, one has been isolated and it is here illustrated (pl. 6, figs. 3a-c) and designated as lectotype of *Rotalia nitida* d'Orbigny 1906.

As will be seen from the illustration (pl. 6, figs. 3a-c), the lectotype of *R. nitida* d'Orbigny 1906 is

almost identical to that of *R. menardii* Parker, Jones and Brady 1865 (see p. 31, pl. 6, figs. 2a-c) and we also believe it to be fully conspecific with *Rotalina cultrata* d'Orbigny 1839 (see p. 34, pl. 6, figs. 1a-c).

Rotalina canariensis d'Orbigny, 1839

Plate 5, figure 4

Rotalina canariensis d'ORBIGNY, 1839, Foraminifères des Îles Canaries (in Barker-Webb and Berthelot, Hist. Nat. Îles Canaries), Paris, vol. 2, pt. 2, Zool., p. 130, pl. 1, figs. 34-36.

General remarks.—In 1839, d'Orbigny described this species from recent beach sands of Teneriffe Island, Canary Islands. A tube extant in the A. d'Orbigny collections in Paris bears the inscription "*Rotalina canariensis*, Îles Canaries" and d'Orbigny's original label, which is pasted on the reverse side of the mount reads:

"Can. *Rotalina canariensis*
1 - 34 - 36"

The two specimens which this tube contains must comprise the only available syntypic series. One of these specimens is broken and completely unrecognisable, and the other specimen is also damaged and is very fragile. Accordingly, neither specimen was removed from its mount. Unfortunately, the species *Rotalina canariensis* must be based upon these specimens since no neotype can be proposed whilst this original syntypic material exists. Hence, the less badly preserved of the two specimens is here illustrated and is designated lectotype.

The lectotype could only be viewed in its ventral aspect, owing to its extreme fragility. It appears to be coiled in a low trochospire and about 4½ chambers were visible in the last whorl. The test appears to be dorso-ventrally compressed, with the ventral side of the chambers being little inflated. The periphery is sub-circular, and is initially weakly lobulate, but becoming increasingly so during ontogeny. The periphery is fairly acute but does not possess either a carina or

EXPLANATION OF PLATE 6

FIGS.	PAGE
1. <i>Rotalina cultrata</i> d'Orbigny 1839 [= <i>Globorotalia cultrata</i> (d'Orbigny)]; neotype, × 50. Fig. 1a, ventral view; fig. 1b, axial peripheral view; fig. 1c, dorsal view. The specimen was obtained from near-topotypic recent marine sediments from off Cape Cruz, Cuba, deposited in the Earland Collection of the British Museum (Natural History). The neotype is registered in the British Museum (Natural History) as specimen no. 1959.7.27.4.	34
2. <i>Rotalia menardii</i> Parker, Jones and Brady 1865 [= <i>Globorotalia menardii</i> (Parker, Jones and Brady) ? = <i>Globorotalia cultrata</i> (d'Orbigny)]; lectotype, × 75. The specimen was obtained by H. B. Brady from recent marine sediments, at 15 fathoms depth, off Laxey, Isle of Man, Irish Sea; it is now deposited in the British Museum (Natural History), registered as specimen no. 1959.7.27.3. Fig. 2a, ventral view; fig. 2b, axial peripheral view; fig. 2c, dorsal view. The last chamber is broken peripherally, and the dorsal surface of the third chamber of the last whorl is damaged	31
3. <i>Rotalia nitida</i> d'Orbigny 1906 [= <i>Globorotalia nitida</i> (d'Orbigny) = <i>Globorotalia cultrata</i> (d'Orbigny)]; lectotype, × 100. Fig. 3a, ventral view; fig. 3b, axial peripheral view; fig. 3c, dorsal view. This specimen was obtained by d'Orbigny from recent marine sediments off St. Helena, and it is now deposited in the A. d'Orbigny collection in the Muséum Nationale de l'Histoire Naturelle, Paris	33

pseudocarina. The ventral intercameral sutures are initially indistinct but they become increasingly, although still weakly, depressed towards the terminal chamber. These sutures are slightly curved to nearly radial. The umbilicus is very small, and is virtually closed. The aperture is not clearly visible, but appears to be a low, slit-like, interiomarginal, umbilical-extra-umbilical opening. The surface of the test is smooth, being roughened, as far as can be seen, only on the earlier part of the ventral surface. The test appears to be finely perforate. Maximum diameter of lectotype: approximately 0.44 mm.

In view of the facts that this fragile specimen is broken, that the last chambers are almost certainly missing, and that it is not possible to examine the dorsal surface, it is impossible to form an opinion as to the complete morphological identity of the species. Whilst the ventral and peripheral characters suggest an affinity to the form described by Brady (1882) (see also this work, p. 27, pl. 5, fig. 5) as *Pulvinulina scitula*, it is not possible to be sure of this. Indeed, the lectotype of *R. canariensis*, showing only the ventral characters, could be referable to forms such as that described by d'Orbigny himself, in 1839, as *Rotalina hirsuta* (see also, for example, Cushman and Henbest, 1940, pl. 8, figs. 6a-c). However, the lectotype shows no trace of a carina and it seems unlikely that the form described by Brady (1884, pl. 103, figs. 8-10) as *Pulvinulina canariensis* (d'Orbigny) is correctly identified.

We consider, in view of the above writing, that *Rotalina canariensis* d'Orbigny 1839 is an unrecognisable species, that the name should be considered *nomen dubium* and should not be used when describing other material.

***Rotalina cultrata* d'Orbigny, 1839**

Plate 6, figures 1a-c

Rotalina (Rotalina) cultrata D'ORBIGNY, 1839, in de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, Bertrand, Paris, p. 76, (plates published separately, vol. 8, pl. 5, figs. 7-9).

Taxonomic remarks.—D'Orbigny (1839) described this species from recent marine sands of Cuba, Martinique, Guadeloupe and Jamaica. It was adequately described both in Latin and French and well illustrated. With the assistance of MM. Marie, Lys and Sornay we searched through the A. d'Orbigny collections in Paris but were unable to find any syntypic material of this species. The French authorities are in agreement with us that no syntypes exist. Consequently, we examined topotypic material for specimens which agree with d'Orbigny's descriptions and illustrations. A specimen (illustrated here) was found in material collected by A. Earland from recent sands off Cape Cruz, Cuba, and it is clearly conspecific with d'Orbigny's form. We could find no other form which could possibly be ascribed to that described and illustrated by

d'Orbigny. D'Orbigny noted (*op. cit., loc. cit.*) that *R. cultrata* was common in the areas he mentioned; the specimen here illustrated belongs to a species which is common in the same areas, and which, like d'Orbigny's species *R. cultrata*, shows ". . . les plus grands rapports avec nos *Rotalina limbata* de l'Adriatique et *R. nitida* de l'île Sainte-Helene; mais elle s'en distingue par une plus grande dépression, ce qui la rend bien plus tranchante" (d'Orbigny, *op. cit.*, p. 76). The specimen illustrated here (pl. 6, figs. 1a-c) which came from unsorted material in the Earland collection in the British Museum (Natural History), is now isolated into a single-celled slide and registered as specimen number 1959.7.27.4 in the British Museum (Natural History) records. In accordance with the Copenhagen Decisions on Zoological Nomenclature (Hemming, 1957, pp. 28-31) we hereby propose this specimen as *neotype* of the species *Rotalina cultrata* d'Orbigny 1839.

