Smaller Foraminifera From Guam

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By RUTH TODD

GEOLOGY AND HYDROLOGY OF GUAM, MARIANA ISLANDS

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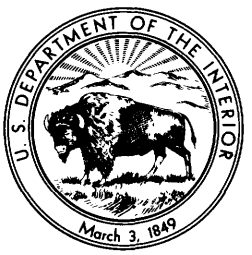
Four hundred and fifty-three species, subspecies, and varieties (one species new) from upper Eocene, lower Oligocene, Miocene, and Recent deposits



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SMALLER FORAMINIFERA FROM GUAM

By RUTH TODD

ABSTRACT

Rich assemblages of smaller Foraminifera are tabulated from two samples representing the upper Eocene, four samples representing the lower Oligocene, and seven samples representing the Miocene; some of the species are illustrated. A late Eocene (Tertiary *b*) age for part of the Alutom Formation is supported by the planktonic species of the foraminiferal population. Abundant planktonic Foraminifera in the Mahlac Member of the Alutom Formation permit correlation of the Mahlac Member with the *Globigerina sellii* zone of early Oligocene age, which was described from East Africa.

The hiatus between Oligocene and Miocene is marked by a major faunal change in which more than 40 percent of the Oligocene assemblage became extinct. The Miocene assemblage from the Janum Formation is similar in species and in paleoecology to modern sediments around Guam. Although larger Foraminifera indicate a probable age of Tertiary *g* for part of the Janum Formation, the evidence of the planktonic Foraminifera favors an age of Tertiary *f*.

Because the correlation of the planktonic Foraminifera zonation with the Oligocene–Miocene boundary and with the European time scale has been altered during the past decade, it is necessary to correct two of the age assignments originally made. The Donni Sandstone Member of the Tagpochau Limestone of Saipan is now considered as approximately Tortonian (Tertiary *f*) and the *Globigerinatella insueta/Globigerinoides bispherica* zone on Saipan and Yap is considered as early Miocene (Aquitanian and Tertiary *e*). Correlation of the Janum Formation is based chiefly on *Globigerina nepenthes*, and the age of the Janum is estimated to be slightly younger than that of the Donni, but still approximately Tortonian in part.

Study of species from beaches, reefs, lagoons, channels, and outer slopes around Guam provides a basis for paleoecologic interpretation of moderately deep outer-slope deposition in the three formations studied.

INTRODUCTION

This paper records the assemblages and illustrates some of the species of smaller Foraminifera characteristic of three different ages of sedimentary rocks on Guam: late Eocene (Tertiary *b*) in the Alutom Formation, early Oligocene (Tertiary *c*) in the Mahlac Member of the Alutom Formation, and Miocene (Tertiary *f* or *g*) in the Janum Formation. The Foraminifera found in the beach sands, on the reefs, in the lagoons and channels, and on the outer slopes around Guam, are also recorded.

The several assemblages here discussed are compared with those of comparable ages and ecology that have already been described from the nearby island of Saipan, about 120 miles north-northeast of Guam (Todd, 1957). Comparisons are also made with Recent and fossil assemblages described from several islands of the Marshall Island group, particularly Eniwetok and Bikini, respectively some 1,150 to 1,350 miles east of Guam (Cushman and others, 1954; Todd and Post, 1954; Todd and Low, 1960).

I am grateful for helpful advice, discussions, and suggestions received from many colleagues during the course of my work. Doris Low worked with me and gave invaluable assistance in the preparation of the material for study and the tabulation of results. The drawings are the work of Elinor Stromberg.

ANALYSES OF FAUNAS

EOCENE, TERTIARY *b*

The Eocene is represented by only two samples: Ei 4–1 and Jl 2–1. In both these samples from the Alutom Formation of late Eocene and Oligocene age, planktonic specimens are noticeably predominant, and the benthonic specimens, although comprising a larger number of species, are few. Because of this predominance of the planktonic element, both samples are interpreted as relatively deep water deposits, such as are currently being deposited on the outer slopes of Guam.

The interpretation of the age of the foraminiferal assemblage is based upon several considerations. First, the two most abundant planktonic species, *Globorotalia centralis* Cushman and Bermudez and *Globigerapsis index* (Finlay), indicate middle or upper Eocene (Bolli, 1957c, text fig. 26 [range chart]).

Second, both samples contain rare specimens of the Eocene genus *Hantkenina*. Sample Ei 4–1 contains *Hantkenina alabamensis* Cushman, and in sample Jl 2–1, both *H. alabamensis* and *H. inflata* Howe are present. Both of these species are reported in the upper Eocene, and *H. alabamensis* is reported to range also into the middle Eocene, at least sporadically (Thalmann, 1942, table 1).

Third, several other planktonic forms from these two samples, all rare, also have restricted ranges, as follows: *Globorotalia spinulosa* Cushman and *G. spinuloinflata* (Bandy) are both reported (Bolli, 1957c, text fig. 26 [range chart]) to be confined to the middle Eocene. *Globorotalia wilcoxensis* Cushman and Ponton is reported (Bolli, 1957a, text fig. 11 [range chart]) to be restricted to the lowermost Eocene. Still other planktonic species, also rare, are less narrowly restricted but do include the Eocene within their ranges. They are *Globigerina pera* Todd and *G. yeguaensis* Weinzierl and Applin, which range from middle Eocene to but not into the Chattian, *Globigerina gortanii* (Borsetti), which ranges from upper Eocene to but not into the Chattian (Eames and others, 1962, text fig. 20 [range chart]), and *Globigerina venezuelana* Hedberg, which ranges from middle Eocene upward throughout the Oligocene and Miocene (Bolli, 1957b; 1957c, text figs. 18, 26 [range charts]).

In spite of the apparent restriction of a few of the rarer Eocene planktonic species to middle and lower Eocene, I believe the age of these two samples from the Alutom Formation can be best interpreted as late Eocene.

Among the benthonic species, only a few appear to have restricted stratigraphic ranges. Of these, the following support the late Eocene age that is indicated by the planktonic specimens. An asterisk indicates species that seem to have become locally extinct after the Eocene.

Significant benthonic Foraminifera in the Eocene samples of the Alutom Formation

Species	Reported occurrences elsewhere
Alabamina conica Todd	Upper Eocene, Densinyama and Hagman Formations of Saipan.
Bulimina semicostata Nuttall.	Upper Eocene of Saipan; lower Eocene of California; Eocene, Guayabal Formation of Mexico; and Eocene of Cuba.
**Bulimina tuxpamensis* Cole.	Upper Eocene of Saipan; Eocene, Chapapote Formation of Mexico; Eocene of Cuba and Dominican Republic; Oligocene of Trinidad; Miocene and Eocene of Spain; Eocene of Italy.
Cibicides havanensis Cushman and Bermudez.	Eocene of Cuba; middle and upper Eocene and lower Oligocene of Barbados.
**Cibicides macrocephalus* (Gümbel).	Upper Eocene of Eniwetok; Eocene of Bavaria.
**Cibicides tuxpamensis* Cole.	Eocene, Aragon and Chapapote Formation of Mexico; lower Oligocene, Alazan Formation of Mexico; lower Oligocene of Dominican Republic.
**Eponides ocalanus* Cushman.	Upper Eocene of Eniwetok; upper Eocene of southeastern United States.
**Neorotalia floscula* (Todd and Post).	Eocene and Oligocene of Bikini and Eniwetok.
**Nuttallides trumpyi* (Nuttall).	Paleocene and Eocene of mid-Pacific Mountains; Eocene, Guayabal Formation of Mexico; Eocene of Trinidad, Haiti, and Barbados; Oligocene of Cuba; Oligocene of the Apennines; Eocene of Czechoslovakia; Tertiary of the Caucasus; Paleocene and Danian of the Crimea; Eocene of New Zealand.
Pleurostomella cubensis Cushman and Bermudez.	Eocene of Cuba; Eocene and Oligocene of Trinidad; Eocene of Mississippi; Eocene in submarine core off northeastern United States; Eocene of central Seran Indonesia.

The remaining benthonic species are either wider ranging or are too poorly preserved to be identified with certainty. A few, such as *Oridorsalis umbonatus* (Reuss) and *Osangularia culter* (Parker and Jones), appear to have ranges extending from Eocene to Recent.

Table 1 gives the species found in the two Eocene samples of the Alutom Formation.

TABLE 1.—*Distribution of smaller Foraminifera in the Eocene of Guam*

Species	Localities	
	Ei 4-1	Jl 2-1
Valvulinidae:		
Valvulina martii Cushman and Bermudez		×
Miliolidae:		
Triloculina sp. B		×
Pyrgo sp		×
Lagenidae:		
Robulus sp		×
Vaginulinopsis? sp		×
Dentalina? spp		×
Nodosaria affinis Reuss?		×
Chrysalogonium longicostatum Cushman and Jarvis	×	
Buliminidae:		
Bulimina semicostata Nuttall	×	×
tuxpamensis Cole		×
Bolivina choctawensis Cushman and McGlamery?		×
Orthomorphina parvula Todd, n. sp		×
rohri (Cushman and Stainforth)	×	
Stilostomella nuttalli (Cushman and Jarvis)?	×	
subspinosa (Cushman)		×
verneuili (d'Orbigny)		×
Ellipsoidinidae:		
Pleurostomella cubensis Cushman and Bermudez	×	
Ellipsoglandulina labiata (Schwager)	×	
Discorbidae:		
Rosalina sp	×	×
Rotaliidae:		
Gyroidina nitidula (Schwager)	×	
Eponides ocalanus Cushman		×
Oridorsalis umbonatus (Reuss)	×	
Nuttallides trumpyi (Nuttall)	×	×
Valvulineria? sp	×	
Stomatorbina torrei (Cushman and Bermudez)		×
Osangularia culter (Parker and Jones)	×	×
Alabamina conica Todd		×
Neorotalia floscula (Todd and Post)		×
Amphisteginidae:		
Asterigerina marshallana Todd and Post		×
Amphistegina bikiniensis Todd and Post		×

TABLE 1.—*Distribution of smaller Foraminifera in the Eocene of Guam*—Continued

Species	Localities	
	Ei 4-1	Jl 2-1
Cymbaloporidae:		
Halkyardia bikiniensis Cole		×
Nonionidae:		
Nonion maoricum (Stache)		×
Anomalinidae:		
Cibicides floridanus (Cushman)	×	
havanensis Cushman and Bermudez	×	×
macrocephalus (Gümbel)		×
tuxpamensis Cole		×
Planorbulinidae:		
Gypsina globula (Reuss)		×
Rupertiidae:		
Carpenteria hamiltonensis Glaessner and Wade?		×
Globigerinidae:		
Globigerina conglomerata Schwager	×	×
gortanii (Borsetti)	×	
pera Todd	×	
yeguaensis Weinzierl and Applin		×
Globigerapsis index (Finlay)	×	×
Hantkeninidae:		
Hantkenina alabamensis Cushman	×	×
inflata Howe		×
Globorotaliidae:		
Globorotalia centralis Cushman and Bermudez	×	×
spinuloinflata (Bandy)	×	
spinulosa Cushman	×	×
wilcoxensis Cushman and Ponton	×	

OLIGOCENE, TERTIARY *c*

Tertiary *c* beds are represented by four samples from the Mahlac Member of the Alutom Formation. The assemblages in two of these samples, Hi 6–1 and Gj 13–1, are very rich and well preserved.

A few species are identical with those in the Eocene fauna, but the Oligocene assemblages are much richer than those of the Eocene and include more than 2½ times as many species. Like the Eocene samples, these Oligocene ones are predominantly composed of planktonic specimens. Therefore, I intrepret them as from the outer slope, probably from moderately deep deposits.

Again, as in the Eocene samples, the interpretation of age is based primarily on the planktonic assemblages.

The planktonic assemblage is more varied than that in the Eocene samples. The most narrowly restricted forms are *Globigerina sellii* (Borsetti) and *Globigerina tripartita* Koch *tapuriensis* Blow and Banner, whose ranges are indicated (Eames and others, 1962, text fig. 20 [range chart]) to be restricted to Lattorfian and Rupelian.

Globigerina ampliapertura Bolli, *G. gortanii* (Borsetti), *G. increbescens* Bandy, *G. senilis* Bandy, *G. yeguaensis* Weinzierl and Applin, and *Cassigerinella chipolensis* (Cushman and Ponton) all include the Lattorfian-Rupelian in their ranges. *Globigerina ampliapertura* ranges slightly higher and slightly lower; *G. gortanii*, *G. increbescens*, and *G. senilis* range lower but no higher; *G. yeguaensis* ranges much lower but no higher; and *Cassigerinella chipolensis* ranges much higher but no lower (Eames and others, 1962, text fig. 20 [range chart]). *Globigerina dissimilis* Cushman and Bermudez, *G. suteri* (Bolli), and *G. venezuelana* Hedberg are all reported (Bolli, 1957b; 1957c, text figs. 18, 26 [range charts]) as having long ranges, extending from Eocene to Miocene. *Globigerina opima nana* (Bolli) is reported as ranging no higher than Oligocene in Trinidad (Bolli, 1957b, text fig. 18 [range chart]) but as having a long range, from Eocene to Miocene, in East Africa (Eames and others, 1962, text fig. 20 [range chart]). In either interpretation, its range does include the Lattorfian-Rupelian. *Globigerina danvillensis* Howe and Wallace and *Globigerinella danvillensis* (Howe and Wallace) (originally described under *Nonion*) were both first described from the Jackson Eocene at Danville Landing, La. Both have been reported from other areas, mostly in the Eocene but also in the lower Oligocene. *Chiloguembelina cubensis* (Palmer), described from the upper Eocene and lower Oligocene of Cuba, is reported (Beckmann, 1957, text fig. 16) to extend the upper part of its range into the *Globigerina ampliapertura* and *Globorotalia opima opima* zones of the Oligocene in Trinidad.

In consideration of the ranges reported for the various planktonic species found in the four Oligocene samples, it may be said with a fair amount of confidence that the age of the samples falls somewhere in the Lattorfian or Rupelian and also within the *Globigerina sellii* zone (Blow and Banner, 1962, p. 68, text fig. 20 [range chart]).

Probably the closest known assemblage (both in faunal similarity and geographic distance) to this one from the Alutom Formation is the one reported from Lindi in Tanganyika on the east coast of Africa (Blow and Banner, 1962).

The finding of a single specimen of the Eocene genus *Hantkenina* in the Oligocene sample Hi 6–1 throws doubt on the inclusion of this sample with the other three of Oligocene age. In spite of diligent search for additional specimens of *Hantkenina* to confirm its occurrence in Hi 6–1, no more specimens were found, and it was concluded that the single specimen was redeposited from older beds. Moreover, evidence of reworking in Hi 6–1 has already been reported by Cole (1963, p. E4 and table 1) who found Eocene larger Foraminifera in this sample.

The lack of *Globigerina sellii* (Borsetti), the zone fossil that is reported to be limited to the zone, throws further doubt on the precise correlation of sample Hi

6–1 with the other three samples, Gj 13–1, Gj 11–1, and Gj 14–1, that are assigned to this zone. The further circumstance that sample Hi 6–1 contains three additional planktonic species, namely *Globigerina danvillensis* Howe and Wallace, *G. yeguaensis* Weinzierl and Applin, and *Globigerinella danvillensis* (Howe and Wallace), none of which are found in any of the other three Oligocene samples and all of which have ranges extending farther downward than upward from the lower Oligocene, is yet another point in favor of differentiating sample Hi 6–1 from the remaining three Oligocene ones. The recognition in sample Hi 6–1 of forms transitional between *Globigerina ampliapertura* Bolli and *Globorotalia centralis* Cushman and Bermudez—forms identical with some illustrated from the highest Eocene zone in Trinidad—is an additional point in favor of interpreting Hi 6–1 as slightly older than the *Globigerina sellii* zone.