Description of neotype.—The fairly large test consists of about three whorls of fairly rapidly enlarging chambers arranged in a moderately low trochospire. There are about six chambers present in the last whorl. The equatorial profile of the test is sub-circular and its equatorial periphery is moderately lobulate. In axial profile the test is compressed, being almost equally bi-convex, and the axial periphery is acute and carinate. In dorsal aspect the chambers are weakly inflated and are little, if at all, embracing; the chambers are nearly as broad radially as they are long circumferentially. The dorsal sutures are slightly depressed and are thickened with a deposit of clear shell material which appears to be continuous with the imperforate peripheral carina. The proximal ends of the dorsal intercameral sutures meet the moderately lobulate spiral suture almost at right angles or obtusely, the angle increasing during ontogeny. These sutures are strongly recurved and meet the periphery almost tangentially. In ventral aspect the chambers are sub-triangular and are moderately inflated. The ventral intercameral sutures are depressed, not thickened or limbate, and are nearly radial, being slightly curved to sinuous. The umbilicus is small (compared to overall test size) but it is open and deep. The inner parts of the ventral chamber sides form inconspicuous umbilical shoulders. The primary aperture is interiomarginal, umbilical-extraumbilical, a moderately high arch extending for the full length of the ventral basal suture of the final chamber. The primary aperture is furnished along its length with a thin, fairly broad lip. Relict parts of the apertures of the later chambers of the last whorl, together with their lips, may be seen within the umbilicus. The apertural face of the terminal chamber is slightly flattened although there is no angular delimitation between it and the adjacent ventral face; the apertural face is limited peripherally by a slender continuation of the carina and the face becomes very slightly concave between the carina and the aperture. The wall is finely

perforate, except in the imperforate regions of the dorsal sutures and the peripheral carina. The surface of the test is smooth except for weakly pustulose areas on the ventral faces of the first two chambers of the last whorl and on the umbilical shoulder of the third chamber of the last whorl. The early part of the peripheral carina is faintly hispid. Maximum diameter of neotype: 0.92 mm.

Remarks.—As d'Orbigny pointed out (*op. cit.*, p. 76) *Rotalina cultrata* only differs from *Rotalia limbata* and *R. nitida* in its flatter, more compressed test and in the presence of six chambers in the last whorl as compared to five in "*limbata*" and "*nitida*." It is interesting to note that although d'Orbigny's syntypes of *R. limbata* and *R. nitida* are the same as the popular concept of "*R. menardii* d'Orbigny," d'Orbigny, himself, never used his earlier name *R. menardii* after 1826. A review of forms ascribed by authors to "*Globorotalia menardii* d'Orbigny" shows a variation in the number of chambers in the last whorl, ranging from 5 - 8. Like these authors, we consider that the number of chambers in the last whorl, within these limits and by themselves, are not of taxonomic importance in this species. The number of chambers per whorl often increases during ontogeny and seems to be associated with ecological factors. However, certain large multicamerate forms, at present largely restricted to tropical waters, seem to be worth considering at subspecific level. These forms include those described as *Globorotalia menardii* var. *multicamerata* Cushman and Jarvis 1930 and *Globorotalia menardii* var. *fijiensis* Cushman 1934. Besides merely possessing additional chambers in the last whorl, there are other differences such as chamber shape and rate of the opening of the spire which have to be considered. It seems likely that these multicamerate forms show geographical subspeciation originating from *Rotalina cultrata* which is here considered to be referable to the genus *Globorotalia* Cushman 1927 *sensu stricto* (see Banner and Blow, 1959).

We believe that *Rotalina limbata* d'Orbigny, *Rotalia nitida* d'Orbigny, *Rotalia menardii* Parker, Jones and Brady and *Discorbina sacharina* Schwager 1866 are all conspecific with (although not necessarily fully synonymous with) *Rotalina cultrata* d'Orbigny 1839.

Globorotalia cultrata (d'Orbigny) has been recorded by authors (as "*Globorotalia menardii* (d'Orbigny)") from Uppermost Burdigalian to Recent (see Blow, 1959); an outline of the phylogeny of the *G. cultrata* stock is given in text-figure 2 (p. 28).

Sphaeroidina bulloides* d'Orbigny var. *dehiscens

Parker and Jones, 1865

Plate 7, figures 3a-b

Sphaeroidina bulloides d'Orbigny var. *dehiscens* PARKER and JONES, 1865, Roy. Soc. London, Philos. trans., London, vol. 155, p. 369, pl. 19, figs. 5a-b.

Sphaeroidina dehiscens Parker and Jones, BRADY, 1884, Rept. Voy. Challenger, Zool., vol. 9, pt. 22, p. 621, pl. 84, figs. 8-11.

Sphaeroidinella dehiscens (Parker and Jones), CUSHMAN, 1927, Contr. Cushman Lab. Foram. Res., vol. 3, pt. 1, no. 39, p. 90, pl. 19, fig. 2 (after Parker and Jones).

Sphaeroidinella dehiscens (Parker and Jones), BOLLI, LOEBLICH and TAPPAN, 1957, U. S. Nat. Mus. Bull. 215, pp. 32-33, pl. 6, figs. 1-3, 5, ?4, [lectotype designated].

Taxonomic remarks.—Parker and Jones (1865) based their original description on material collected from the "Tropical Atlantic Ocean." A series of syntypic specimens, registered in the British Museum (Natural History) and contained in slide no. 94.4.3.368, originated from 1080 fathoms, latitude 2° 20' N., long. 28° 44' W.; from amongst these, Dr. A. R. Loeblich selected a lectotype during his visit to Europe in the year 1953-1954. The lectotype was formally designated by Bolli, Loeblich and Tappan (1957, p. 33) and is deposited and registered in the British Museum (Natural History) as specimen number ZF. 3580. This lectotype is here illustrated and described for the first time (pl. 7, fig. 3).

The species *Sphaeroidina dehiscens* (1865) was designated by Cushman (1927) as the type species of the genus *Sphaeroidinella* Cushman 1927 and this is the type genus of the subfamily Sphaeroidinellinae Banner and Blow 1959. The genus *Sphaeroidinella* Cushman 1927 was restricted and emended by Banner and Blow 1959.

Description of lectotype.—The large globose test shows only three chambers externally. The chambers are subspherical, much inflated, partially embracing, rapidly enlarging and appear to be trochospirally coiled. The test is involute both dorsally and ventrally. The sutures are broadly depressed and the periphery of the test is broadly lobulate. The apertures are sutural and multiple. The primary aperture appears to be interiomarginal, umbilical and ventral in position, but it, like the umbilicus, is infilled by extraneous material. The dorsal supplementary aperture is sutural in position but it is also infilled with extraneous material and consequently its true extent and nature cannot be ascertained in the lectotype. The apertures are furnished with thick flange-like lips of clear imperforate shell material; these flanges extend around the umbilical margins of the chambers and on both sides of the supplementary aperture. The sutures appear to be deeply incised in the vicinity of the apertures and the flanges border these incisions throughout their length and in part bridge them. The wall of the test is calcareous, apparently radial in structure and it is uniformly and coarsely perforate except for the flange-like areas. The surface of the test is smooth and highly polished especially in the vicinity

of the apertures where the material of the flanges appears to spread thickly over the chamber surfaces. Maximum diameter of lectotype: 0.88 mm.

Remarks.—In view of the fact that the lectotype is not well enough preserved to show all the morphological features associated with this species, it is necessary to refer to better preserved conspecific material. For this purpose reference is made to the specimens figured by Brady (1884) and by Bolli, Loeblich and Tappan (1957). The "paratype" (probably one of Parker and Jones' syntypes) which is now deposited in the U. S. National Museum (no. P. 4224a) and which was illustrated by Bolli, Loeblich and Tappan (*op. cit.*, pl. 6, figs. 2a-b) shows the deeply incised nature of the sutures in the apertural regions. The other "paratype," U.S.N.M. no. P. 4224b, (*op. cit.*, *loc. cit.*, figs. 3a-b) possesses small abortive chambers which are common in this species but which may be seen, from their irregular and apparently haphazard development, to be distinct from bullae. The dissected hypotype, U.S.N.M. no. P. 4225a, (*op. cit.*, *loc. cit.*, fig. 1) shows the intra-umbilical position of the primary aperture of the penultimate chamber, the broadly arched shape of the dorsal supplementary aperture of the last chamber and the involute, tightly trochospiral coiling of this form. The coiling mode was also clearly illustrated by Brady (1884, pl. 84, fig. 11) in his sectioned specimen. This section also illustrates the characteristically thick and coarsely perforate walls of *S. dehiscens*, and it can be seen from his illustration that the walls are perforate beneath the apertural flanges. Our own investigations (Blow 1959, Banner and Blow 1959) show that this imperforate material, thickest in the apertural and sutural areas, extends over most at least of the remainder of the test surface as a superficially (probably secondary) cortex. This cortex seals or restricts the pores of the primary wall and gives the test its characteristically shiny appearance. Often the cortex is lost or partially lost in fossil specimens and it seems to be composed of less stable shell material than the earlier formed parts of the primary wall.

The genus, as now restricted, is monotypic and is believed to range from Sarmatian to Recent.

Truncatulina humilis Brady, 1884

Plate 8, figures 1a-c

Truncatulina humilis BRADY, 1884, Rept. Challenger, Zool., vol. 9, pt. 22, pp. 665-6, pl. 94, figs. 7a-c.

Taxonomic remarks.—This species was first described by Brady (1884), when he based his description on specimens collected from the North Atlantic and South Pacific oceans by the "Challenger" Expedition. Brady (*op. cit.*, p. 666) recorded that this "extremely obscure" species was a deepwater form, and was found at only a few localities — three stations in the North Atlantic between latitudes 24° N. and 40° N., at

depths between 1000 and 2750 fathoms, and two stations in the South Pacific between latitudes 13° S. and 40° S., at depths of 1825 and 2350 fathoms respectively.

In the "Challenger" Collection of the British Museum (Natural History) are two slides containing syntypes of *Truncatulina humilis* Brady. The slide numbered ZF.2529 contains about 60 specimens, all from "Challenger" station 276, depth 2350 fathoms, South Pacific; this slide is labelled with this information on its reverse in Brady's handwriting, and he also wrote there the date of collection (16/9/75), and the plate and figure numbers ("94. 7abc"). Although the specimens were examined in order to try to identify the specimen actually illustrated by Brady, it could not be found; many of the specimens are damaged, and all are in a very fragile state. The other slide, numbered ZF.2530, contains about 50 specimens, obtained from "Challenger" Station 5, at 2740 fathoms depth, S.W. of the Canary Islands; this information, together with the date of collection (21/2/73) is written in Brady's handwriting on the reverse of the slide. These specimens, the majority of them clearly conspecific with those in slide ZF. 2529, were well preserved, and it is from among them that a lectotype of *Truncatulina humilis* was selected, and it is here designated, described and illustrated (pl. 8, figs. 1a-c); the lectotype is deposited in the British Museum (Natural History) and registered as specimen number 1959.10.2.1.

Description of lectotype.—The minute test consists of about three whorls of slowly enlarging chambers, arranged six to a whorl in the early stages, increasing to seven in a whorl in the adult, forming a very low trochospire. The chambers are inflated, subglobular in shape, much appressed, and partially embracing. The equatorial profile is subcircular, with a moderately lobulate periphery; the axial profile is sub-oval, and the axial periphery is smoothly and broadly rounded. The final chamber is bulla-like and extends from the normal position to cover the umbilicus; it possesses very short, broad tunnel-like prolongations or re-entrants over the ventral intercameral sutures of the final whorl. The intercameral sutures are broadly and weakly depressed ventrally and dorsally, becoming more deeply depressed peripherally in the later parts of the last whorl; they are nearly radial ventrally, but are slightly curved dorsally, meeting both the spiral suture and the periphery at broad angles. The external apertures are multiple, consisting only of low, arched accessory apertures, one being present at each junction of the bulla-like last chamber with the ventral intercameral sutures of the last whorl. The wall is finely and densely perforate, the punctations being slightly finer on the bulla-like last chamber than on the other chambers. The surface of the test is finely and sparsely hispid. Maximum diameter of lectotype: 0.21 mm.

Remarks.—More than one hundred specimens of this species, all syntypic, are present in the "Challen-

ger" Collection of the British Museum (Natural History); they show that the bulla-like last chamber is remarkably constant in form, even when different populations from widely separated localities are compared. The gross morphology of the test is similar to that of *Globigerina cristata* Heron-Allen and Earland (p. 10, pl. 7, figs 5a-c) and that of *Globigerinita parkerae* Loeblich and Tappan (specimens of which have been kindly sent to us by Miss F. L. Parker), so that we would consider these three species to be congeneric. However, *Globigerinita naparimaensis* Brönnimann (restricted by Loeblich and Tappan, 1957), the type species of *Globigerinita* Brönnimann 1951 (as emended by Loeblich and Tappan, 1957), although considered congeneric with *Globigerinita parkerae* by Loeblich and Tappan, is as yet inadequately known in regard to the position of its primary aperture. Loeblich and Tappan (1957, p. 112) state that the primary aperture of the holotype of *G. naparimaensis* is "interiomarginal and umbilical," which would show its affinity to genera of the Globigerininae; however, specimens of "*Globigerinita*" *parkerae*, *Globigerina cristata* and *Truncatulina humilis*, in which the last (bulla-like) chamber has been dissected away, show an umbilical-extraumbilical primary aperture, typical of the Globorotaliinae. Until the morphology and affinities of *G. naparimaensis* are understood, we therefore only provisionally place the species *Truncatulina humilis* Brady in the genus *Globigerinita*.

We think that in the family Globigerinidae, the Globigerininae, the Orbulininae, and the Globorotaliinae have produced bullate representatives; thus, *Globigerinita* has arisen from *Globigerinoides*, *Globigerinatheka* has developed from *Globigerapsis*, *Catapsydrax* and *Tinophodella* from *Globigerina*, and forms such as "*Globigerinita*" *parkerae*, "*G.*" *humilis* and "*G.*" *cristata* have descended from *Globorotalia* (*Turborotalia*). There seems to be little fundamental morphological difference between the "genera" *Catapsydrax* and *Tinophodella*, and it may be that the former should be considered as a junior synonym of the latter. The whole subfamily "Catapsydracinae" needs detailed revision, and this work is actively in progress.

Truncatulina humilis Brady is specifically distinguished from "*Globigerinita*" *parkerae* Loeblich and Tappan by its broader bullate part of the final chamber with shorter, broader, accessory-apertural extensions, its more slowly opening spire, its more closely appressed chambers and less compressed test. No records of fossil occurrences of this species are known to us.

CONCLUSION: OTHER SPECIES

Our researches, in conjunction with MM. Marie, Sornay and Lys, failed to reveal the presence of syntypic material for the following species:

Globigerina trigonula d'Orbigny (1826) 1903
Globigerina gibba d'Orbigny (1826) 1898
Globigerina fragilis d'Orbigny (1826) 1852
Nonionina pelagica d'Orbigny 1839
Rotalina hirsuta d'Orbigny 1839
Globigerina hirsuta d'Orbigny 1839
Globigerina inflata d'Orbigny 1839
Rotalina truncatulinoides d'Orbigny 1839

The species *Globigerina globularis* d'Orbigny 1826 and *Globigerina trilocularis* d'Orbigny 1826 are both *nomina nuda*; *G. globularis* must be credited to Roemer (1838) and *G. trilocularis* belongs to Deshayes (1832) as these authors were alone responsible for the first published descriptions of the species.

A type for *Orbulina universa* d'Orbigny 1839 was isolated by Dr. A. R. Loeblich, and is present in a single-celled slide in the A. d'Orbigny collections. This type shows no external trace of the earlier chambers and the apertural pores are randomly distributed over the final chamber.

A neotype for *Nonionina pelagica* d'Orbigny 1839 has been proposed by us (Banner and Blow, 1960). The syntype of *Globigerina siphonifera* d'Orbigny 1839, designated as lectotype of that species, has also been described by us (*op. cit.*, *loc. cit.*). The remaining species in the above list need neotypes proposed for them. It is hoped to do this using as far as possible the original topotypic samples studied by d'Orbigny.