Nevertheless, in spite of the fact that the previously discussed points favor a pre-early Oligocene age for sample Hi 6–1, there are some weighty reasons for including it with the Oligocene rather than with the Eocene, as follows: First, the presence of *Cassigerinella chipolensis* (Cushman and Ponton) in abundance favors Oligocene age because this genus has not been reported in the Eocene. However, the question of exclusion of *Cassigerinella* from the Eocene is currently under debate owing to Tsunemasa Saito's finding (written commun., Jan. 10, 1964) of some small specimens of it in a deep-sea core in the Atlantic off Florida where it was reported in association with undoubted Eocene planktonic Foraminifera. Second, the presence of many species characteristic of the lower Oligocene, such as *Bolivina beyrichi* Reuss, *B. fastigia* Cushman, *B. oligocaenica* Spandel, *B. vicksburgensis* (Howe), *Angulogerina byramensis* (Cushman), *A. vicksburgensis* Cushman, *Asterigerinata bracteata* (Cushman), and *Pararotalia byramensis* (Cushman), favors the inclusion of Hi 6–1 with the other Oligocene samples. Third, the almost total dissimilarity of the planktonic assemblage of Hi 6–1 and the Eocene planktonic assemblage from the Alutom Formation, with only 3 of the 11 species in Hi 6–1 identical with 3 of the 9 species in the Eocene, also favors the placement of Hi 6–1 in the Oligocene rather than in the Eocene. Furthermore, of the three species that are identical in the two dissimilar assemblages, one, *Globigerina gortanii* (Borsetti), is represented by only a single specimen in the Eocene, whereas it is common in the Oligocene, and the other two, *Globigerina venezuelana* Hedberg and *G. yeguaensis* Weinzierl and Applin, are long-ranging forms. Moreover, the major constituents of the Eocene assemblages—*Globigerapsis index* (Finlay) and *Globorotalia centralis* Cushman and Bermudez—are totally lacking in sample Hi 6–1, whereas the major constituents of Hi 6–1 are *Globigerina venezuelana* Hedberg, *G. gortanii* (Borsetti), and *G. ampliapertura* Bolli.

It is therefore concluded that sample Hi 6–1 is early Oligocene in age, probably slightly older than the other three lower Oligocene samples. The presence of the single specimen of *Hantkenina inflata* Howe can be interpreted either as a redeposited specimen or as an example of extension of the Eocene genus across the Eocene-Oligocene border. Such reported upward extensions of *Hantkenina* are not unknown. (See Thalmann, 1942, p. 817–818, tables 1, 2.)

The benthonic parts of the Oligocene samples are much richer, more varied, and more abundant than the benthonic parts of the Eocene samples. Among the benthonic species, a considerable number have variously restricted stratigraphic ranges, and these ranges support the interpretation of early Oligocene (Tertiary *c*) age for these four samples of the Mahlac Member of the Alutom Formation. All the species given below seem to have become locally extinct after the Oligocene. Others may also have become extinct, but their identification is questionable or tentative, or they are so closely allied to other (later) species that their extinction should not be assumed.

Significant benthonic Foraminifera in Oligocene samples from the Mahlac Member of the Alutom Formation

Species	*Reported occurrences elsewhere*
Alabamina conica Todd	Upper Eocene, Densinyama and Hagman Formations of Saipan.
Amphimorphina californica Cushman and McMasters.	Eocene of Japan; Eocene of Washington; middle Eocene of California.
Angulogerina byramensis (Cushman).	Oligocene of Mexico, Venezuela, Trinidad, Alabama, Mississippi, and Texas.
Angulogerina cooperensis Cushman.	Eocene of Saipan; Eocene of Oregon; upper Eocene of Mississippi, Georgia, and South Carolina; Eocene of Maryland; upper Oligocene of Puerto Rico.
Angulogerina vicksburgensis Cushman.	Eocene of Saipan; Eocene of Georgia; lower Oligocene of Mississippi and Alabama; middle Oligocene of Dominican Republic.
Anomalina granosa (Hantken).	Eocene of Hungary, Netherlands, Italy, and Egypt; Eocene-Oligocene of U.S.S.R.
Asterigerinata bracteata (Cushman).	Oligocene of Eniwetok; Oligocene of Texas, Mississippi, and Alabama; lower Oligocene of Ukraine.
Baggina parva Todd	Miocene of Saipan.
Bolivina beyrichi Reuss	Oligocene of Germany; Eocene of Hungary.
Bolivina fastigia Cushman	Upper Oligocene of Germany; Oligocene of Belgium.
Bolivina gardnerae Cushman.	Upper Eocene of Alabama, Georgia, and Maryland.
Bolivina cf. *B. minutissima* Spandel.	Oligocene of Germany.
Bolivina oligocaenica Spandel.	Oligocene of Germany and France.

Significant benthonic Foraminifera in Oligocene samples from the Mahlac Member of the Alutom Formation—Continued

Species	*Reported occurrences elsewhere*
Bolivina plicatella mera Cushman and Ponton.	Miocene of Florida; Oligocene of Texas; Tertiary of Dominican Republic.
Bolivina tumida Cushman.	Miocene of California.
Bolivina vicksburgensis (Howe).	Oligocene of Eniwetok; lower Oligocene of Mississippi and Alabama.
Bolivinopsis cubensis (Cushman and Bermudez).	Upper Eocene of Cuba; Eocene and Oligocene of Trinidad.
Bulimina alazanensis Cushman.	Oligocene of Mexico, Cuba, Trinidad, and Dominican Republic; Eocene of California, Cuba, and Trinidad; Oligocene and Miocene of the Virgin Islands; mid-Tertiary of Venezuela; Aquitanian of northern Colombia; Miocene of Majorca; Aquitanian of Italy.
Bulimina bleeckeri Hedberg.	Oligocene of Venezuela, Cuba, Dominican Republic, Trinidad, and Texas; Aquitanian of northern Colombia.
Bulimina semicostata Nuttall.	Eocene of Saipan; Eocene, Guayabal Formation of Mexico; Eocene of California and Cuba.
Caucasina grata (Parker and Bermudez).	Eocene of Cuba, Trinidad, and California; Oligocene of Trinidad; upper Eocene and lower Oligocene of Barbados.
Chilostomella cyclostoma Rzehak.	Eocene of Saipan; Oligocene of Austria.
Chrysalogonium ciperense Cushman and Stainforth.	Oligocene of Trinidad.
Chrysalogonium lanceolum Cushman and Jarvis.	Oligocene of Trinidad; Eocene of Cuba and Trinidad; Miocene of Jamaica, Dominican Republic, and Majorca; middle Eocene to lower Oligocene of Barbados.
Chrysalogonium longicostatum Cushman and Jarvis.	Oligocene of Trinidad and Dominican Republic; upper Eocene and lower Oligocene of Barbados; Miocene of Majorca; lower Miocene of Algeria.
Chrysalogonium tenuicostatum Cushman and Bermudez.	Eocene of Cuba and Trinidad; Oligocene of Trinidad and Dominican Republic; middle Eocene to lower Oligocene of Barbados; Miocene of Majorca.
Cibicides havanensis Cushman and Bermudez.	Eocene of Cuba; middle Eocene to lower Oligocene of Barbados.
Cycloloculina cubensis Cushman and Bermudez.	Eocene of Cuba; middle Oligocene to lower Miocene of Puerto Rico.
Ellipsoglandulina labiata (Schwager).	Miocene of Kar Nicobar; Eocene of Saipan; lower Oligocene of Mexico and California; Eocene and Oligocene of Trinidad; Eocene of Ecuador; middle Eocene to lower Oligocene of Barbados; upper Miocene of Dominican Republic; Miocene of Majorca and Spain; Oligocene of Italy.
Eponides duprei ciervoensis Cushman and Simonson.	Oligocene, Tumey Formation (of Atwill, 1935) of California; Eocene, Oligocene, and Miocene of Eniwetok.
Eponides kiliani (Andreae).	Miocene of Saipan; Oligocene of Alsace.
Halkyardia bikiniensis Cole.	Oligocene of Bikini; Eocene and Oligocene of Eniwetok.
Nodosarella robusta Cushman.	Miocene? of Virgin Islands; Eocene and Oligocene of Trinidad; middle Eocene to lower Oligocene of Barbados.

Significant benthonic Foraminifera in Oligocene samples from the Mahlac Member of the Alutom Formation—Continued

Species	*Reported occurrences elsewhere*
Nodosarella subcylindrica Cushman.	Miocene? of Virgin Islands; Oligocene of Trinidad.
Nonion maoricum (Stache).	Upper Eocene and lower Oligocene of New Zealand.
Nonion micrum Cole.	Eocene of Saipan, Eniwetok, and mid-Pacific Mountains; Eocene, Guayabal Formation of Mexico; Eocene of California, Texas, Louisiana, Mississippi, and Georgia; Eocene in submarine core off northeastern United States.
Pararotalia byramensis (Cushman).	Oligocene of Mississippi, Alabama, and Florida; upper Eocene of Cuba; upper Oligocene and lower Miocene of Puerto Rico; Miocene of Eniwetok.
Pleurostomella bierigi Palmer and Bermudez.	Oligocene of Cuba, Trinidad, and Dominican Republic; Eocene of Trinidad; middle Eocene to lower Oligocene of Barbados; upper Oligocene and lower Miocene of Puerto Rico; Oligocene and Miocene of Venezuela; Miocene of Jamaica and Majorca.
Pleurostomella cubensis Cushman and Bermudez.	Eocene of Cuba; Eocene of Mississippi; Oligocene of Trinidad; Eocene in submarine core off northeastern United States; Eocene of Saipan.
Pleurostomella naranjoensis Cushman and Bermudez.	Eocene of Cuba and Trinidad; Oligocene of Trinidad; middle and upper Eocene of Barbados.
Stilostomella recta (Palmer and Bermudez).	Oligocene of Cuba and Trinidad; lower Oligocene of Barbados; Eocene of Trinidad, Ecuador, and Peru; Eocene in submarine core off northeastern United States; Miocene of California and Jamaica.
Stilostomella subspinosa (Cushman).	Lower Miocene of Trinidad; Miocene? of Virgin Islands; Eocene and Oligocene of Trinidad; middle Eocene to lower Oligocene of Barbados.
Stomatorbina torrei (Cushman and Bermudez).	Upper Eocene of New Zealand; Eocene of Cuba.
Vaginulinopsis sublituus multicamerata (Cushman and Stainforth).	Oligocene of Trinidad.
Virgulina colei Cushman.	Oligocene of Mexico.
Virgulina zetina Cole.	Eocene, Guayabal Formation of Mexico; Eocene of California, Louisiana and Georgia; Oligocene of Alabama.

Table 2 gives the species of smaller Foraminifera of Oligocene age found in the Mahlac Member of the Alutom Formation on Guam. The few species noted in a preliminary study that was made of these same samples and incorporated into a report by Tracey and others (1964, p. A22) included a few names not given in the following table. These discrepancies have resulted from the shifting of a species from one genus to another (such as *Cassidulina chipolensis* to *Cassigerinella*), from the synonymizing of one species with another (such as *Siphogenerina seriata*, a synonym of *S. striata*), from the correction of identification (such as *Bolivina* aff. *B. tricosta* for *B. choctawensis*), and

from the refinement of identification (such as *Bolivinopsis cubensis* for *B.* sp.).

TABLE 2.—*Distribution of smaller Foraminifera in the Oligocene of Guam*

Species	Localities			
	Hi 6–1	Gj 13–1	Gj 11–1	Gj 14–1
Textulariidae:				
Vulvulina spinosa Cushman	×			
Bolivinopsis cubensis (Cushman and Bermudez)	×	×		
Valvulinidae:				
Karreriella chilostoma (Reuss)	×	×		×
sp.			×	
Miliolidae:				
Triloculina sp. A		×		
Pyrgo sp.	×			
Lagenidae:				
Robulus cf. *R. cleriici* (Fornasini)	×	×		
rotulus (Stache)			×	×
sp.	×			
Marginulina glabra d'Orbigny		×		
Vaginulinopsis sublituus multicamerata (Cushman and Stainforth)	×	×		
Saracenaria sp.			×	
Dentalina cooperensis Cushman	×			
sp. B	×		×	
sp. C	×	×		
sp. D	×			
Enantiomorphina sp.			×	
Nodosaria consobrina (d'Orbigny)	×	×		
longiscata d'Orbigny	×			
aff. *N. tosta* Schwager		×		×
vertebralis (Batsch)	×	×		×
Chrysalogonium ciperense Cushman and Stainforth?		×	×	
lanceolum Cushman and Jarvis	×	×		×
longicostatum Cushman and Jarvis		×		
tenuicostatum Cushman and Bermudez	×	×		
sp.		×		
Rectoglandulina sp.		×		
Plectofrondiculariidae:				
Amphimorphina californica Cushman and McMasters	×			
Buliminidae:				
Buliminella septata Keyzer?		×		
Bulimina alazanensis Cushman	×			
bleeckeri Hedberg	×	×		×
ovata d'Orbigny	×			×
semicostata Nuttall	×			
sp.	×		?	
Caucasina grata (Parker and Bermudez)		×		
Fissurina fimbriata (Brady)		×		
lagenoides (Williamson)		×		
spp.	×			×
Oolina squamosa catenulata (Williamson)		×		
n. sp. aff. *O. gibbera* (Buchner)		×		
Bolivina beyrichi Reuss	×			
fastigia Cushman	×	×		
gardnerae Cushman	×		×	
cf. *B. minutissima* Spandel	×			
oligocaenica Spandel	×			
paula Cushman and Cahill		×		
plicatella mera Cushman and Ponton	×	×		
rhomboidalis (Millett)	×			
tortuosa Brady	×	?		
aff. *B. tricosta* Cushman and Bermudez	×			
tumida Cushman	×			
vicksburgensis (Howe)	×			
sp. A	×			
sp. B	×	×		×
Bolivina (*Loxostomum*) *rostra* (Cushman)	×			
Virgulina colei Cushman	×			
zetina Cole	×			
Reussella sp.	×			
Uvigerina ampullacea Brady	×			×
Angulogerina byramensis (Cushman)	×	?		
cooperensis Cushman	×	×	×	×
vicksburgensis Cushman	×	×	?	×
sp.	×			×
Siphogenerina striata (Schwager)	×			
Siphogenerina? sp.	×			
Orthomorphina parvula Todd, n. sp.	×	×	×	×
Stilostomella aff. *S. adelinensis* (Palmer and Bermudez)	×			
curvatura (Cushman)	×			
nuttalli (Cushman and Jarvis)	×			
recta (Palmer and Bermudez)	×	×		
subspinosa (Cushman)	×	×		
verneuili (d'Orbigny)	×	×	×	×
Ellipsoidinidae:				
Pleurostomella bierigi Palmer and Bermudez	×	×	×	
cubensis Cushman and Bermudez	×	×	×	×
naranjoensis Cushman and Bermudez		×		
sp.	×			
Ellipsoglandulina labiata (Schwager)	×	×	×	×
Nodosarella aff. *N. acus* Cushman and Bermudez	×			
robusta Cushman		×		
subcylindrica Cushman		×		
Discorbidae:				
Rosalina cf. *R. wrightii* (Brady)	×			
Neoconorbina celsa (Todd)	×			
Discorbis balcombensis Chapman, Parr, and Collins	×			
Rotaliidae:				
Asterigerinata bracteata (Cushman)	×			
Gyroidina girardana (Reuss)	×	×	×	×
lamarckiana (d'Orbigny)?		×		
nitidula (Schwager)		×		×
Eponides duprei ciervoensis Cushman and Simonson	×	×		×
kiliani (Andreae)		×		
sp.	×			
Oridorsalis umbonatus (Reuss)	×	×	×	×
Baggina parva Todd	×			
Stomatorbina torrei (Cushman and Bermudez)	×			
Osangularia culter (Parker and Jones)		×		×
Alabamina conica Todd	×	×		
Pararotalia byramensis (Cushman)	×			
Cycloloculina cubensis Cushman and Bermudez	×			
Amphisteginidae:				
Asterigerina marshallana Todd and Post?	×			
Cymbaloporidae:				
Halkyardia bikiniensis Cole	×			
Elphidiidae:				
Elphidium sp.	×			
Nonionidae:				
Nonion maoricum (Stache)		×	×	×
micrum Cole		×	×	×
"*Nonionella*" *minutissima* Todd	×			