We noted, whilst in Paris, the existence of syntypes for *Globigerina parisiensis* d'Orbigny (1826) 1850 and *Globigerina regularis* d'Orbigny 1846. Specimens of the former were badly preserved but it is highly likely that both these species are referable to the genus *Baggina* Cushman 1926. A tube bearing d'Orbigny's original label, reading:

"Rosalina candeina,
 IV
 2 - 4"

(also inscribed "TYPE, 97. IV, 2 - 4" in another hand), contains two specimens. Neither of these is similar to the form illustrated by d'Orbigny (1839) as *Rosalina candeina*; one is probably a bolivinid and the other may be a polymorphinid, and both are badly damaged. As these must constitute the only available syntypes, we consider that the name *Rosalina candeina* d'Orbigny should be considered a *nomen dubium* as no neotype can be erected while the syntypes exist, whatever they may subjectively be considered to represent.

The primary types for the following species have been described by us previously (Banner and Blow 1959, 1960):

Globigerina aequilateralis Brady 1879
Globigerina digitata Brady 1879 (partim)
Hastigerina murrayi Thomson 1876

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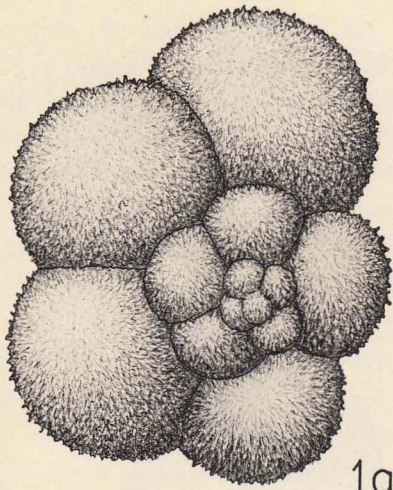
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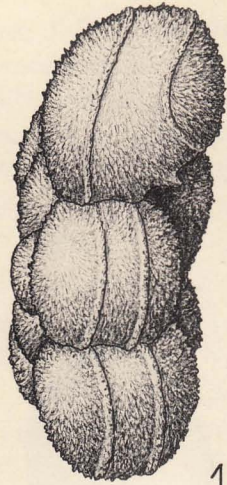
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EXPLANATION OF PLATE 7

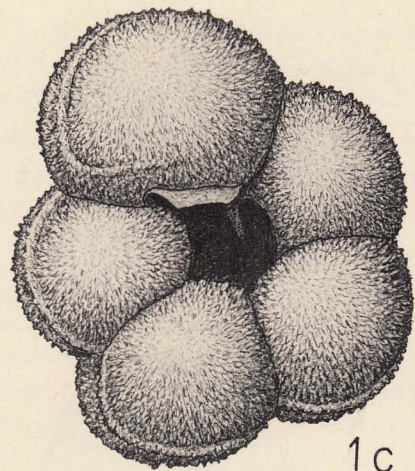
- | FIGS. | PAGE |
|--|------|
| 1. <i>Globigerina cretacea</i> d'Orbigny 1840 [= <i>Globotruncana cretacea</i> (d'Orbigny, 1840) (<i>non Globotruncana cretacea</i> Cushman 1938 = <i>Globotruncana mariei</i> Banner and Blow <i>nom. nov.</i>)], lectotype, $\times 100$. Fig. 1a, dorsal view; fig. 1b, axial peripheral view, showing the two widely-spaced carinae; fig. 1c, ventral view, showing the intraumbilical primary aperture bordered by a broken porticus. The specimen was obtained by d'Orbigny from the Campanian (<i>Belemnitella mucronata</i> zone) chalk of St. Germain, near Paris, and is deposited in the A. d'Orbigny collection of the Muséum Nationale de l'Histoire Naturelle, Paris | 8 |
| 2. <i>Globigerina seminulina</i> Schwager 1866 [= <i>Sphaeroidinellopsis seminulina</i> (Schwager)]; neotype, $\times 50$. Fig. 2a, ventral view; fig. 2b, dorsal view. This specimen was obtained by Schwager from the "Pliocene" (? Sarmatian) of Kar Nikobar, and was sent by him to H. B. Brady; it is now deposited in the British Museum (Natural History) and registered as specimen no. P. 44035 | 24 |
| 3. <i>Sphaeroidina bulloides</i> d'Orb. var. <i>dehiscens</i> Parker and Jones 1865 [= <i>Sphaeroidinella dehiscens</i> (Parker and Jones)]; lectotype, $\times 50$. Fig. 3a, ventral side; fig. 3b, dorsal side. This is the type of the genus <i>Sphaeroidinella</i> Cushman 1927. The specimen was obtained from the Atlantic Ocean, 2° 20' N., 28° 44' W., at 1080 fathoms depth; it is registered in the British Museum (Natural History) as specimen no. ZF. 3580 | 35 |
| 4. <i>Pullenia sphaeroides</i> var. <i>obliquiloculata</i> Parker and Jones 1865 [= <i>Pulleniatina obliquiloculata</i> (Parker and Jones)]; lectotype, $\times 50$. Fig. 4a, dorsal view; fig. 4b, axial peripheral view, showing streptospiral coiling; fig. 4c, ventral view. This is the type of the genus <i>Pulleniatina</i> Cushman 1927. The specimen was obtained from the Atlantic Ocean, 22° 54' S., 40° 37' W., off the Abrolhos Bank, at 260 fathoms depth; it is registered in the British Museum (Natural History) as specimen no. ZF. 3583. A broken annelid tube is attached to the aboral periphery-dorsal surface of the lectotype. | 25 |
| 5. <i>Globigerina cristata</i> Heron-Allen and Earland 1929 [= <i>Globigerinita?</i> <i>cristata</i> (Heron-Allen and Earland)]; lectotype, $\times 250$. Fig. 5a, ventral view, showing accessory apertures at the margins of the bulla; fig. 5b, axial peripheral view; fig. 5c, dorsal view. The specimen was obtained by the "Discovery" Expedition of 1925-1927, from the southern Atlantic Ocean, 26° 17' 40" S., 14° 26' 28" E., north of Possession Island off the coast of S.W. Africa; it is now deposited in the British Museum (Natural History) and registered as specimen number 1959.7.1.3 | 10 |



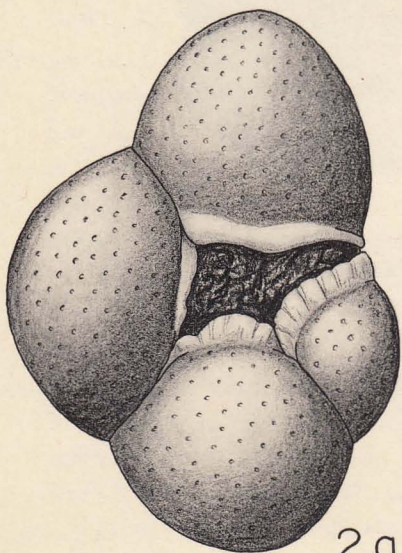
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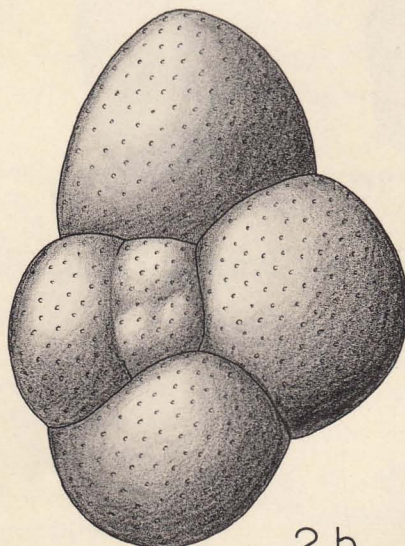
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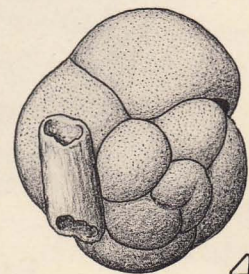
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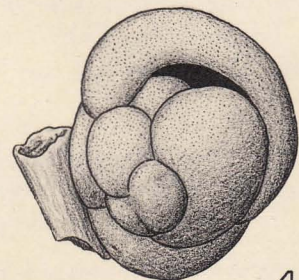
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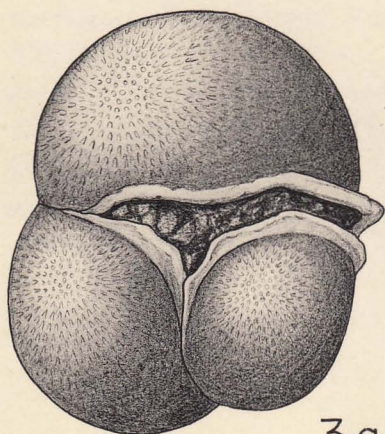
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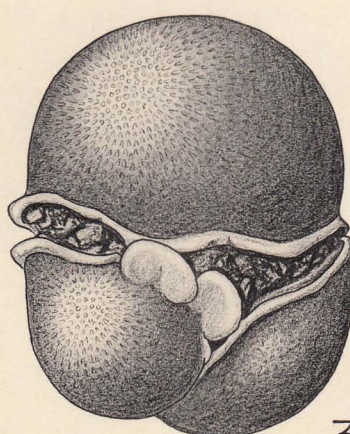
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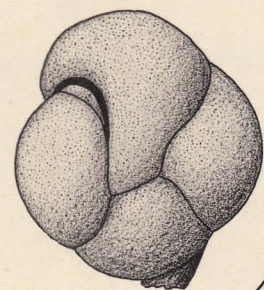
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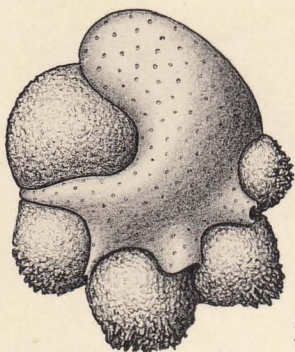
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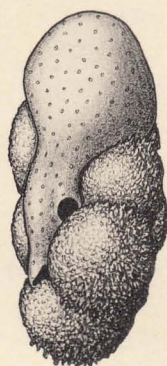
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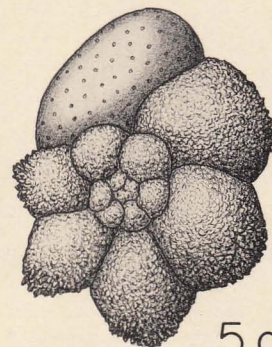
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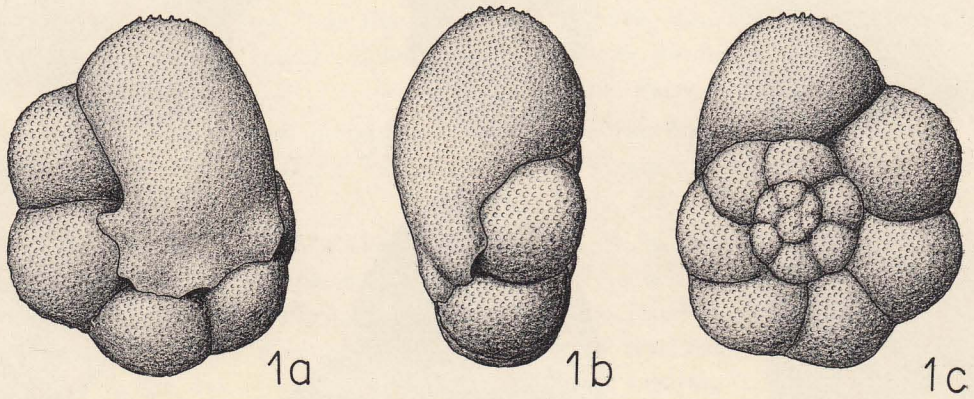
5a



5b



5c



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EXPLANATION OF PLATE 8

FIGS.

PAGE

1. *Truncatulina humilis* Brady 1884 [= *Globigerinita? humilis* (Brady)]; lectotype, $\times 175$. Fig. 1a, ventral view; fig. 1b, axial peripheral view; fig. 1c, dorsal view. Specimen obtained by Brady from "Challenger" Station no. 5, sample taken at 2470 fathoms, recent sea, S.W. of the Canary Islands; now deposited in the British Museum (Natural History) and registered as specimen no. 1959.10.2.1 36

CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION
FOR FORAMINIFERAL RESEARCH