TABLE 2.—*Distribution of smaller Foraminifera in the Oligocene of Guam*—Continued

Species	Localities			
	Hi 6–1	Gj 13–1	Gj 11–1	Gj 14–1
Nonionidae—Continued				
Nonionella sp	×			
Astrononion cf. *A. australe* Cushman and Edwards	×			
cf. *A. pusillum* Hornibrook		×		×
Cassidulinidae:				
Cassidulina subglobosa Brady		×	×	
tricamerata Galloway and Heminway	×	×		
sp. A		×		
sp. B	×	×		×
sp. C				×
Cassidulina? sp. D				×
Chilostomellidae:				
Chilostomella cyclostoma Rzehak	×	×		
Pullenia bulloides (d'Orbigny)		×		
sp		×		
Anomalinidae:				
Anomalina granosa (Hantken)		×	×	×
Cibicides brevoralis Carter	×			
carinatus (Terquem)	×			
floridanus (Cushman)	×	×		
havanensis Cushman and Bermudez		×		
lobatulus (Walker and Jacob)	×	×		
praecursorius (Schwager)	×			
pseudoungerianus (Cushman)	×			
Cibicidina danvillensis (Howe and Wallace)?	×			
Planulina wuellerstorfi (Schwager)		×	×	
Planorbulinidae:				
Planorbulinella larvata (Parker and Jones)	×			
Heterohelicidae:				
Chiloguembelina cubensis (Palmer)	×			
Globigerinidae:				
Globigerina ampliapertura Bolli	×	×		
conglomerata Schwager	×	×	×	×
danvillensis Howe and Wallace	×			
dissimilis Cushman and Bermudez		×		
gortanii (Borsetti)	×	×	×	×
increbescens Bandy	×	×	×	
opima nana (Bolli)	×	×		
sellii (Borsetti)		×	×	×
senilis Bandy		×		
suteri (Bolli)	×		×	
tripartita tapuriensis Blow and Banner		×		
yeguaensis Wienzierl and Applin	×			
Globigerinella danvillensis (Howe and Wallace)	×			
Globigerinoides trilobus (Reuss)?	×		×	
Cassigerinella chipolensis (Cushman and Ponton)	×	×		
Hantkeninidae:				
Hantkenina inflata Howe	×			

Above the Mahlac Member of the Alutom Formation, a considerable thickness of Miocene beds intervenes between the Mahlac Member and the next higher formation in which smaller Foraminifera are found. Therefore, a radical difference in smaller Foraminifera is evident between the fauna of the lower Oligocene and that of the upper Miocene. In many of its aspects the Miocene is only subtly different from the Recent now found around Guam in a comparable environment. The Eocene, although much less rich and less varied than the Oligocene, has a large proportion of its species (44 percent) in common with the overlying Oligocene. The Oligocene assemblage, on the other hand, although composed of nearly 150 species as compared with the 92 species of the Miocene, has only 14 species (less than 10 percent) in common with the Miocene. Moreover, probably more than 60 species (more than 40 percent of the Oligocene assemblage) became extinct between the lower Oligocene and the upper Miocene.

MIOCENE, TERTIARY *f* OR *g*

The Miocene Janum Formation, like the upper Eocene and Oligocene Alutom Formation, was formed in moderately deep water. Planktonic specimens are predominant and are accompanied by meager representatives of a varied benthonic assemblage.

A total of seven samples from vertical sections (four at Catalina Point, two at Lujuna Point, and one at Anao Point) represent the Miocene Janum Formation. Only one sample, Rr 15–1, has a rich fauna. Locations of these three vertical sections as well as of the other samples studied on Guam are shown in figure 1.

As is true for the other fossil assemblages, the interpretation of age is based primarily on a few planktonic species; however, several of the many benthonic species serve to support and confirm the age indicated by the planktonic species. Because the original determination of the Janum Formation was made (Cole, 1963, p. E10; Tracey and others, 1964, p. A43) largely on the basis of field evidence—a Tertiary *f* species of *Lepidocyclina* within a pebble interpreted as having been reworked and two species characteristic of the Barrigada Limestone of Tertiary *g* age that were found in place at the base of the Janum Formation—the assignment of the Janum Formation to Tertiary *g* may be open to question. Correlation of the Janum Formation is discussed under incongruities of correlations (p. I21–I23).

On Guam the following planktonic species are characteristic of and restricted to Miocene; the species marked by an asterisk are undoubtedly known in the Recent (see Todd, 1964) but were not found in the Recent *Globigerina* ooze around Guam:

Globigerina nepenthes Todd
**Globigerina conglomerata* Schwager
Globoquadrina altispira (Cushman and Jarvis)
**Orbulina bilobata* (d'Orbigny)
Orbulina suturalis Bronnimann
Sphaeroidinella disjuncta Finlay
Sphaeroidinella kochi (Caudri)
Sphaeroidinella seminulina (Schwager)
Globorotalia menardii fijiensis Cushman
Globorotalia menardii-tumida transition form

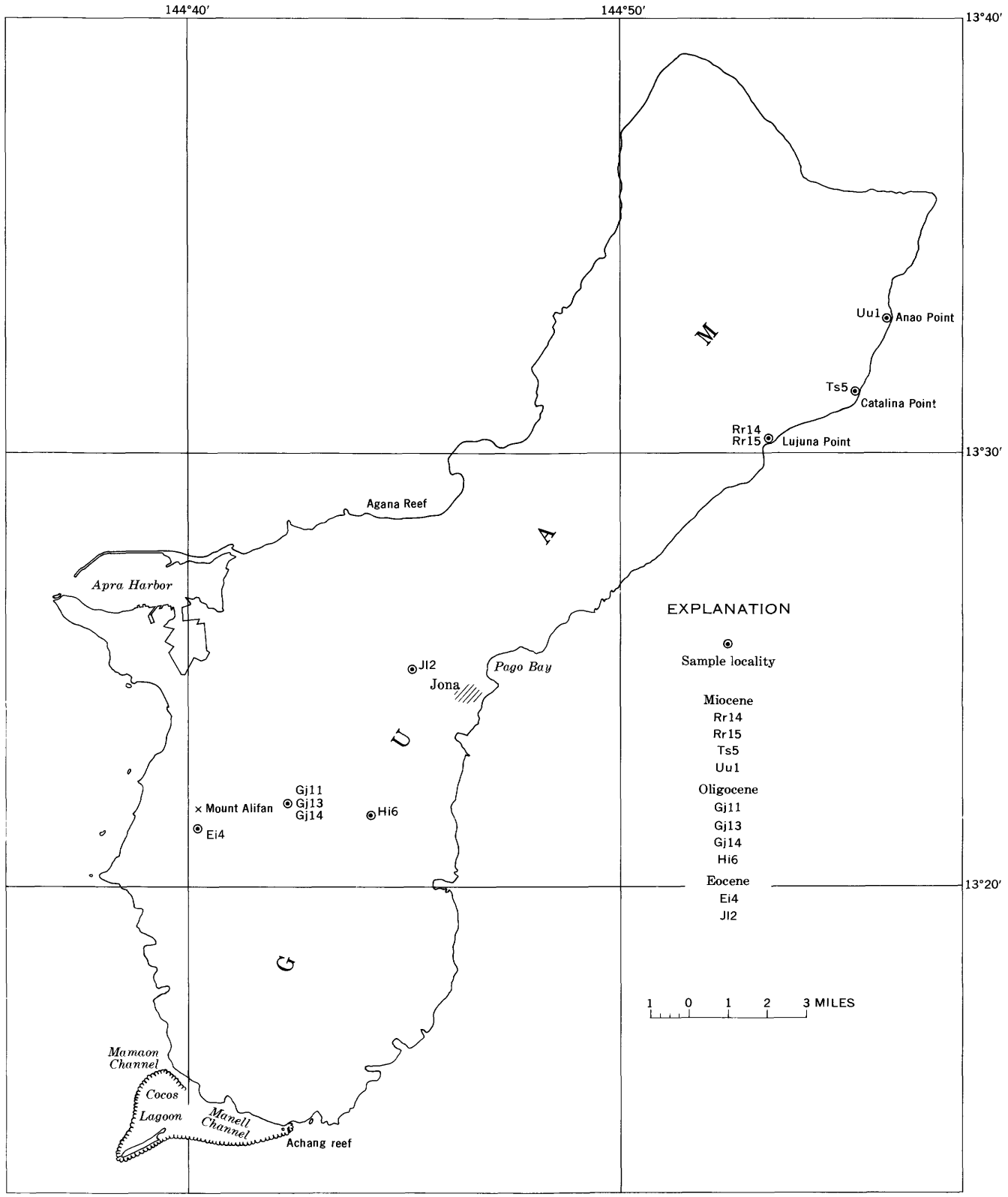


FIGURE 1.—Localities of Eocene, Oligocene, and Miocene smaller Foraminifera studied from Guam.

Globorotalia tumida flexuosa (Koch)
Globorotalia fohsi robusta Bolli

Among the planktonic species, only the ones mentioned below seem to be useful in limiting the age of the formation to a specific part of the Miocene.

Globigerina nepenthes Todd was described from the Donni Sandstone Member of the Tagpochau Limestone of Saipan. Its vertical range in Venezuela and Japan is reported (Blow, 1959, p. 178; Takayanagi and Saito, 1962, text fig. 2) to be limited to the *Globorotalia mayeri/Globigerina nepenthes* subzone and the *Globorotalia menardii menardii/Globigerina nepenthes* zone. These two zones encompass the upper part of the Vindobonian and the lower part of the Sarmatian. The occurrence of *G. nepenthes* in several deep-sea cores from North Atlantic sediment interpreted as Pliocene (Ericson and others 1963, text fig. 5) does not require the upward extension of range of this species, inasmuch as these authors mention (p. 733) the Miocene aspect of the Pliocene and state that "the survival of Miocene species into the Pliocene epoch implies that no abrupt or drastic temperature change occurred at the Miocene-Pliocene time boundary." A more reasonable explanation of the presence of Miocene species in the Pliocene might be that the sediments are, in reality, Miocene and that the Pliocene is less thick in the deep-sea Atlantic than has been thought.

Globoquadrina altispira (Cushman and Jarvis) was originally described from the Miocene of Jamaica and has been widely reported from the Miocene of many parts of the world in the equatorial belt. Its reported occurrences indicate that *G. altispira* may be expected in any part of the Miocene, although it possibly has greater or lesser restricted ranges in various areas. On Saipan it was found (Todd, 1957, table 3) in the Donni Sandstone Member of the Tagpochau Limestone, where it occurred in association with *Globigerina nepenthes* Todd. It also occurs, but without the association of *Globigerina nepenthes*, in the underlying Fina-sisu Formation (Todd, 1957, table 2), which was originally described as of late Oligocene age but here is regarded as of early Miocene age. In the Trinidad zonation it was reported (Bolli, 1957b, text fig. 18) to range within most of the Miocene, with the exception of the one lowest zone and the two highest zones. In Trinidad, *Globoquadrina altispira* and *Globigerina nepenthes* are reported to have mutually exclusive ranges; *G. nepenthes* occurs in the two uppermost zones of the Miocene. Likewise in Venezuela, the ranges of *Globoquadrina altispira* and *Globigerina nepenthes* are mutually exclusive. *Globigerina nepenthes* first appears at a higher horizon than the highest known occurrence of *Globoquadrina altispira* (Blow, 1959, p. 179, 183).

In some short deep-sea cores from a guyot adjoining Eniwetok Atoll (Todd, 1964), *Globoquadrina altispira* occurs in the sections of the cores interpreted as late Miocene. Other recorded occurrences of *G. altispira* from the Miocene in the Pacific are from the Mid-Pacific Mountains (Hamilton, 1953), Sylvania Guyot off Bikini (Hamilton and Rex, 1959), and Yap Island in the Carolines (Cole and others, 1960).

Several estimates of the age ranges of these two species have been made. Blow (1959, chart 1) assigns the zones in which he reports *Globoquadrina altispira* to the Aquitanian and Burdigalian, and he assigns the zones in which he reports *Globigerina nepenthes* to the Vindobonian and Sarmatian. Stainforth (1960, range chart and p. 222) reports the range of *Globoquadrina altispira* to be from Stampian and Chattian to the Helvetian. Drooger (1956, text fig. 1) reports the range of *Globoquadrina altispira* to be from Aquitanian to Tortonian.

The genus *Sphaeroidinella* is well represented in the Janum Formation. The specimens belonging in this genus fall into four species that are connected, by transitional individuals, into a single complex. This *Sphaeroidinella* complex includes, at one extreme of morphological development, specimens having five or more chambers in the final whorl and a distinctly lobulated periphery—*S. kochi* (Caudri). At the opposite extreme are specimens of *S. dehiscens* (Parker and Jones), the common Recent species that is nearly globular and unindented and that is composed of three chambers in the final whorl. The forms intermediate between these two extremes are identified as *S. seminulina* (Schwager). They show three or four chambers in the final whorl and have a slightly indented periphery. The fourth member of the *Sphaeroidinella* complex is *S. disjuncta* Finlay, which is distinguished by its coarsely reticulated wall surface. In number of chambers per final whorl and in the lobulation of its periphery, *S. disjuncta* includes both specimens that would be called *S. kochi* and others that would be called *S. seminulina*.

Three of the previously discussed species of *Sphaeroidinella*, that is, all but *S. dehiscens*, are Miocene species. Moreover, *S. dehiscens*, although characteristic of, and abundant in, many Recent deepwater samples, has also been found in the Miocene (Todd, 1957, pl. 79, fig. 8). Thus the *Sphaeroidinella* complex supports a Miocene age for part of the Janum Formation.

Another highly variable complex in the Miocene may be called the *Globorotalia menardii-tumida* transition form. It includes rare individuals that, by themselves, could be regarded as typical of *G. menardii* (d'Orbigny)

and of *G. tumida* (Brady); however, most of the specimens fall somewhere between the two. The transition form has a rather broad and thick test that has heavy walls, a limbate keel, a slightly curved dorsal surface, and chambers slightly inflated ventrally. With these specimens are others nearly typical of the subspecies *fijiensis*, which is characterized by a slightly flatter and rounder test, more numerous chambers, and a tendency toward peripheral lobulation; the subspecies *ungulata*, which is characterized by a more nearly planoconvex test, a more inflated ventral surface, and an angled ventral face of the final chamber; and the subspecies *flexuosa*, which is characterized by a final chamber that is reduced in size and is bent under nearly 90° toward the ventral side.