VOLUME XI, PART 1, JANUARY, 1960

RECENT LITERATURE ON THE FORAMINIFERA

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

- ADAMS, C. G. Foraminifera from limestone and shale in the Batu Gading area, Middle Baram, East Sarawak.—Borneo, British, Geol. Survey Dept., Ann. Rept. for 1958, 1959, p. 73-85, pls. 14, 15.—Illustrations (thin sections) and lists of Foraminifera from upper Eocene (Tertiary **b**) and lower Miocene (Tertiary **e** 1-4).
- AKADEMII NAUK SSSR. Osnovy Paleontologii (edited by U. A. ORLOV). General part, Protozoa (edited by D. M. RAUZER-CHERNOUSOVA and A. V. FURSENKO), Moscow, 1959, 482 p., illust.—Well illustrated treatise. Section on Foraminifera (p. 115-368, pls. 1-13, text figs. 1-894) is the work of A. V. FURSENKO, D. M. RAUZER-CHERNOUSOVA, N. N. SUBBOTINA, E. V. BYKOVA, E. A. REITLINGER, N. A. VOLOSHINOVA, L. G. DAIN, A. D. M. MACLAY, S. E. ROZOVSKAJA, T. I. SHLYKOVA, V. T. BALAKHMATOVA, A. K. BOGDANOVICH, V. P. VASSILENKO, E. V. MJATLIUK, I. V. KACHARAVA, and L. P. GROZDILOVA. Sixty-seven families are grouped in 13 superfamilies, plus 4 more families in a group of *incertae sedis*.
- BANNER, F. T., and BLOW, W. H. The classification and stratigraphical distribution of the Globigerinaceae. Part 1.—Palaeontology (Pal. Assoc. London), v. 2, pt. 1, October 1959, p. 1-27, pls. 1-3, text figs. 1-5.—The superfamily is subdivided, chiefly on the basis of external structural modifications of the apertures, into 3 families: Globigerinidae, Hantkeninidae, and Globotruncanidae. The 3 families are subdivided, chiefly on the basis of modifications of the primary apertures themselves, into 11 subfamilies, 2 new: Globorotaloidinae and Sphaeroidinellinae. Emendation of 5 of the subfamilies results in 2 new genera and 2 new subgenera: *Sphaeroidinellopsis* gen. nov. (type species *Sphaeroidinella dehiscens subdehiscens* Blow); *Pseudohastigerina* gen. nov. (type species *Nonion micrus* Cole); *Bolliella* subgen. nov. (type species *Hastigerina (Bolliella) adamsi* sp. nov.); and *Clavihedbergella* subgen. nov. of *Praeglobotruncana* (type species *Hastigerinella subcretacea* Tappan). Suggested phylogeny is graphically represented.
- BÉ, ALLAN W. H. A method for rapid sorting of Foraminifera from marine plankton samples.—Jour. Paleontology, v. 33, No. 5, Sept. 1959, p. 846-848, pl. 118, text figs. 1, 2.—Density separation of shelled from non-shelled plankton uses saturated sodium chloride solution.
- BELFORD, D. J. Stratigraphy and micropalaeontology of the Upper Cretaceous of Western Australia.—Geol. Rundschau, Stuttgart, Band 47, heft 2, 1958 (June 1959), p. 629-647, text figs. 1-9 (map, paleogeographic maps, correlation table).—Lists of Foraminifera from Cenomanian to Maestrichtian.
- BHATIA, S. B., and MANDWAL, N. K. Smaller Foraminifera from the Agate-conglomerates (Burdigalian) of the Surat-Broach area, western India.—Jour. Pal. Soc. India, v. 2, D. N. Wadia Jubilee Number, 1957, p. 163-173, text figs. A-C (pls.).—Twenty-six species and varieties, 7 indeterminate, none new.
- BOLLI, HANS M. *Grimsdaleinella*, a new genus of the foraminiferal family Heterohelicidae.—Eclogae Geol. Helvetiae, v. 52, No. 1, August 1959, p. 1-4, pl. 1.—From the Senonian of Trinidad, a form with strongly elongate chambers tapering to long thin spines; type species *G. spinosa* n. sp.
- BOLTOVSKOY, ESTEBAN. Recent Foraminifera of southern Brazil and their relation with those of Argentina and the West Indies.—Argentina Serv. Hidrografia Naval, Publ. H.1005, 1959, p. 1-124, pls. 1-20, 1 map, tables 1, 2.—Study based on 32 bottom samples, mostly from the Brazilian shelf and mostly between 18 and 135 meters depth. A total of 262 forms, 241 benthonic (1 species, 2 varieties, and 2 formas new) and 21 planktonic, are recorded and most of them illustrated. Affinities are more with the West Indian province than with the Argentine shelf and Patagonian region.
- BYSTRICKA, HEDVIGA. Die Sarmatischen Foraminiferengesellschaften aus der Ostslowakei. (German summary of Czech text).—Acta Geologica et Geographica, Univ. Comenianae (Bratislava), Geol. Nr. 1, 1958, p. 57-88, pls. 10-13, distrib. table.—Fifty-two species and varieties, none new.
- CHALILOV, D. M. Novye Vidy Semejstva Allomorphinidae Paleogenovykh Otlozhenij Azerbajdzhana.—Trudy Akad. Nauk Azerbaidzhan. SSR, Baku, Instit. geol., tom 19, 1958, p. 37-71, pls. 1-7, text figs. 1, 2 (evolution diagrams).—Sixteen species and one variety of *Chilostomella* and 13 species and 3 varieties of *Chilostomelloides*, all new except one species of *Chilostomella*.
- Novye Predstaviteli Foraminifer Paleogenovykh Otlozhenij Azerbajdzhana.—Akad. Nauk Azerbaidzhan. SSR, Baku, Kheberleri. Keol.-chograf, Elmleri ser., No. 2, 1958, p. 3-14, pls. 1, 2.—Seven species (6 new) and 2 new varieties. *Azera* n. gen. (type species *A. transversa* n. sp.), a rotaliform genus with peripheral aperture.
- CHESSEX, RONALD. La géologie de la haute vallée d'Abondance Haute-Savoie (France).—Eclogae Geol. Helvetiae, v. 52, No. 1, August 1959, p. 295-400, pls. 1, 2 (geol. map, sections), text figs. 1-28 (columnar sections, sketches).—Beds dated by Foraminifera between Upper Jurassic and Paleocene.
- CHIJI, MANZO. Some species of *Uvigerina* and their stratigraphic occurrences in the Nadaura district of the Toyama Tertiary Basin, Japan.—Bull. Osaka Mus. Nat. Hist., No. 11, March 1959, p. 15-32, pl. 7, map, tables 1-3.—Nine species, one indeterminate, recorded and illustrated and their ranges in the Miocene and Pliocene shown graphically.
- On the Miocene Foraminifera *Vaginulina yoshihamaensis* Inoue et Nakaseko.—Bull. Osaka Mus. Nat. Hist., No. 11, March 1959, p. 47-48, pl. 11.—Emendation based on additional and better preserved material. The species is a good key species indicating Tertiary **f**₃.
- CICHA, IVAN. Die entwicklung der mikrofauna des Unteren Miozäns im Waagtal (in Czech with German summary).—Sbornik Ustred. Ustavu Geol., ser. Paleont., v. 24, 1957 (1958), p. 349-384, pls. 50-56, distrib. table.—Illustrations and discussions of 23 species, none new. Numerous other species are listed.
- CIFELLI, RICHARD. Bathonian Foraminifera of Eng-