In addition there appears to be a close and probably transitional relationship with specimens placed in *Globorotalia fohsi robusta* Bolli. Biologically, the two species *Globorotalia menardii* (d'Orbigny) and *Globorotalia fohsi robusta* Bolli may have no connection, but morphologically, they seem closely related. *G. fohsi robusta* has the heavy limbate keel that is characteristic of the *G. menardii-tumida* complex. However, *G. fohsi robusta* is a flatter, more compact form having one or two more chambers per final whorl, and its aperture is a low slit rather than an arch, as in the *G. menardii-tumida* transition form.

Globorotalia fohsi robusta Bolli, which is a zone marker in the upper part of the Burdigalian and just beneath the lowest part of the range of *Globigerina nepenthes* Todd, is represented by only a few specimens and is found only in sample Rr 15–1. Its occurrence together with *G. nepenthes* may serve to define the age of the Janum Formation as near the upper limit of the range of the older species—*Globorotalia fohsi robusta* Bolli—and near the lower limit of the range of the younger one—*Globigerina nepenthes* Todd.

It is of interest that some 20 years ago, well before the recognition of the value of planktonic species as age indicators, Glaessner (1943, p. 68–69) published a "tentative list of selected species of smaller Foraminifera," under the heading "Miocene index Foraminifera." In the list of 44 species, all but 2 species of *Sphaeroidinella* are benthonic forms. Six species in Glaessner's list of 44, namely the 2 species of *Sphaeroidinella*, *Nodosaria skobina* Schwager, *Nodosaria equisetiformis* Schwager, *Pyrulina labiata* (Schwager), and *Osangularia culter* (Parker and Jones) (=*Pulvinulinella bengalensis* in Glaessner's list), are identical with the species identified from the Miocene of the Janum Formation of Guam.

In addition, there is a high degree of generic similarity between Glaessner's list of "Miocene index Foraminifera" and the Miocene species from Guam. Disregarding the 6 species in Glaessner's list that are found in the Miocene of Guam, the 38 remaining species fall into 25 genera. Twelve of these genera are represented in the Miocene of Guam, and it is possible that some of the species will prove to be not only generically identical but specifically so. For example, *Vulvulina nicobarensis* (Schwager) is possibly identical with *V. spinosa* Cushman; *Eggerella? subovalis* (Schwager) is possibly identical with *Eggerella bradyi* (or with *Karreriella bradyi?*); *Karreriella siphonella* (Reuss) is possibly identical with *K. bradyi* (Cushman); and *Uvigerina hispida* Schwager is possibly identical with *Uvigerina proboscidea* Schwager.

The benthonic assemblage of the Janum Formation can add no refinement to the age of the beds. Several species included in the following list, however, are known to occur elsewhere in the Miocene but not in the Recent of comparable facies around Guam. The presence of these species in the Janum samples serves as supporting evidence of Miocene age. Additional species are present in the Miocene of Guam but not in the Recent around Guam. The apparent elimination (or local extinction) of some of these Miocene species is probably due to incomplete collection of specimens or erratic distribution of rare species. Moreover, the Janum Formation includes only 65 benthonic species, about a third as many as the 187 species that are found in the composite Recent assemblage from the outer slopes off Guam.

Significant benthonic Foraminifera in the Miocene samples of the Janum Formation

Species	*Reported occurrences elsewhere*
Bolivina pusilla Schwager	Miocene of Kar Nicobar; Miocene of Egypt.
Bolivina silvestrina Cushman.	Pliocene and Pleistocene of Italy.
Bulimina aguafrescaensis Todd and Kniker.	Eocene of Chile.
Buliminella septata Keyzer.	Miocene of Saipan; "Miopliocene" of Buton (Malay archipelago).
Cassidulina carandelli Colom.	Miocene (Burdigalian) of Majorca.
Cassidulina carapitana Hedberg.	Oligocene of Venezuela; upper Oligocene of Trinidad; middle Oligocene of Dominican Republic; Miocene of Aruba; Aquitanian of Colombia; Oligocene of Belgium and Germany.
Cassidulina sagamiensis Asano and Nakamura.	Pliocene to Recent of Japan.
Cassidulina sp. E of Todd, 1957.	Miocene, Donni Sandstone Member of Tagpochau Limestone of Saipan.
Cassidulina nov. sp. of Germeraad.	"Young-Neogene" of central Seran, Indonesia.
Dentalina tauricornis (Schwager).	Pliocene of Fiji; Miocene of Kar Nicobar; middle Miocene of Japan.
Nodosaria equisetiformis Schwager.	Pliocene of Fiji; Miocene of Kar Nicobar.

Significant benthonic Foraminifera in the Miocene samples of the Janum Formation—Continued

Species	*Reported occurrences elsewhere*
Nodosaria insecta Schwager.	Miocene of Kar Nicobar and Java; late Miocene and early Pliocene of Borneo; Tertiary of Japan.
Nodosaria skobina Schwager.	Miocene of Kar Nicobar.
Orthomorphina fijiensis (Cushman).	Pliocene of Fiji.
Orthomorphina perversa (Schwager).	Miocene of Kar Nicobar; Miocene of Jamaica; Oligocene of Cuba; Pliocene of Italy.
Osangularia culter (Parker and Jones).	Miocene of Kar Nicobar; Eocene, Oligocene, and Miocene of Saipan; Eocene of Mexico and California; middle Eocene to lower Oligocene of Barbados; Eocene and Miocene of Spain; Aquitanian of Algeria; Eocene of Bulgaria.
Pleurostomella alternans Schwager.	Miocene of Kar Nicobar; Miocene and Pliocene of Borneo; Pliocene of Fiji; Miocene of Jamaica; Tertiary of Dominican Republic; Eocene and Oligocene of Barbados; Miocene of Spain, France, and Egypt; Pliocene of Italy and Greece.
Pleurostomella brevis Schwager.	Miocene of Kar Nicobar; Pliocene of Fiji; Miocene of Japan; Eocene of Saipan; Miocene of Jamaica and Dominican Republic; Miocene of Spain, France, and Algeria.
Pyrulina labiata (Schwager).	Miocene of Kar Nicobar; Pliocene of Fiji.
Siphogenerina striata (Schwager).	Miocene of Kar Nicobar; Miocene and Pliocene of Borneo and Java; Eocene and Miocene of Saipan; Eocene and Oligocene of Trinidad.
Stilostomella verneuili (d'Orbigny).	Miocene of Vienna Basin; Miocene of Sumatra; Eocene, Oligocene, and Miocene of West Indies; Eocene, Oligocene, and Miocene of Spain.
Vulvulina spinosa Cushman.	Oligocene, Alazan Formation of Mexico; upper Eocene of Venezuela; Oligocene of Trinidad; upper Oligocene of Dominican Republic; middle Eocene to lower Oligocene of Barbados; Miocene of Spain; Pliocene of Japan; Recent of Philippines.

The chief local differences between the Miocene and the Recent benthonic faunas are in the families Textulariidae (7 species in the Recent and 1 in the Miocene), Miliolidae (52 in the Recent and 2 in the Miocene), Spirillinidae and Discorbidae (15 in the Recent and not represented in the Miocene), and the families Rotaliidae, Pegidiidae, Amphisteginidae, Calcarinidae, and Cymbaloporidae (27 in the Recent and only 3 rotaliids in the Miocene). Thus there is not much in common between the Miocene benthonic and the Recent benthonic faunas. If anything, I believe the kinds of benthonic species present in the Miocene, supported by the negative evidence of the kinds that are not present in the Miocene, indicate that the beds represented by the few Miocene samples studied were deposited at greater depths and farther from shore than the Recent outer slope samples that were taken from depths less than 200 fathoms.

Table 3 gives by localities the smaller Foraminifera of Miocene age found in the Janum Formation on Guam. Discrepancies are to be found between the species noted in my original examination of these same samples (Tracey and others, 1964, p. A43) and the species given in table 3. These discrepancies have resulted from (a) the shifting of a species from one genus to another (such as *Eponides umbonatus* to *Oridorsalis* and *Siphonodosaria fijiensis* to *Orthomorphina*); (b) the synonymizing of one species with another (such as *Globigerina venezuelana*, a synonym of *G. conglomerata*, and *Osangularia bengalensis*, a synonym of *O. culter*); (c) the correction of identification (such as *Pulleniatina obliquiloculata* for *Globigerina inflata* and *Globorotalia hirsuta* for *G. canariensis*); and (d) the refinement of identification (such as *Gyroidina lamarckiana* and *G. soldanii* for *G. spp.*). In addition, some of the indeterminate species and those whose generic placement was questioned in the original study have been eliminated from table 3.

TABLE 3.—*Distribution of smaller Foraminifera in the Miocene of Guam*

Species	Localities						
	Rr 15-1	Rr 14-1	Ts 5-10	Ts 5-7	Ts 5-6	Ts 5-5	Un 1-3
Textulariidae:							
Vulvulina spinosa Cushman	×	--	--	--	--	--	--
Valvulinidae:							
Eggerella bradyi (Cushman)	×	--	--	--	--	--	--
Karreriella bradyi (Cushman)	×	--	--	--	--	--	--
Miliolidae:							
Quinqueloculina lamarckiana d'Orbigny	×	--	--	--	--	--	--
Pyrgo murrhina (Schwager)	×	--	--	×	--	--	--
Lagenidae:							
Robulus sp	--	?	--	×	--	--	--
Dentalina communis d'Orbigny	×	--	--	--	--	--	--
tauricornis Schwager	×	--	--	×	--	--	--
sp. A	--	--	--	×	--	--	--
Dentalina? spp	×	--	--	--	--	--	--
Nodosaria equisetiformis Schwager	×	?	×	--	×	--	--
insecta Schwager	×	--	--	--	--	×	--
skobina Schwager	×	--	--	--	--	--	--
Lagena gracilis Williamson	×	--	--	--	--	--	--
Polymorphinidae:							
Pyrulina labiata (Schwager)	×	--	--	--	--	--	--
Buliminidae:							
Buliminella septata Keyzer	×	--	--	--	--	--	--
Bulimina aguafrescaensis Todd and Kniker	×	--	--	--	--	--	--
Fissurina alveolata (Brady)	×	--	--	--	--	--	--
circulum Seguenza	×	--	--	--	--	--	--
formosa (Schwager)	×	--	--	--	--	--	--
globosa Bornemann	×	--	--	--	--	--	--
Bolivina aff. *B. nitida* Brady	--	--	×	×	--	--	×
pusilla Schwager	×	--	--	×	--	--	--
silvestrina Cushman	×	--	--	×	--	--	--
aff. *B. sinuatum* Galloway and Wissler	×	--	--	×	--	--	--

TABLE 3.—*Distribution of smaller Foraminifera in the Miocene of Guam*—Continued

Species	Localities						
	Rr 15-1	Rr 14-1	Ts 5-10	Ts 5-7	Ts 5-6	Ts 5-5	Uu 1-3
Buliminidae—Continued							
Reussella simplex (Cushman)	--	--	×	--	--	--	--
Uvigerina proboscidea Schwager	×	--	--	--	--	--	--
proboscidea var. *vadescens* Cushman	×	--	--	--	--	--	--
Siphogenerina striata (Schwager)	--	--	--	×	--	--	--
Orthomorphina fijiensis (Cushman)	×	×	--	×	--	--	×
parvula Todd, n. sp	×	--	--	--	--	--	--
perversa (Schwager)	×	--	--	×	--	--	--
Stilostomella verneuili (d'Orbigny)	×	×	×	×	--	--	--
Trifarina bradyi Cushman	--	--	×	×	--	--	--
Ellipsoidinidae:							
Pleurostomella alternans Schwager	×	×	×	×	--	--	--
brevis Schwager	--	--	--	×	--	--	--
Ellipsopleurostomella sp	×	--	--	--	--	--	--
Rotaliidae:							
Gyroidina lamarckiana (d'Orbigny)	--	--	--	×	--	--	--
soldanii d'Orbigny	×	--	×	×	--	--	--
Oridorsalis umbonatus (Reuss)	×	×	--	--	×	×	--
Osangularia culter (Parker and Jones)	×	--	?	?	--	--	--
Elphidiidae:							
Elphidium sp	×	×	×	--	--	--	--
Nonionidae:							
Nonion pompilioides (Fichtel and Moll)	--	--	×	--	--	--	--
Nonionella sp	--	--	--	×	--	--	--
Astrononion novozealandicum Cushman and Edwards	×	--	--	--	--	--	--
Cassidulinidae:							
Cassidulina aff. *C. angulosa* Cushman	×	--	--	--	--	--	--
carandelli Colom	--	--	×	--	--	--	--
carapitana Hedberg	×	--	--	--	--	--	--
delicata Cushman	--	--	×	--	--	--	--
minuta Cushman	--	×	--	×	--	--	--
pacifica Cushman	×	--	×	--	--	×	--
sagamiensis Asano and Nakamura	×	×	×	?	--	×	--
subglobosa Brady	×	×	×	×	×	×	--
subtumida Cushman	--	×	--	×	--	--	--
nov. sp. of Germeraad (1946)	--	--	×	--	--	--	--
sp. E of Todd (1957)	--	--	--	×	--	--	--
Ehrenbergina albatrossi Cushman	×	--	--	--	--	--	--
Chilostomellidae:							
Pullenia bulloides (d'Orbigny)	×	--	--	--	×	--	--
sp	×	×	--	--	--	×	--
Sphaeroidina bulloides d'Orbigny	--	--	--	×	--	×	--
Anomalinidae:							
Laticarinina pauperata (Parker and Jones)	--	--	--	×	--	--	--
Planulina wuellerstorfi (Schwager)	×	--	×	×	--	--	--
Cibicides cicatricosus (Schwager)	--	×	--	×	--	--	--
lobatulus (Walker and Jacob)	×	--	--	--	--	--	--
cf. *C. pseudoungerianus* (Cushman)	×	--	--	--	--	×	--
Globigerinidae:							
Globigerina aff. *G. apertura* Cushman	×	--	--	--	--	×	×
conglomerata Schwager	×	--	--	×	--	--	×
hexagona Natland	×	--	--	--	--	--	--
nepenthes Todd	×	×	--	--	×	--	--
Globoquadrina altispira (Cushman and Jarvis)	×	--	×	×	×	×	×
Globigerinoides conglobatus (Brady)	×	×	×	×	×	×	×
sacculifer (Brady)	×	--	--	--	×	×	×
trilobus (Reuss)	--	--	×	--	--	--	--
Globigerinella aequilateralis (Brady)	×	--	--	--	--	--	--
Globigerinita glutinata (Egger)	×	--	--	--	--	--	--
Orbulina bilobata (d'Orbigny)	×	--	--	--	--	--	--
suturalis Bronnimann	×	--	--	--	--	--	--
universa d'Orbigny	×	×	×	×	×	--	×
Pulleniatina obliquiloculata (Parker and Jones)	×	--	--	×	--	?	--

TABLE 3.—*Distribution of smaller Foraminifera in the Miocene of Guam*—Continued

Species	Localities						
	Rr 15-1	Rr 14-1	Ts 5-10	Ts 5-7	Ts 5-6	Ts 5-5	Uu 1-3
Globigerinidae—Continued							
Sphaeroidinella dehiscens (Parker and Jones)	×	×	×	×	×	×	×
disjuncta Finlay	×	--	--	--	--	--	--
kochi (Caudri)	×	×	--	×	×	--	×
seminulina (Schwager)	×	×	--	×	×	×	×
Candeina nitida d'Orbigny	×	--	--	--	--	--	--
Hastigerina pelagica (d'Orbigny)	×	--	--	--	--	--	--
Globorotaliidae:							
Globorotalia fohsi robusta Bolli	×	--	--	--	--	--	--
hirsuta (d'Orbigny)	×	--	--	×	--	--	×
menardii fijiensis Cushman	×	--	×	--	×	×	--
menardii ungulata Bermudez	×	--	--	--	--	--	--
menardii-tumida transition form	×	×	×	×	×	×	×
tumida (Brady)	--	×	--	×	×	--	×
tumida flexuosa (Koch)	×	--	--	--	--	--	--

RECENT

Foraminifera were studied from 98 Recent samples. The samples have been grouped into the following categories:

Beaches:
(15 samples).

Reefs:
Agana Reef (10 samples).
Achang Reef (8 samples).
Pago Reef (12 samples).
Cocos Barrier Reef (3 samples).

Cocos Lagoon:
East-West profile (12 samples).
North-South profile (9 samples).

Channels:
Mamaon Channel (NW. end of Cocos Lagoon, 7 samples).
Manell Channel (into Achang Bay, 4 samples).
Pago Channel (into Pago Bay, 8 samples).

Outer slopes surrounding Guam:
(10 samples).

The seven deepest of the outer-slope samples (those from between 315 and 1,170 ft) provide the richest assemblages found in the Recent. These seven samples of globigerine ooze are similar to the samples of Miocene globigerine ooze from the Janum Formation, but they differ by having an admixture of shallower water material from upslope that is not found in the Miocene samples.

The major differences between the Miocene samples and the Recent outer-slope samples may be briefly summarized as follows: The Recent samples show (a) an increase in numbers and diversity of arenaceous species;

(b) great increase in abundance of specimens and diversity of species of Miliolidae and Ophthalmidiidae; (c) appearance in some abundance of camerinids and peneroplids that probably originated upslope; (d) disappearance of the family Ellipsoidinidae; (e) appearance of species in the families Spirillinidae and Discorbidae; (f) increase in numbers and diversity of species in the family Rotaliidae; (g) appearance in abundance of representatives of the families Amphisteginidae, Calcarinidae, and Cymbaloporidae, most of which also probably originated upslope; (h) decrease in numbers and diversity of species in the Cassidulinidae; and (i) appearance of species in the Planorbulinidae, Rupertiidae, and Homotremidae.

The other four main ecologic subdivisions of Recent samples—beaches, reefs, lagoons, and channels—together contain a composite fauna that differs only slightly in its four parts but is distinctly different from the fauna from the outer-slope samples.

The major differences between the deeper samples from the outer slope and the shallower ones from the beaches, reefs, lagoons, and channels may be briefly summarized as follows: The shallower samples show (a) an increase in abundance of the miliolids; (b) the complete disappearance of the families Lagenidae, Polymorphinidae, Cassidulinidae, Chilostomellidae, Rupertiidae, and Ceratobuliminidae; (c) the almost complete disappearance of the families Heterohelicidae, Spirillinidae, Robertinidae, Globigerinidae, and Globorotaliidae; (d) an increase in abundance of the camerinids, peneroplids, and elphidiids; (e) a decrease in numbers and diversity of species in the Buliminidae; (f) a nearly complete absence of all the deeper water species of Amphisteginidae, leaving only *A. madagascariensis;* and (g) an increase in abundance and robustness of the three species: *Amphistegina madagascariensis*, *Calcarina spengleri*, and *Baculogypsina sphaerulata.*

The Recent beach accumulations are typical of beaches in the tropical Pacific, being characterized by a predominance of reef-dwelling species—*Baculogypsina sphaerulata* (Parker and Jones), *Calcarina spengleri* (Gmelin), and *Marginopora vertebralis* Blainville—and by a scarcity of other species. The assemblages collected from the reefs, from the lagoons, and from the channels have little to distinguish them one from another. If anything, there is perhaps a greater diversity of species in the lagoons and channels than on the reefs and perhaps even a slightly greater diversity in the lagoons, where the circulation of water is less active than in the channels.

Table 4 gives by sample locality numbers the smaller Foraminifera of Recent age collected from Guam.

INCONGRUITIES OF CORRELATIONS IN THE WESTERN PACIFIC

During the past 10 years a rather detailed zonation based on planktonic Foraminifera has been built up within the Cretaceous and Tertiary. It originated mostly in the West Indian region but has been extended to Europe, Africa, and Asia and is now regarded by most of its users as having worldwide validity in the equatorial regions.

Because it was established on the basis of planktonic Foraminifera and without any reference to either larger Foraminifera or mollusks, there is no positive and indisputable way in which the zonation can be correlated with either the European time scale or with the Indonesian letter classification. Moreover, there is no universal agreement as to where the various zones are to be placed in terms of either of these other time scales. Nevertheless, some speculative correlations, as indicated in figure 2, may be made.

As a fundamental premise to the building up of correlations between beds that contain planktonic Foraminifera, we must accept the hypothesis of worldwide contemporaneous existence of these zones and their unchanging sequential relation to one another. Keeping in mind that these two assumptions—contemporaneous worldwide existence and unchanging sequence—are the keystone of our whole structure of correlation by planktonic faunas, we may proceed with tentative speculations about some of the correlations in the western Pacific.

The occurrence of *Globigerina nepenthes* in the Donni Sandstone Member of the Tagpochau Limestone on Saipan and in the Janum Formation on Guam raises the question of the correlation of these two occurrences and their placement in the worldwide planktonic zonation. Estimated age (Todd, 1957, p. 280) of the Donni Sandstone Member was limited upward by the presence of *Orbulina suturalis* and limited downward by the presence of *Globorotalia menardii.* In addition, the presence of *Globigerina nepenthes*, a species described from the Donni although already known in the West Indian section, served to restrict the age more narrowly through its limitation in the West Indian planktonic zonation. The resulting estimation of the age of the Donni Sandstone Member as earliest Miocene was made in terms of the *Globorotalia mayeri* and *G. menardii* zones which were at that time regarded as lowermost Miocene.

Other authors have placed these two zones higher in the European time scale. The lack of agreement regarding their age is demonstrated by some of the current interpretations of these two zones. Drooger (1956,

797-972 O—66——2

TABLE 4.—*Distribution of Recent*

	Beaches															Reefs																				
																Agana										Achang								Pago		
	78	532	541	201	200	212	7	193	109	644	26	32	83	59	63	86	87	88	89	90	91	92	93	94	95	213	214	215	216	217	218	219	220	645	649	652
Saccamminidae:																																				
Saccammina sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hyperamminidae:																																				
Sagenina frondescens (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--
Textulariidae:																																				
Textularia agglutinans d'Orbigny	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--	--	X	--	X	--	--	--	X	--	--	X	--	--	--
alveata Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
conica d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
dupla Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
foliacea Heron-Allen and Earland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
foliacea var. *oceanica* Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
kerimbaensis Said	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--
semialata Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Verneuilinidae:																																				
Gaudryina triangularis var. *angulata* Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
trullissata Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(*Siphogaudryina*) *rugulosa* Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X	--	--	--	X	X
siphonifera (Brady)	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
transversaria (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Valvulinidae:																																				
Clavulina difformis Brady	X	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X
Valvulina davidiana Chapman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X
Liebusella bradyi Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Miliolidae:																																				
Quinqueloculina agglutinans d'Orbigny	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	X	--	--	--	--	--	--
anguina var. *arenata* Said	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
apicula Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
berthelotiana d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bidentata d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--
bosciana d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
distorqueata Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X	--	--	--	--	--	--
ferussaci d'Orbigny	X	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	X	X	--	--	X	--	--	--	--	X	X	X	X	X	--	--	X	X	--
lamarckiana d'Orbigny	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	--	--	X	--	X	--	--	--	--	X	--	X	--	X	--	--	X	--	--	--
neostriatula Thalmann	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	--	X	X	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--
parkeri (Brady)	--	--	--	X	--	X	--	--	--	--	--	X	--	--	--	--	X	--	X	--	--	--	--	--	--	--	--	--	X	--	--	X	X	--	--	--
poeyana d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X	--	--	--	--	--	--
polygona d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X	--	--	--	--	--	--	--	--
cf. *Q. seminulum* (Linné)	--	--	--	--	X	X	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--
subarenaria Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
subcuneata Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sulcata d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	X	--	--	--	--	--	--	--	X	--	--	--	--	X	--	--	X
tubus Todd	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Miliolinella australis (Parr)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
labiosa (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	X	X	X	X	X	--	--	--	--	--	--	--	--	X	X	X	X	X	X	--	X
oceanica (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	--	--
oceanica var. *flintiana* (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Massilina durrandi (Millett)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	X	--	--	--	--	--	--	--	--	--	X	--	--	X	--	--	--
secans (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
secans reticulata Heron-Allen and Earland	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Spiroloculina angulata Cushman	--	X	--	--	--	X	--	X	--	--	--	--	--	--	--	--	X	X	X	--	--	X	X	--	--	--	X	X	X	X	--	--	X	--	--	--
caduca Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
clara Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
communis Cushman and Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
eximia Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
folium Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
foveolata Egger	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
hadai Thalmann	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
marshallana Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
rugosa Cushman and Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Articulina pacifica Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nubeculina divaricata (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
divaricata advena Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hauerina diversa Cushman	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	X	--	X	--	--	--	--
involuta Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
milletti Cushman	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X	--	X	--	--	--	--
pacifica Cushman	X	--	--	--	--	X	--	X	--	--	--	--	--	--	--	X	X	--	--	--	--	--	--	--	--	X	X	--	X	X	X	X	X	--	--	X
Schlumbergerina alveoliniformis (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X
Ammomassilina alveoliniformis (Millett)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Triloculina cf. *T. bassensis* Parr	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
aff. *T. bicarinata* d'Orbigny	--	--	--	X	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	X
earlandi Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
incisura Todd	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
involuta Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
irregularis (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	X	X	--	--	--	--	--	--	X	--	--	X	X	--	--	X
kerimbatica (Heron-Allen and Earland)	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	X	--
marshallana Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
oblonga (Montagu)	X	X	--	--	--	--	--	--	--	X	--	--	--	--	X	--	--	X	X	X	--	--	--	--	--	X	X	--	X	X	--	--	X	X	--	X
spinata Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Foraminifera around Guam