- land.—Bull. Mus. Comp. Zool., v. 121, No. 7, Sept. 1959, p. 265-368, pls. 1-7, text figs. 1-4 (correl. table, composite section, outline drawings), tables 1-18.—Illustrated catalog of 104 species, subspecies and varieties (1 species and 1 subspecies new and 15 indeterminate) from 4 areas. Variation of species discussed and illustrated. Four faunules are distinguished.
- COCKBAIN, A. E. Notes on the Foraminifera of Cyprus.—Cyprus Geol. Survey Dept. Ann. Rept. for 1958, Feb. 12, 1959, p. 32-36.—Many species of smaller Foraminifera are used in determining age and ecology of Maestrichtian, middle Eocene, Oligocene?, Miocene, and Pliocene beds.
- COLE, W. STORRS. Faunal associations and the stratigraphic position of certain American Paleocene and Eocene larger Foraminifera.—Bull. Amer. Paleo., v. 39, No. 182, July 31, 1959, p. 377-393, pls. 32, 33, table 1.—*Operculina catenula* zone of probable upper Paleocene age recognized at several West Indian and Caribbean localities. *Pseudophragmina (Proporocyclina) tobleri* fauna of Soldado Rock provisionally assigned to middle Eocene. Species from both faunas are discussed, some having several synonyms, and 4 are illustrated. *Discocyclina (Discocyclina)* includes no more than 11 species (possibly as few as 5) in the Americas and ranges from Paleocene to middle Eocene.
- CORMINBOEUF, PAUL. Sur les couches de Cucloz-Villarvolard en Suisse occidentale.—Ecolgae Geol. Helvetiae, v. 52, No. 1, August 1959, p. 271-294, text figs. 1-4 (maps), tables 1-3.—Paleocene age based on planktonic Foraminifera.
- CROUCH, R. W. Inspissation of post-Oligocene sediments in southern Louisiana.—Geol. Soc. America Bull., v. 70, No. 10, October 1959, p. 1283-1292, pl. 1 (contour map), table 1.—Electric-log correlations combined with depths to Foraminifera markers used to determine aggregate thicknesses.
- DIDKOV'S'KIJ, V. J. Pro Mikrofaunu Nizhn'ogo Sarmatu Prichornomors'koji Zapadini v Mezkhakh URSS.—Geol. Zhurnal, Akad. Nauk Ukrain. RSR, tom 19, vyp. 3, 1959, p. 84-91, map, table.—Distribution and abundance of 48 species and varieties, mostly miliolids and *Elphidium*.
- DIZER, ATIFE. Observations on a fauna of Foraminifera from Montian beds in Turkey.—Jour. Pal. Soc. India, v. 2, D. N. Wadia Jubilee Number, 1957, p. 38-41, pls. 1, 2, text fig. 1 (map).—Three species of *Lafitteina*, one described as new.
- DROOGER, C. W., and BATJES, D. A. J. Planktonic Foraminifera in the Oligocene and Miocene of the North Sea basin.—Proc. Kon. Nederl. Akad. Wetensch., ser. B, Phys. Sci., v. 62, No. 3, 1959, p. 172-186, pl. 1, figs. 1-3 (map, range chart, distrib. table).—Two different planktonic associations are recognized; the Oligocene consisting of a monotonous fauna of intergrading types of *Globigerina*; the Miocene richer and more varied. Specimens are smaller-sized than those of the Tethys region and the Miocene associations do not fit exactly with the Trinidad succession. Eleven species are illustrated. The study is based on numerous outcrops and borings in Belgium, Netherlands, Germany, and Denmark.
- DROOGER, C. W., and MAGNÉ, J. Miogypsinids and planktonic Foraminifera of the Algerian Oligocene and Miocene.—Micropaleontology, v. 5, No. 3, July 1959, p. 273-284, pls. 1, 2, text figs. 1-4 (map, sections, range chart).—Discussion of a sequence of 6 (possibly 7) species of miogypsinids extending from Rupelian to Helvetian and the planktonic species associated with them. Most of the species are illustrated.
- ELIAS, MAXIM K. Fusulinid genera *Protriticites*, *Pseudotrivicites*, and *Putrella*.—Okla. Geol. Notes, v. 19, No. 8, August 1959, p. 165-178, text figs. 1-4, tables 51-54.—Includes translations from the Russian.
- ELLERMANN, CLARA. Die mikrofaunistische Gliederung des Oligozäns im Schacht Kapellen bei Moers (Niederrhein), in Die Niederrheinische Braunkohlenformation, ein Symposium.—Fortschr. Geol. Rheinland und Westfalen, Band 1, July 1958, p. 205-214, pls. 1-3, tables 1-3.—Photographs of middle and upper Oligocene Foraminifera assemblages from 3 distinctive horizons.
- GEODAKCHAN, A. A. Novye Predstaviteli Foraminifer Senoman-Con'jakshikh Otlozhenij Severo-Vostochnogo Azerbajdzhana.—Akad. Nauk Azerbaidzhan. SSR, Baku, Kheberleri. Keol.-chograf. Elmleri ser., No. 1, 1958, p. 87-97, pls. 1, 2.—Eight species and one variety, all new.
- HANZAWA, SHÔSHIRÔ. Occurrence of the foraminiferal species *Acervulina linearis* Hanzawa from St. Bartholomew Island, French West Indies.—Jour. Paleontology, v. 33, No. 5, Sept. 1959, p. 843-845, pl. 117.—Recorded previously only from upper Eocene (Tertiary b) of the Indo-Pacific region, this encrusting species is discussed and illustrated in thin section from middle Eocene limestone. Associated species are listed.
- HILTERMANN, HEINRICH. Allochthone Foraminiferen in den Neurather Sanden und in einem Zwischenmittel im Flöz Frimmersdorf, in Die Niederrheinische Braunkohlenformation, ein Symposium.—Fortschr. Geol. Rheinland und Westfalen, Band 1, July 1958, p. 159-164, pl. 1, text fig. 1.—Photographs of Upper Cretaceous assemblages.
- HONJO, SUSUMU. Neoschwagerinids from the Akasaka limestone (A paleontological study of the Akasaka limestone, 1st report.).—Hokkaido Univ., Fac. Sci. Jour., ser. 4, Geology and Mineralogy, v. 10, No. 1, March 1959, p. 111-161, pls. 1-12, text figs. 1-8, tables 1, 2.—Twelve species, 5 new, included in 3 genera. *Minoella* n. subgen. of *Neoschwagerina* (type species *Caenocellina nipponica* Ozawa) and *Gifuella* n. gen. (type species *G. gifuensis* n. sp.) are erected.
- INDANS, JULIJA. Mikrofaunistische Korrelationen im marinen Tertiär der Niederrheinischen Bucht, in Die Niederrheinische Braunkohlenformation, ein Symposium.—Fortschr. Geol. Rheinland und Westfalen, Band 1, July 1958, p. 223-238, pls. 1-8, text figs. 1-3.—Photographs of Foraminifera assemblages from 8 distinctive horizons between Paleocene and middle Miocene.
- ISMAJYLOV, G. A., and TAIROV, CH. E. Shimali Gobustany (Chehnuh-Shergi Gafgaz) Ust Tebashi Chfkuntuleri Ve Onlaryn Stratigrafik Bflkusu.—Akad. Nauk Azerbaidzhan. SSR, Baku, Kheberleri. Keol.-chograf. Elmleri ser., No. 1, 1959, p. 23-33, 1 table.—Foraminifera listed from Cenomanian to Danian.
- LANKFORD, ROBERT R. Distribution and ecology of Foraminifera from East Mississippi Delta Margin.—Bull. Amer. Assoc. Petr. Geol., v. 43, No. 9, Sept. 1959, p. 2068-2099, pls. 1-3, text figs. 1-11 (distrib. maps, graphs), tables 1-4.—Quantitative study of living and dead specimens permits recognition of assemblages characteristic of 6 environments: Marsh, inter-distributary bay, fluvial marine, deltaic marine, sound, and open shelf. Size of standing crops and median specimen size are quantitatively studied. The 50 commonest species are illustrated.
- LYS, M., and SERRE, B. Contribution a la connaissance des microfaunes du Paléozoïque. Études micropaléontologiques dans le Carbonifère marin des Asturies (Espagne).—Rev. Institut. Français du Pétrole et Ann. Combust. Liquides, v. 13, No. 6, June 1958, p. 879-