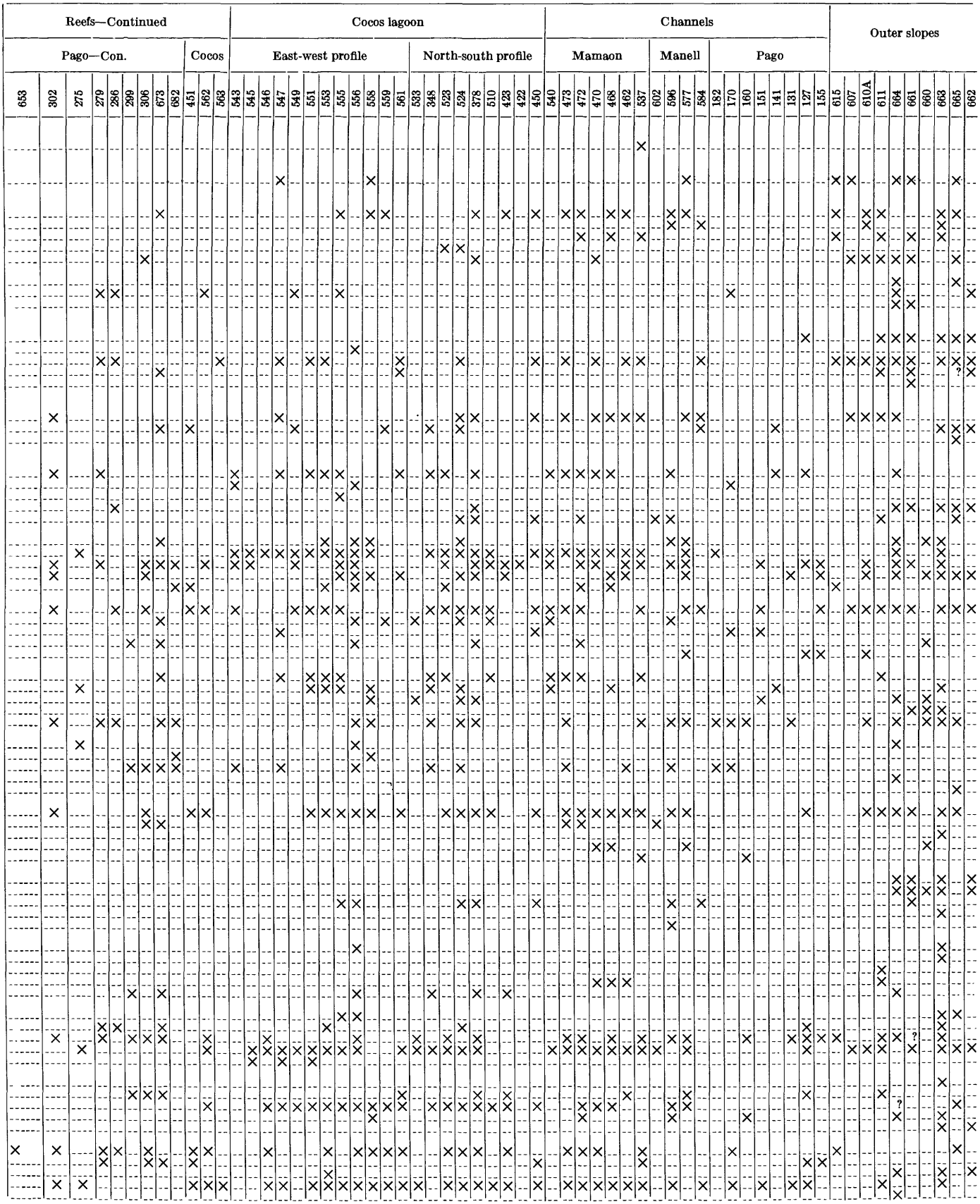


TABLE 4.—*Distribution of Recent*

	Beaches														Reefs																				
															Agana									Achang										Pago		
	78	532	541	201	200	212	7	193	109	644	26	32	83	59	63	86	87	88	89	90	91	92	93	94	95	213	214	215	216	217	218	219	220	645	649	652
Miliolidae—Continued																																				
Triloculina—Continued																																				
subgranulata Cushman								X									X	X	X	X		X		X	X	X				X				X	X
subplanciana Cushman																																				
terquemiana (Brady)															X										X				X			X			
transversestriata (Brady)																																				
tricarinata d'Orbigny																																				X
trigonula (Lamarck)		X						X																		X	X		X			X				X
Flintina bradyana Cushman																																				
Pyrgo denticulata (Brady)																																				
denticulata var. *striolata* (Brady)																																				
Biloculinella globula (Bornemann)																																				
Ophthalmidiidae:																																				
Cornuspira planorbis Schultze																																				
Vertebralina striata d'Orbigny																																				
Planispirinella exigua (Brady)																																				
Parrina bradyi (Millett)																					X															
Trochamminidae:																																				
Rotaliammina mayori Cushman																																				
Carterina spiculotesta (Carter)																																				
Placopsilinidae:																																				
Bdelloidina aggregata Carter											X																									
Haddonia torresiensis Chapman								X			X						X	X			X		X		X		X	X				X			X
Placopsilina? sp																																				
Lagenidae:																																				
Robulus limbosus (Reuss)																																				
orbicularis (d'Orbigny)																																				
vortex (Fichtel and Moll)																																				
Darbyella sp																																				
Astacolus bradyi (Cushman)																																				
aff. *A. californicus* Galloway and Wissler																																				
planulata Galloway and Wissler																																				
Marginulina costata (Batsch)																																				
Dentalina mucronata Neugeboren																																				
Nodosaria calomorpha Reuss																																				
Lagenonodosaria scalaris (Batsch)																																				
Frondicularia robusta Brady var. *repanda* Cushman																																				
Polymorphinidae:																																				
Polymorphinella pacifica Cushman and Hanzawa																																				
Camerinidae:																																				
Operculina ammonoides (Gronovius)							X																							X			X	X	
Heterostegina suborbicularis d'Orbigny						X	X	X				X					X									X	X	X	X	X	X	X	X	X	X	X
Cycloclypeus carpenteri Brady																																				
Peneroplidae:																																				
Peneroplis elliptica d'Orbigny												X																								
proteus d'Orbigny																																				
Spirolina acicularis (Batsch)																		X																		
arietina (Batsch)	X							X							X		X	X	X						X		X		X	X	X	X	X	X	X	X
Sorites marginalis (Lamarck)																																				
Marginopora vertebralis Blainville	X		X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Alveolinellidae:																																				
Borelis pulchrus (d'Orbigny)										X																		X								
Heterohelicidae:																																				
Bolivinella folium (Parker and Jones)																																				
Buliminidae:																																				
Buliminella milletti Cushman																																				
Buliminoides williamsoniana (Brady)																																				
Bulimina costata d'Orbigny																																				
Bolivina compacta Sidebottom																				X																
hantkeniana Brady																																				
pseudopygmaea Cushman																																				
rhomboidalis (Millett)																																				
robusta Brady																																				
spinescens Cushman																																				
striatula Cushman																																				
tortuosa Brady															X																					
zanzibarica Cushman																																				X
(*Lozostomum*) *limbata* Brady																														X						
limbata var. *costulata* Cushman																																				
mayori Cushman																																				
porrecta Brady																																				
Rectobolivina bifrons var. *striatula* (Cushman)																																				
Reussella pulchra Cushman																																				
simplex (Cushman)															X		X																			
Chrysalidinella earlandi Cushman																																				

Foraminifera around Guam—Continued

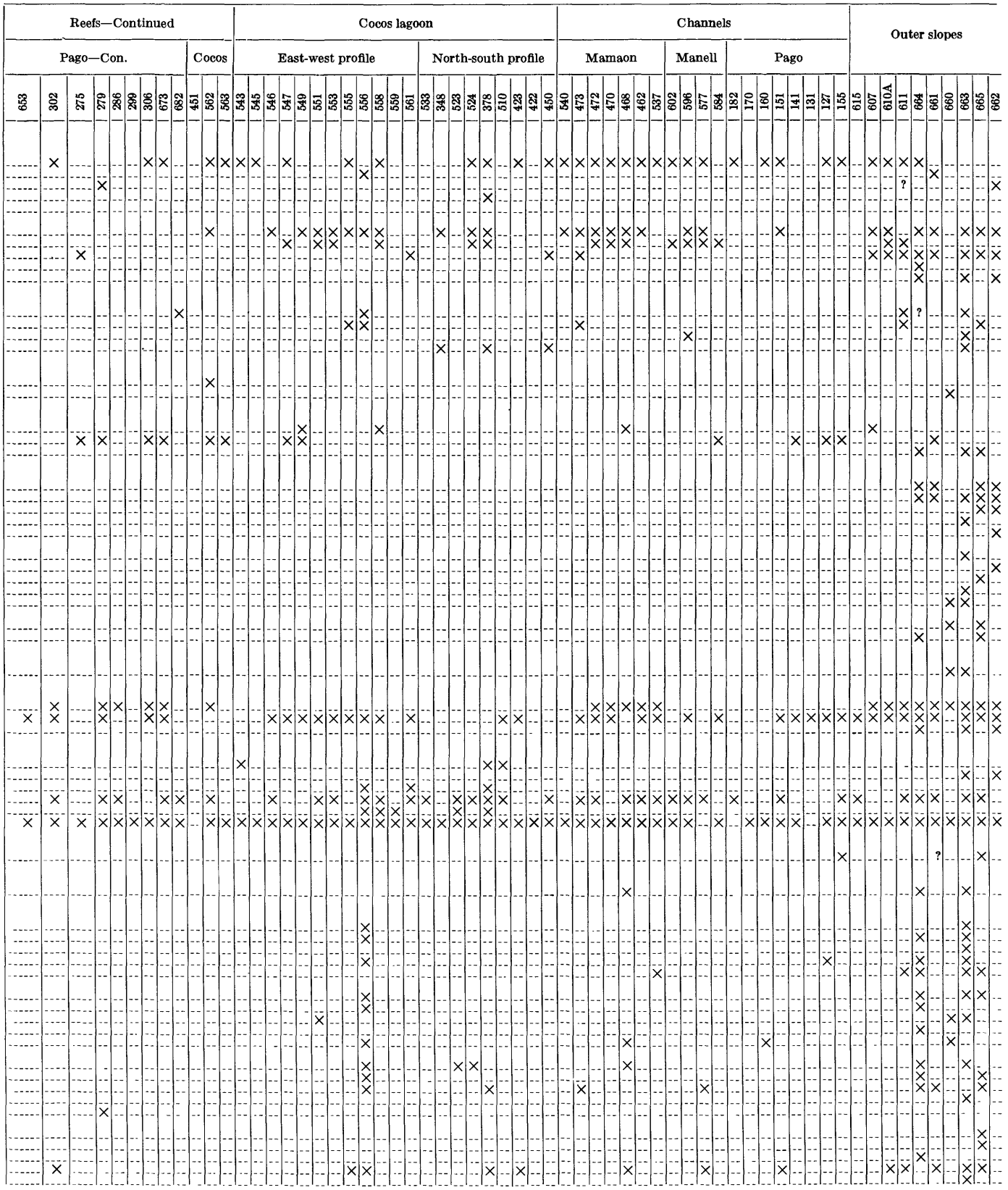


TABLE 4.—*Distribution of Recent*

	Beaches															Reefs																				
																Agana										Achang								Pago		
	78	532	541	201	200	212	7	193	109	644	26	32	83	59	63	86	87	88	89	90	91	92	93	94	95	213	214	215	216	217	218	219	220	645	649	652
Buliminidae—Continued																																				
Uvigerina ampullacea Brady																																				
porrecta Brady																																				
proboscidea var. *vadescens* Cushman																																				
Siphogenerina raphana (Parker and Jones)																																				
Angulogerina albatrossi Cushman																																				
Trifarina bradyi Cushman																																				
Spirillinidae:																																				
Spirillina decorata Brady																																				
denticulogranulata Chapman																													X							
tuberculatolimbata Chapman																																				
vivipara Ehrenberg																																				
vivipara var. *revertens* Rhumbler																																				
Conicospirillina semiinvoluta Cushman																																				
Discorbidae:																																				
Patellina advena var. *altiformis* Cushman																																				
Rosalina concinna (Brady)																																				
floridana (Cushman)																X	X		X			X							X	X						X
micens (Cushman)																																				
rugosa d'Orbigny																																				
Svratkina australiensis (Chapman, Parr, and Collins)																																				
Neoconorbina crustata (Cushman)																																				
fulva (Todd)																																				
patelliformis (Brady)																																				
tabernacularis (Brady)																																				
terquemi (Rzehak)																																				
tuberocapitata (Chapman)																																				
Planodiscorbis rarescens (Brady)																																				
Rotaliidae:																																				
Gavelinopsis praegeri (Heron-Allen and Earland)																																				
Rotorbinella? mira (Cushman)						X										X	X									X		X	X	X	X		X			X
Eponides repandus (Fichtel and Moll)								X										X			X	X			X											
Cancris sagra (d'Orbigny)																																				
Baggina totomiensis Makiyama																																				
Siphonina tubulosa Cushman																																				
Siphoninoides echinatus (Brady)																																				X
Stomatorbina concentrica (Parker and Jones)																																				
Paumotua terebra (Cushman)																																				
Epistomaroides polystomelloidés (Parker and Jones)						X				X																	X		X			X	X			
Bronnimannia haliotis (Heron-Allen and Earland)																																				
Streblus beccarii (Linné)	X		X			X	X																			X		X								
beccarii tepida (Cushman)																X													X							
beccarii var. of Todd (1957)	X	X							X	X												X				X										
Epistominella cf. *E. obtusa* (Burrows and Holland)																																				
rugosa (Phleger and Parker)																																				
tubulifera (Heron-Allen and Earland)																			X																	
Pegidiidae:																																				
Pegidia dubia (d'Orbigny)																																		X		
Sphaeridia papillata Heron-Allen and Earland																		X												X	X					
Amphisteginidae:																																				
Amphistegina lessonii d'Orbigny																																				
madagascariensis d'Orbigny	X			X		X	X	X		X	X	X	X		X	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
radiata (Fichtel and Moll)																																				
var. *papillosa* Said																																				
var. of Cushman, Todd, and Post (1954)																																				
var																																				
Calcarinidae:																																				
Calcarina spengleri (Gmelin)	X		X			X	X	X	X	X				X			X	X			X					X	X	X	X	X	X	X	X	X	X	X
Baculogypsina sphaerulata (Parker and Jones)	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cymbaloporidae:																																				
Cymbaloporetta bradyi (Cushman)		X													X		X	X	X	X		X			X	X			X	X		X	X			X
squammosa (d'Orbigny)																									X											
Cymbaloporella tabellaeformis (Brady)																X		X																		
Tretomphalus concinnus (Brady)																																				
planus Cushman										X		X				X	X										X									
Elphidiidae:																																				
Elphidium advenum (Cushman)						X	X																								X					
crispum (Linñe)	X	X										X																X				X				X
hyalocostatum Todd		X													X	X		X	X								X	X	X	X		X	X	X	X	
jenseni (Cushman)																																				
simplex Cushman		X																																		
striatopunctatum (Fichtel and Moll)		X	X			X	X				X															X	X	X				X	X			X
Cassidulinidae:																																				
Cassidulina delicata Cushman																																				
minuta Cushman																																				
subglobosa Brady																																				
Chilostomellidae:																																				
Sphaeroidina bulloides d'Orbigny																																				