- 916, pls. 1-11, tables 1, 2.—Ranges of smaller and larger Foraminifera in Westphalian of Spain. Illustrations of species, mostly in thin section.
- MANLAC-SAMANIEGO, REMEDIOS, and GONZALES, BENJAMIN A. Some common smaller Foraminifera from the Pliocene of Panay Island.—*Jour. Pal. Soc. India*, v. 2, D. N. Wadia Jubilee Number, 1957, p. 193-208, pls. 21-24, text figs. 1, 2 (maps).—Fifty-eight of the commonest species, none new, from a large fauna are recorded and illustrated.
- MAYNC, WOLF. *Torinosuella* n. gen., eine mesozoische Gattung der lituoliden Foraminiferen.—*Eclogae Geol. Helvetiae*, v. 52, No. 1, August 1959, p. 5-14, pl. 1, text fig. 1 (graph).—From the Kimmeridgian of Portugal. Type species *Choffatella peneropliformis* Yabe and Hanzawa.
- McLEAN, JAMES D., JR. *Textularia yorktownensis*, new name.—*Jour. Paleontology*, v. 33, No. 5, Sept. 1959, p. 969.—New name for *Textularia pseudobliqua* subsp. *aspera* McLean, preoccupied.
- MONTANARO GALLITELLI, EUGENIA. Globotruncane Campaniano-Maestrichtiane nella formazione a facies di flysch di Serramazzone nell'Appennino Settentrionale Modenese.—*Soc. Geol. Italiana Boll.*, v. 77, 1958 (March 1959), p. 171-191, pls. 1-3, text figs. 1-11.—Nine species and subspecies discussed and illustrated in thin section as basis for age determination; an additional 77 species listed.
- MURATA, SHIGEO. Foraminifera from the Nishisonogi Group (Oligocene) in the Sakito-Matsushima Coal-Field, Nagasaki Pref., Kyushu.—*Bull. Kyushu Instit. Tech. (Math., Nat. Sci.)*, No. 5, May 1959, p. 29-47, pls. 1, 2, text fig. 1 (map), table 1 (range and abundance).—Sixty-five species, 3 new and 12 indeterminate, from 5 formations of the Nishisonogi group (correlated with Aquitanian and Burdigalian). Two zonules based on Foraminifera.
- MURATA, SHIGEO, and MOKUDAI, TAKEHIKO. Paleogene stratigraphy in Ainosima, Kokura City, Kyushu.—*Bull. Kyushu Instit. Tech. (Math., Nat. Sci.)*, No. 5, May 1959, p. 49-57, text figs. 1-3 (maps), tables 1, 2, columnar section.—Lists of smaller Foraminifera from 3 members of the Ainosima formation of Aquitanian age.
- NEMKOV, G. I., and BARKHATOVA, N. N. Zones of large Foraminifera in Eocene deposits of the Crimea (in Russian with English summary).—*Vestnik Leningrad. Univ.*, No. 12, ser. geol. geogr., vyp. 2, 1959, p. 121-125, 1 table.—Seven zones, 3 each in lower and middle Eocene, and 1 in upper Eocene, based on nummulites.
- NAGAPPA, Y. Note on *Operculinoides* Hanzawa 1935.—*Palaeontology (Pal. Assoc. London)*, v. 2, pt. 1, October 1959, p. 156-160, pls. 21-23.—Species in this genus fall into 3 groups: (a) those belonging in *Nummulites*, (b) involute forms of *Operculina*, and (c) those belonging in *Ranikothalia*. Hence *Operculinoides* is superfluous.
- OBREGÓN DE LA PARRA, JORGE. *Parvicarinina mexicana*, una especie nueva de Foraminifero del Paleoceno de Nuevo Leon, Mexico.—*Bol. Asoc. Mex. Géol. Petrol.*, v. 10, No. 7-8, 1958, p. 463-468, text figs. 1-3, map.
- OKIMURA, YUJI. Biostratigraphical and paleontological studies on the endothyroid Foraminifera from the Atetsu Limestone Plateau, Okayama Prefecture, Japan.—*Jour. Sci. Hiroshima Univ.*, ser. C (Geol. and Min.), v. 2, No. 3, Oct. 1958, p. 235-264, pls. 30-36.—Five foram zones in Lower Carboniferous. Thirteen species (6 new). *Atetsuella* gen. nov. (type species *A. imamurai* n. sp.) and *Paraplectogyra* gen. nov. (type species *P. masanae* n. sp.).
- PRONINA, M. T. Otlozhenija Srednego Miothena S Faunoj Novykh Vidov *Rotalia* Dzhebrail'skogo Rajona (Azerbaijdzhan).—*Akad. Nauk Azerbaidzhan. SSR. Baku, Kheberleri, Keol.-chograf. Elmleri ser.*, No. 1, 1959, p. 55-61, pl. 1.—Three new species of *Rotalia* from middle Miocene.
- REISS, Z. The wall-structure of *Cibicides*, *Planulina*, *Gyroidinoides*, and *Globorotalites*.—*Micropaleontology*, v. 5, No. 3, July 1959, p. 355, 356, pl. 1.—All have primarily formed double septa. Granules observed in *Cibicides* under polarization are not due to agglutination but are granular-calcareous structure apparently due to diagenesis.
- SACHS, K. N., JR. Puerto Rican upper Oligocene larger Foraminifera.—*Bull. Amer. Paleol.*, v. 39, No. 183, July 31, 1959, p. 399-416, pls. 34-36, tables 1, 2.—Nine species, none new, recorded and illustrated from San Sebastian formation. Correlation discussed.
- SEN GUPTA, BARUN. Zones of the Paleogene of Lakhpat, northwestern Kutch, India.—*Micropaleontology*, v. 5, No. 3, July 1959, p. 365-368, text fig. 1 (map), table 1.—Five zones of marine regression based on (and two of them subdivided by) larger Foraminifera.
- SHEPARD, FRANCIS P., and LANKFORD, ROBERT R. Sedimentary facies from shallow borings in lower Mississippi Delta.—*Bull. Amer. Assoc. Petr. Geol.*, v. 43, No. 9, Sept. 1959, p. 2051-2067, text figs. 1-6 (maps, graphs, columnar sections, diagram, photos of cores).—Depositional environments are indicated by Foraminifera.
- SINGH, S. N. Two aberrant types of Nummulitidae from the Eocene of Rajasthan, India.—*Journ. Pal. Soc. India*, v. 2, D. N. Wadia Jubilee Number, 1957, p. 209-212, pls. 25, 26, text figs. 1, 2.—*Eoassilina elliptica* gen. et sp. nov. is elliptical and slightly trochoid. *Nummulites asymmetrica* sp. nov. has an excentric polar region.
- STSCHEDRINA, Z. G. Dra Novykh Roda Foraminifer Iz Semejstva Trochamminidae (Foraminifera).—*Zool. Instit. Akad. Nauk SSSR, Trudy XVIII*, 1955, p. 5-9, text figs. 1-3.—*Trochamminula* gen. n. (type species *T. fissuraperta* sp. n.) and *Trochamminisca* gen. n. (type species *T. cyclostoma* sp. n.); the former with fissurine aperture at right angle to plane of coiling and the latter with tubular aperture in apertural face.
- Foraminifery Vod Vostochnogo Murmana.—*Murmanskoj Biologicheskoy Stanthii Trudy IV*, 1958, p. 118-129, tables 1, 2.—About 80 species listed.
- O Faune Foraminifer Kurilo-Kamchatskoj Vpadiny.—*Akad. Nauk SSSR, Trudy Instit. Okeanologii, Tom 27*, 1958, p. 161-179, tables 1-3.—Numerous species listed by depth zones.
- Fauna Foraminifer Morskikh Vod Juzhnogo Sakhalina I Juzhnykh Kuril'skikh Ostrovov.—*Issl. Dal'nevost. Morej SSSR, vyp. V*, 1958, *Trudy Kuril-Sakhalinskoj Ehksped.* 1, p. 5-41, 1 text fig. (map), tables 1-3.—Many species enumerated and their depths given.
- The dependence of the distribution of Foraminifera in the seas of the U.S.S.R. on the environmental factors.—*XVth Internat. Congress Zool.*, 1958, Sec. III, Paper 30, 1959, p. 218-221.—Seven groups of species, based chiefly on depth ranges between 0 and over 7,000 meters, are recognizable in Arctic and North Pacific regions.
- Fauna Foraminifer Bostochnogo sektora Antarktici.—*Biol. Sovetsk. Antarkt. Ehksped. No. 3*, 1958, p. 51-54.

- TAI, YOSHIRO. Miocene microbiostratigraphy of West Honshu, Japan.—*Jour. Sci. Hiroshima Univ.*, ser. C, v. 2, No. 4, June 1959, p. 265-395, pls. 37-43 (columnar sections, correlation chart, fossils), text figs. 1, 2 (map, diagram), tables 1-34.—Stages, zones and faunules, introduced for use in 2 provinces, are based mainly on benthonic smaller Foraminifera. Correlation with Indo-Pacific and California regions is discussed. Twenty new species are described and illustrated.
- THIEULOY, JEAN-PIERRE. Étude micrographique des "calcaires à débris" Barrémo-Aptiens sur le pourtour méridional du Vercors.—Grenoble [Univ.] Fac. Sci., Travaux Lab. Géol., tome 35, 1959, p. 39-99, pls. 1-25.—Foraminifera, mostly orbitolinids and miliolids, recorded and illustrated in section.
- THOMPSON, M. L., and RIGGS, E. A. Primitive fusulinids in the southern part of the Illinois Basin, in THOMPSON, M. L., SHAVER, R. H., and RIGGS, E. A., Early Pennsylvanian fusulinids and ostracods of the Illinois Basin.—*Jour. Paleontology*, v. 33, No. 5, Sept. 1959, p. 770-792, pls. 104-107, text figs. 1 (map), 2 (ostracods).—Five identified species (one new) plus indeterminate forms are discussed and illustrated. Three principal zones (**Profusulinella**, **Fusulinella**, and **Fusulina**) summarized.
- WISEMAN, JOHN D., and TODD, ISABELLE. Signification des variations du taux d'accumulation de **Globorotalia menardii menardii** d'Orbigny dans une carotte de l'Atlantique Équatorial, in *La Topographie et la Géologie des Profondeurs Océaniques*.—Colloques Internat. du Centre Nat. Recherche Sci., Nice-Villefranche 5-12 Mai 1958, LXXXIII, 1959, p. 193-208, pls. 1-3, text figs. 1-3, tables 1, 2.—In an undisturbed core, rate of accumulation can be correlated with radiocarbon dated climatic changes. X-ray photographs reveal two distinct calcite layers of the test.
- WOLFENDEN, E. B. Progress report on the survey of the lower Rajang and adjoining areas.—Borneo, British, Geol. Survey Dept., Ann. Rept. for 1958, 1959, p. 85-109, pls. 16-19 (photos), text figs. 7-10 (maps), tables 17-20.—Lists of larger and smaller Foraminifera (mostly generic identifications) from upper Eocene (Tertiary **b**) and lower Oligocene (Tertiary **c-d**).

RUTH TODD