Foraminifera around Guam—Continued

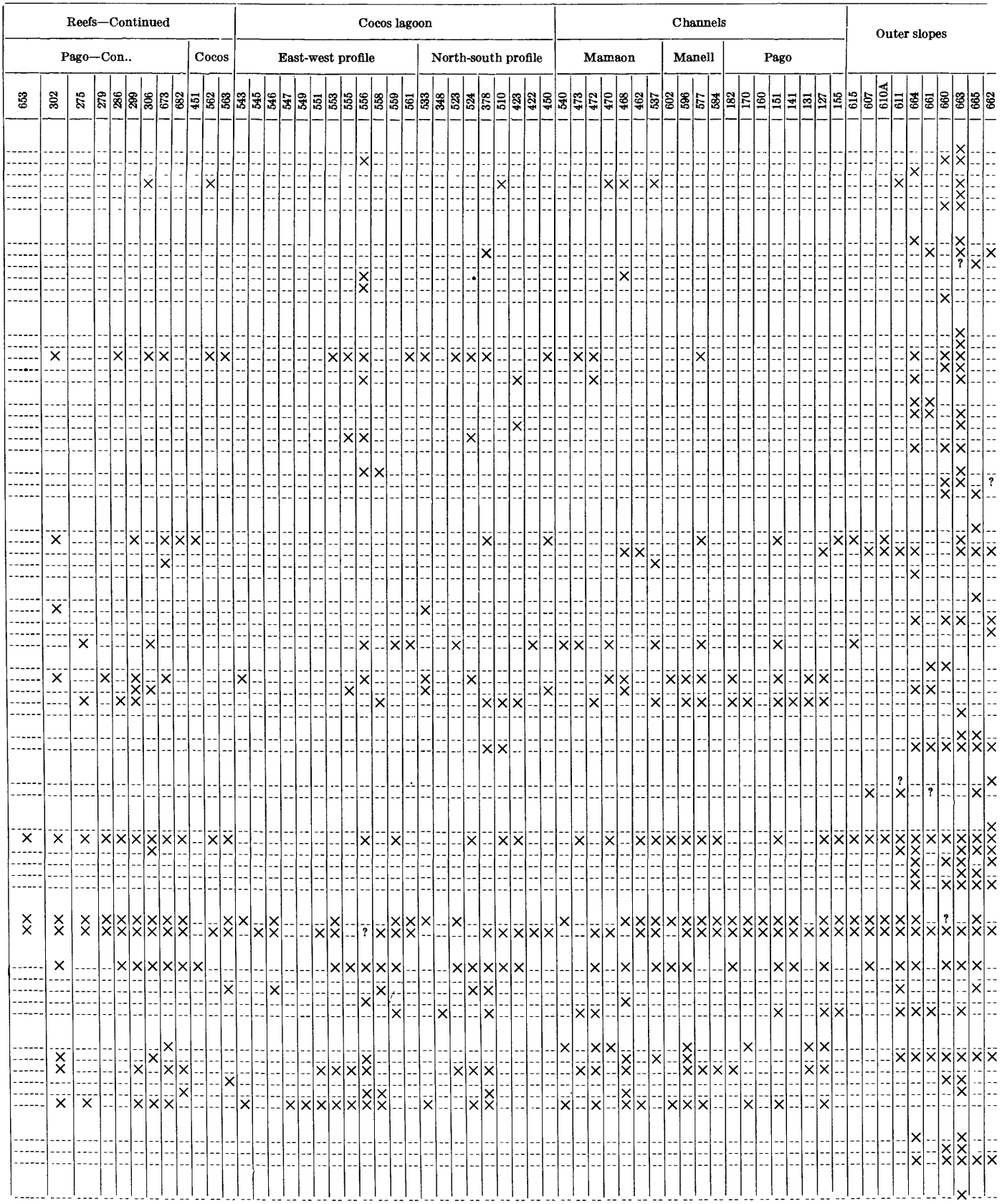


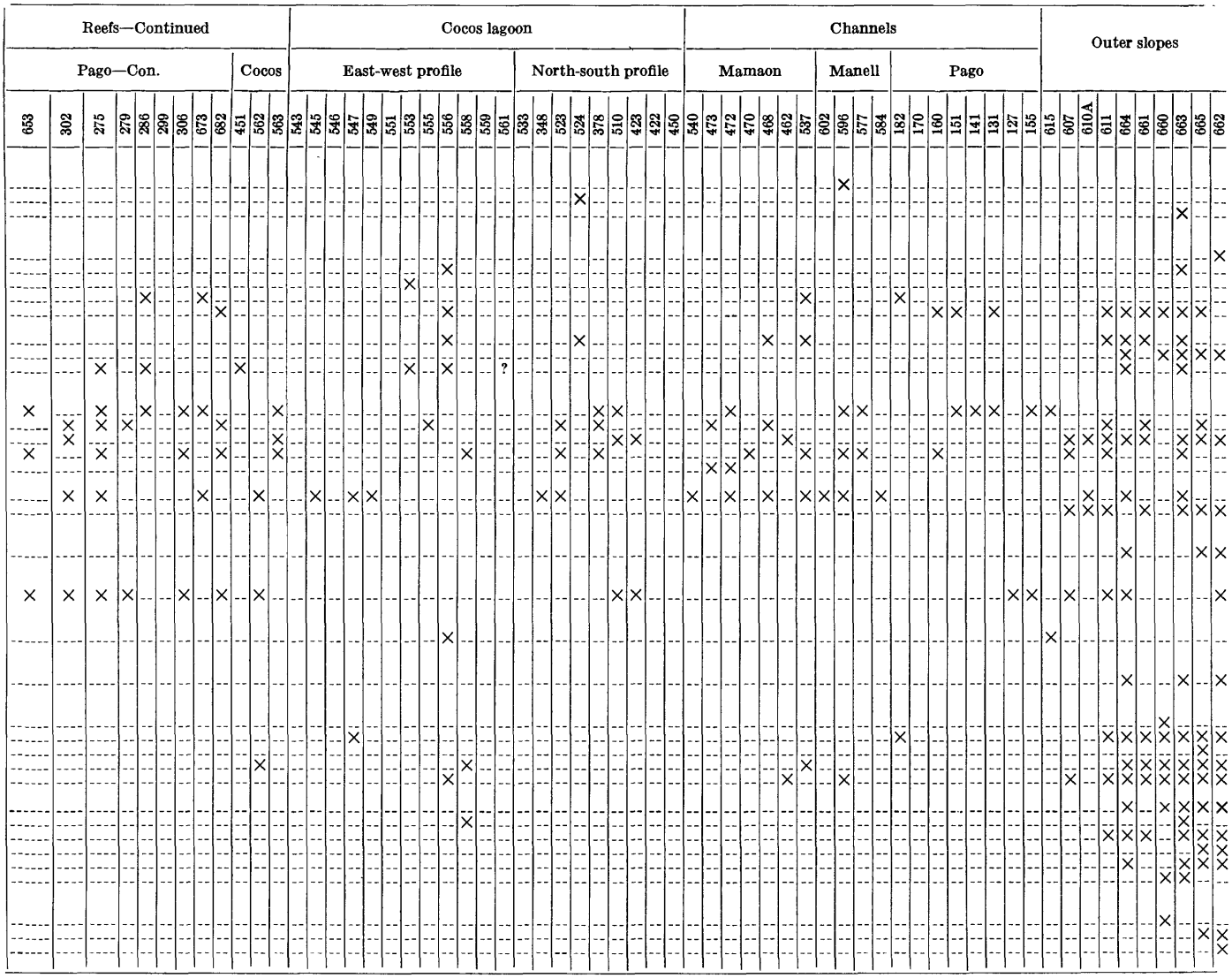
TABLE 4.—*Distribution of Recent*

	Beaches															Reefs																				
																Agana										Achang								Pago		
	78	532	541	201	200	212	7	193	109	644	26	32	83	59	63	86	87	88	89	90	91	92	93	94	95	213	214	215	216	217	218	219	220	645	649	652
Nonionidae:																																				
Nonion boueanum (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
japonicum Asano	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pacificum (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anomalinidae:																																				
Anomalina coronata Parker and Jones	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
glabrata Cushman	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--
Anomalina? maculosa Todd	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cibicides cicatricosus (Schwager)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
lobatulus (Walker and Jacob)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--
mayori (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pseudoungerianus (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cibicidella variabilis (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Planorbulinidae:																																				
Planorbulinoides retinaculatus (Parker and Jones)	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	X	--	--	--	--	X	--	--	--	X	--	--	--	--	--	X	X	X	--	X
Planorbulina acervalis Brady	X	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--
Planorbulinella larvata (Parker and Jones)	--	--	--	--	--	--	--	X	--	X	--	--	--	--	X	--	X	X	--	--	--	--	X	--	X	X	--	--	--	--	--	--	--	--	X	X
Acervulina inhaerens Schultze	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	X	X	--	--	X	--	--	--	--	--	--	X	X	X	X	--	--	X
sp. of Todd (1957)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gypsina globula (Reuss)	--	--	--	X	--	--	--	--	--	--	X	--	--	--	X	--	--	X	--	--	--	X	--	--	--	--	--	X	--	--	--	--	--	X	--	X
vesicularis (Parker and Jones)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rupertiidae:																																				
Carpenteria proteiformis Goës	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Homotremidae:																																				
Homotrema rubrum (Lamarck)	--	--	--	X	X	--	--	X	--	--	X	X	--	--	--	--	X	X	X	X	--	--	X	--	X	--	--	--	--	X	--	X	X	X	--	X
Robertinidae:																																				
Alliatina translucens (Cushman)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ceratobuliminidae:																																				
Hoeglundina elegans (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Globigerinidae:																																				
Globigerina eggeri Rhumbler	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Globigerinoides conglobatus (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
elongatus (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ruber (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sacculifer (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--	--	--	--	X	--	--	--	--	--	--	--
Globigerinella aequilateralis (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Globigerinita glutinata (Egger)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orbulina universa d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pulleniatina obliquiloculata (Parker and Jones)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sphaeroidinella dehiscens (Parker and Jones)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Candeina nitida d'Orbigny	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Globorotaliidae:																																				
Globorotalia hirsuta (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
menardii (d'Orbigny)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
tumida (Brady)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

text fig. 1) indicates that in European and North African sections the approximate boundary between the upper extent of *Globorotalia mayeri* and the lower extent of *Globorotalia menardii* would fall within the upper part of the Tortonian. Blow (1959, chart 1) shows in his studies in Venezuela that the two zones—*Globorotalia mayeri* s. 1. and *Globorotalia menardii* s. 1.—occupy all of the Vindobonian (=Helvetian and Tortonian) and the lower part of the Sarmatian. Stainforth (1960, range chart) shows that the upper extent of *Globorotalia mayeri* (which would be the top of the *Globorotalia mayeri* zone) coincides with the Helvetian-Tortonian boundary. Bolli (1959, table 1) shows the boundary between the *Globorotalia mayeri* and *Globorotalia menardii* zones in the West Indian section as approximately equivalent to the basal Helvetian. Saito (1963, table 16) indicates that on Honshu Island, Japan, this boundary coincides with the boundary between the Helvetian and Tortonian. In Bandy's conception (1964, text fig. 6) of the Cenozoic planktonic Foraminiferal zonation, the uppermost extent of the range of *Globigerina nepenthes* (which would be the upper boundary of the *Globorotalia menardii* zone) coincides with the Sarmatian-Pontian boundary [but Pontian is a continental stage in the upper Miocene and therefore should not enter into correlation by planktonic Foraminifera], whereas the uppermost extent of the range of *Globorotalia mayeri* (which would be the upper boundary of the *Globorotalia mayeri* zone) coincides with the Tortonian-Sarmatian boundary.

Thus it can be seen that there is no universal agreement as to where planktonic Foraminifera zones are to be placed in terms of the European time scale. There is, however, universal acceptance of the contemporane-

Foraminifera around Guam—Continued



ous existence around the world of these zones and their unchanging relation to one another.

The presence of the same assemblage of planktonic Foraminifera (including such a narrowly restricted species as *Globigerina nepenthes* in both the Janum Formation on Guam and the Donni Sandstone Member of the Tagpochau Limestone on Saipan suggests that the original interpretation that the Donni is of Tertiary *e* age is subject to reconsideration. This assignment to Tertiary *e* was made on the basis of larger Foraminifera in the Tagpochau but not in the Donni, coupled with stratigraphic relations indicating that the Donni beds are intercalated with those Tagpochau beds in which the Tertiary *e* larger Foraminifera were found. An alternative interpretation, in which the Donni beds are overlying and not intercalated with the Tagpochau beds and thus might be of post-Tertiary *e* age, should be considered. Another possible explanation of the faunal similarity of the Donni Sandstone Member of Saipan and the Janum Formation of Guam is that although equivalent in facies they are not precisely so in age and that a recurrence of facies brought back the several planktonic species that appear to have a limited stratigraphic range. Both the Donni and the Janum contain *Globigerina nepenthes*, a species restricted to one zone—the *Globorotalia menardii* zone—and the upper part of the underlying zone—the *Globorotalia mayeri* zone. The range of *Globigerina nepenthes* is no longer interpreted as lower Miocene but instead is variously interpreted as approximately Tortonian or as crossing the Helvetian–Tortonian boundary.

The Indonesian letter classification (Tertiary *a* to *f*) was originally set up (Van der Vlerk and Umbgrove, 1927) on the basis of the sequence of larger Foramini-

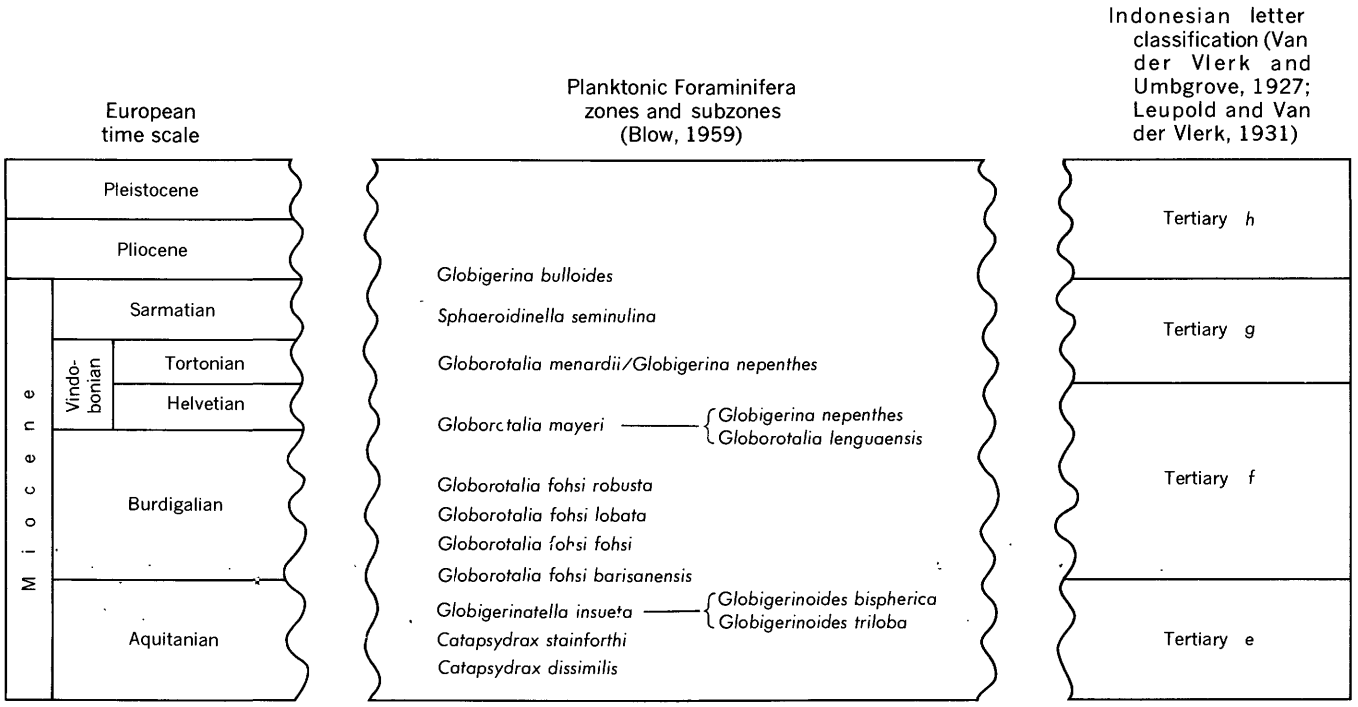


FIGURE 2.—Speculative correlations between planktonic Foraminifera zones, the European time scale, and the Indonesian letter classification.

fera in the Eocene, Oligocene, and Miocene in Indonesia. An upward extension of the classification (Tertiary *g* and *h*) added later (Leupold and Van der Vlerk, 1931) was based mostly on lignitic and estuarine facies. No reference to planktonic Foraminifera was made in either lower or upper part of the classification. Correlation between the letter classification and the European time scale is generally not attempted, particularly in its later parts, Tertiary *e*, *f*, *g*, and *h*. Van der Vlerk's statement (1955, p. 75), made nearly 30 years after the establishment of the Indonesian letter classification, that "correlation between Tertiary *e* and *f* and the Chattian–Aquitanian–Burdigalian (or Vindobonian) is at present quite impossible" is still applicable today.

Glaessner (1959, chart 1), however, has indicated a correlation for the Indo-Pacific region and Australia in which Tertiary *e* is shown as equivalent to the upper part of the Oligocene and the Aquitanian; Tertiary *f* equivalent to the Burdigalian, Helvetian, and Tortonian; Tertiary *g* equivalent to the Sarmatian and the lower part of the Pliocene; and Tertiary *h* equivalent to the upper part of the Pliocene. In Glaessner's correlation table, the Donni Sandstone Member of the Tagpochau Limestone is shown as belonging in the upper part of Tertiary *f* and also as equivalent to the Tortonian. In terms of the currently accepted approximate age of the planktonic species that are present in the Donni, this correlation with the Tortonian (and concurrently with Tertiary *f*) is a more reasonable one than that of early Miocene age (and Tertiary *e*) that was attributed to the Donni by me in 1957 (Todd, 1957, p. 280).

The correlation of the Janum with Tertiary *g* was originally made upon the basis of the evidence of the larger Foraminifera is discussed on page I7. The abundant population of planktonic Foraminifera found in the Janum is also inherently capable of providing a close age determination for the Janum, although not directly in terms of the Indonesian letter classification. The planktonic population of the Janum indicates its probable placement in one of the zones containing *Globigerina nepenthes*.

In terms of Saito's (1962) interpretation of the range of *Globigerina nepenthes*, the Janum would fall somewhere within the upper Helvetian or lower Tortonian. In terms of Blow's (1959) interpretation, it would fall within the "Vindobonian-Sarmatian?." In terms of Bandy's (1964) interpretation, it would fall between the middle Burdigalian and the top of the Sarmatian. In terms of Glaessner's (1959) correlation chart, the Donni Sandstone Member of the Tagpochau Limestone (called Donni Tuff on the chart) is equivalent to the Tortonian and also to the upper part of Tertiary *f*. Thus by a two-stage correlation (starting with the assumption that the Janum is approximately equivalent to the Donni and then that the Donni is equivalent to the Tortonian and to the upper part of Tertiary *f*) a possible interpretation as Tertiary *f* may be arrived at for the Janum.

All these possible interpretations of age of the Janum, however, have to be qualified by the tacit understanding that there is nothing in the Janum that, per se, indicates its direct correlation with Tertiary *f*, with the Tortonian, or with any other stage of the European time scale. However, Drooger's (1964) well-taken point that "the labelling with stage names of deposits all over the world * * * forms a heavy burden to progress in stratigraphic correlations," should not inhibit the attempt to correlate between deposits in distant parts of the world, particularly if it can be done on the basis of planktonic Foraminifera.

Another attempt at correlation by means of planktonic Foraminifera in the western Pacific was discussed by Cole and others (1960). On the island of Yap, planktonic Foraminifera of the *Globigerinatella insueta* zone were found in association with larger Foraminifera. The planktonic Foraminifera were correlatable with those of the Fina-sisu Formation of Saipan, which in turn had originally been regarded as Tertiary *d* in age but without corroboration. The larger Foraminifera were indicative of Tertiary *f* age and correlatable (Cole, 1963, table 3) with the Bonya Limestone of Guam, which is Tertiary *f* in age, and with beds on Fiji dated as Tertiary *f*. After discussing possible explanations of this dilemma, such as reworking and local expansion of zones, the question was left unresolved.

In view of present-day understanding of correlation by planktonic Foraminifera, new light may be shed on this question. The Yap occurrence falls in the *Globigerinatella insueta/Globigerinoides bispherica* subzone. This zone is correlated with the uppermost Aquitanian by several authors (Blow, 1959, chart 1; Bolli, 1959, table 1; Stainforth, 1960, range chart; Saito, 1963, table 16; Hanzawa, 1964, p. 298; Bandy, 1964, text fig. 5), but Drooger correlated this zone with the upper part of the Helvetian (1956, text fig. 1). Only if the youngest estimate of age is used for the *Globigerinatella insueta* zone—namely, the upper part of the Helvetian—would the *insueta* assemblage be contemporaneous with an assemblage of larger Foraminifera of Tertiary *f* age. By placing the Donni in Tertiary *f* instead of Tertiary *e* (as now seems more logical) the dilemma can be resolved. For then both the *insueta/bispherica* subzone and the *nepenthes* zone would fall into Tertiary *f*, the former at the base and the latter at the top. But without both these assumptions (that is, the Donni being Tertiary *f* and the *insueta/bispherica* subzone being Tertiary *f*), I cannot explain the Yap occurrence of *insueta/bispherica* planktonics in association with Tertiary *f* larger Foraminifera. Even though both assemblages might be placed in Tertiary *f*, I cannot conceive of the *insueta* assemblage, characteristic of the Fina-sisu, being contemporaneous with the *nepenthes* assemblage that is characteristic of the Donni.

FAUNAL REFERENCE LISTS

Two alphabetized lists—one for the benthonic species and one for the planktonic—are included to facilitate reference to the original source or to a systematic treatise.

For each species that is illustrated a reference to the plates is included. The figures are grouped into four divisions, corresponding to the four ages that are studied, and the figures are arranged systematically on the plates within each of these divisions. Following the reference, one or more letters are added to indicate the age or ages in which the species was found: E, Eocene, O, Oligocene, M, Miocene, and R, Recent. The samples in which each species was found may be determined by referring to table 1 for the Eocene, table 2 for the Oligocene, table 3 for the Miocene, and table 4 for the Recent. The localities from which the samples were collected are shown in figure 1 and are given following the fauna.

BENTHONIC SPECIES

Plate and figure numbers in parentheses in list below refer to those illustrated in this report.

Acervulina inhaerens Schultze. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 372, pl. 91, figs. 37, 38. **R.**

Acervulina sp. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 292 (table 4), pl. 92, fig. 15. **R.**

Alabamina conica Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 295, pl. 69, fig. 11. **EO.** (Pl. 6, fig. 3.)

Alliatina translucens (Cushman). *Nonionella translucens* Cushman, 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 45, pl. 11, fig. 2. **R.**

Ammomassilina alveoliniformis (Millett). *Massilina alveoliniformis* Millett, 1898, Royal Micros. Soc. Jour., p. 609, pl. 13, figs. 5–7. **R.**

Amphimorphina californica Cushman and McMasters, 1936, Jour. Paleontology, v. 10, p. 513, pl. 75, figs. 21–25. **O.**

Amphistegina bikiniensis Todd and Post, 1954, U.S. Geol. Survey Prof. Paper 260–N, p. 563, pl. 201, fig. 4. **E.**

Amphistegina lessonii d'Orbigny. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 33, pl. 11, fig. 4. **R.**

Amphistegina madagascariensis d'Orbigny. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 34, pl. 11, fig. 3; pl. 12, figs. 1, 2. **R.**

Amphistegina radiata (Fichtel and Moll). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 34, pl. 13, figs. 1–3; pl. 14, figs. 1–3. **R.**

Amphistegina radiata var. *papillosa* Said. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 362, pl. 90, figs. 5, 6. **R.**

Amphistegina radiata (Fichtel and Moll) var. of Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 363, pl. 90, fig. 4. **R.**

Amphistegina radiata (Fichtel and Moll) var. *Amphistegina lessonii* [part] Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 740, pl. 111, fig. 1. **R.**

Angulogerina albatrossi Cushman, 1932, Cushman Lab. Foram. Research Contr., v. 8, p. 45, pl. 6, figs. 11, 12. **R.**

Angulogerina byramensis (Cushman). Cushman and McGlamery, 1942, U.S. Geol. Survey Prof. Paper 197–B, p. 72, pl. 6, figs. 4–10. **O.** (Pl. 5, fig. 15.)

Angulogerina cooperensis Cushman, 1935, U.S. Geol. Survey Prof. Paper 181, p. 42, pl. 16, fig. 9. **O.** (Pl. 5, fig. 16.)

Angulogerina vicksburgensis Cushman, 1935, Cushman Lab. Foram. Research Contr., v. 11, p. 33, pl. 5, figs. 3, 4. **O.** (Pl. 5, fig. 17.)

Angulogerina sp. **O.**

A short, stout form having costae on the initial end.

Anomalina coronata Parker and Jones. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 675, pl. 97, figs. 1, 2. **R.** (Pl. 19, fig. 8.)

Anomalina glabrata Cushman. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 115, pl. 19, fig. 8. **R.**

Anomalina granosa (Hantken). Vassilenko, 1954, Neft. geol. inst., Leningrad, Trudy, n. ser., no. 80, p. 70, pl. 6, figs. 2–4. **O.** (Pl. 6, fig. 6; pl. 7, fig. 3.)

Anomalina? maculosa Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 296, pl. 92, fig. 12. **R.**

Articulina pacifica Cushman, 1944, Cushman Lab. Foram. Research, Spec. Pub. 10, p. 17, pl. 4, figs. 14–18. **R.**

Articulina sp. **R.** (Pl. 17, fig. 10.)

Only two specimens of this distinctive species were found in Recent sample 663 from 972 fathoms off the northeastern coast of Guam. The species appears to be undescribed but cannot be erected on so few specimens.

The test is rather compressed for the genus. The costae are high, sharp, and closely spaced and slightly oblique to the axis of the chamber, thus curved around at the base of the chamber. The periphery is marked by one of the costae being about twice as high as the others, and in the specimen that is not illustrated this costa is serrate because it is broken. The aperture is surrounded by a thickened lip. The illustrated specimen has a second flaring lip below the main one, a freak development that gives the specimen the appearance of a double aperture.

Astacolus bradyi (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 343, pl. 86, fig. 9. **R.** (Pl. 18, fig. 7.)

Astacolus aff. *A. californicus* Galloway and Wissler, 1927, Jour. Paleontology, v. 1, p. 46, pl. 8, fig. 4. **R.**

Astacolus planulatus Galloway and Wissler. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 343, pl. 86, fig. 7. **R.** (Pl. 18, fig. 5.)

Asterigerina marshallana Todd and Post, 1954, U.S. Geol. Survey Prof. Paper 260–N, p. 562, pl. 201, fig. 3. **EO?**

Asterigerinata bracteata (Cushman). Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 843, pl. 260, fig. 8. **O.**

Astrononion cf. *A. australe* Cushman and Edwards, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 33, pl. 3, figs. 13, 14. **O.** (Pl. 6, fig. 4.)

Astrononion novozealandicum Cushman and Edwards, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 35, pl. 3, fig. 18. **M.** (Pl. 12, fig. 13.)

Astrononion cf. *A. pusillum* Hornibrook, 1961, New Zealand Geol. Survey Paleont. Bull. 34 (1), p. 96, pl. 12, figs. 229, 236. **O.** (Pl. 6, fig. 2.)

Baculogypsina sphaerulata (Parker and Jones). Todd, 1960, Tōhoku Univ. Sci. Repts., 2d ser. (Geology), spec. v. 4, p. 101, pl. 10, figs. 2, 5–7. **R.**

Baggina parva Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 297, pl. 83, fig. 8. **O.**

Baggina totomiensis Makiyama. Asano, 1951, Illustrated catalogue of Japanese Tertiary smaller Foraminifera. Pt. 14: Rotaliidae, p. 21, figs. 154, 155. **R.** (Pl. 19, fig. 4.)

Bdelloidina aggregata Carter. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 827, pl. 263, fig. 8. **R.**

Biloculinella globula (Bornemann). Boltovskoy, 1959, Argentina Servicio Hidrografia Naval Pub. H1005, p. 57, pl. 6, fig. 11. **R.** (Pl. 17, fig. 11.)

Bolivina beyrichi Reuss. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 74, pl. 9, figs. 3–6. **O.** (Pl. 5, fig. 6.)

Bolivina choctawensis Cushman and McGlamery? Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 72, pl. 8, fig. 24. **E.**

Bolivina compacta Sidebottom. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 135, pl. 17, figs. 22–24. **R.**

Bolivina fastigia Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 76, pl. 9, figs. 12–14. **O.** (Pl. 5, fig. 13.)

Bolivina gardnerae Cushman. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 60, pl. 7, figs. 25, 26. **O.**

Bolivina hantkeniana Brady. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 127, pl. 16, figs. 18–20 **R.** (Pl. 18, fig. 8.)

Bolivina cf. *B. minutissima* Spandel. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 73, pl. 8, fig. 28. **O.** (Pl. 5, fig. 9.)

Bolivina aff. *B. nitida* Brady. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 136, pl. 17, fig. 25. **M.**

Bolivina oligocaenica Spandel. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 74, pl. 9, figs. 1, 2. **O.** (Pl. 5, fig. 7.)

Bolivina paula Cushman and Cahill. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 91, pl. 11. fig. 9. **O.**

Bolivina plicatella mera Cushman and Ponton. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 90, pl. 11, figs. 5–8. **O.** (Pl. 5, fig. 8.)

Bolivina pseudopygmaea Cushman. Cushman, 1942, U.S. Natl. Mus. Bull. 161, pt. 3. p. 29, pl. 8, fig. 6. **R.**

Bolivina pusilla Schwager. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 114, pl. 14, figs. 8, 9. **M.**

Bolivina rhomboidalis (Millett). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 138, pl. 18, fig. 7. **O R.** (Pl. 5, fig. 10.)

Bolivina robusta Brady. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 131, pl. 17, figs. 1–4. **R.**

Bolivina silvestrina Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 109, pl. 13, figs. 14–16. **M.** (Pl. 12, fig. 11.)

Bolivina aff. *B. sinuata* Galloway and Wissler. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 120, pl. 14, figs. 19, 20. **M.** (Pl. 12, fig. 12.)

Bolivina spinescens Cushman. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 142, pl. 18, figs. 17–19. **R.**

Bolivina striatula Cushman. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 154, pl. 18, figs. 30, 31. **R.**

Bolivina tortuosa Brady. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 133, pl. 17, figs. 11–19. **O R.**

Bolivina aff. *B. tricosta* Cushman and Bermudez. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 57, pl. 7, fig. 11. **O.** (Pl. 5, fig. 12.)

Bolivina tumida Cushman. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 99, pl. 10. fig. 21. **O.**

Bolivina vicksburgensis (Howe). [Not *Bolivina vicksburgensis* Cushman, 1922, which is now *Bifarina.*] *Pleurostomella vicksburgensis* Howe, 1930. Jour. Paleontology, v. 4, p. 331, pl. 27, fig. 5. **O.** (Pl. 5, fig. 14.)

Bolivina zanzibarica Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 151, pl. 22, figs. 25, 26. **R.**

Bolivina sp. A. **O.**

Straight, oblique, and fiush sutures; smooth wall.

Bolivina sp. B. **O.** (Pl. 5, fig. 19.)

Straight, oblique, and depressed sutures; rugose wall.

Bolivina (*Loxostomum*) *limbata* Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 419, pl. 52, figs. 26–28. **R.**

Bolivina (*Loxostomum*) *limbata* var. *costulata* Cushman. *Loxostoma limbatum* (H. B. Brady) var. *costulatum* (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 187, pl. 21, figs. 30, 31. **R.**

Bolivina (*Loxostomum*) *mayori* Cushman. *Loxostoma mayori* (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 195, pl. 22, figs. 16–21. **R.**

Bolivina (*Loxostomum*) *porrecta* Brady. *Loxostoma porrectum* (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 190, pl. 22, figs. 7–10. **R.**

Bolivina (*Loxostomum*) *rostra* (Cushman). *Loxostoma rostrum* Cushman. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 195, pl. 22, fig. 34. **O.** (Pl. 5, fig. 11.)

Bolivinella folium (Parker and Jones). Cushman, 1942, U.S. Natl. Mus. Bull. 161, pt. 3, p. 3, pl. 2, figs. 1–4, 6. **R.**

Bolivinopsis cubensis (Cushman and Bermudez). *Spiroplectoides cubensis* Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 13, pl. 1, figs. 44, 45. **O.** (Pl. 4, fig. 1.)

Borelis pulchrus (d'Orbigny). Cushman, 1930, U.S. Natl. Mus. Bull. 104, pt. 7, p. 55, pl. 15, figs. 9, 10. **R.**

Bronnimannia haliotis (Heron-Allen and Earland). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 27, pl. 5, fig. 2. **R.** (Pl. 19, fig. 3.)

Bulimina aguafrescaensis Todd and Kniker, 1952, Cushman Found. Foram. Research, Spec. Pub. 1, p. 22, pl. 4, fig. 5. **M.**

Bulimina alazanensis Cushman. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 103, pl. 24, figs. 14–16. **O.** (Pl. 5, fig. 3.)

Bulimina bleeckeri Hedberg, 1937, Jour. Paleontology, v. 11, p. 675, pl. 91, figs. 12, 13. **O.** (Pl. 5, figs. 1, 2.)

Bulimina costata d'Orbigny. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 115, pl. 27, figs. 2, 3. **R.**

Bulimina ovata d'Orbigny. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 106, pl. 25, figs. 8, 9. **O.**

Bulimina semicostata Nuttall. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 93, pl. 21, figs. 28, 29. **EO.** (Pl. 1, fig. 1; pl. 5, fig. 4.)

Bulimina tuxpamensis Cole. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 101, pl. 24, fig. 6. **E.**

Bulimina sp. **O.**

Triangular, small (0.2 mm).

Buliminella milletti Cushman. Cushman, 1942, U.S. Natl. Mus. Bull. 161, pt. 3, p. 7, pl. 3, figs. 1–4. **R.**

Buliminella septata Keyzer. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 298, pl. 73, fig. 3; pl. 75, figs. 27–29. **MO.**

Buliminoides williamsoniana (Brady). *Bulimina williamsoniana* Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 408, pl. 51, figs. 16, 17. **R.**

Calcarina spengleri (Gmelin). Todd, 1960, Tōhoku Univ. Sci. Repts., 2d ser. (Geology), spec. v. 4, p. 101, pl. 10, figs. 1, 3–5. **R.**

Cancris sagra (d'Orbigny). Cushman and Todd, 1942, Cushman Lab. Foram. Research Contr., v. 18, p. 77, pl. 19, figs. 3–7. **R.** (Pl. 19, fig. 2.)

Carpenteria hamiltonensis Glaessner and Wade?, 1959, Micropaleontology, v. 5, p. 200, pl. 1, figs. 9–11; pl. 3, figs. 1, 2. **E.**

Carpenteria proteiformis Goës. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 679, pl. 97, figs. 8–14. **R.**

Carterina spiculotesta (Carter). Loeblich and Tappan, 1955, Smithsonian Misc. Colln., v. 128, no. 5, p. 37, pl. 4, figs. 9, 10. **R.**

Cassidulina aff. *C. angulosa* Cushman. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 40, pl. 17, fig. 2. **M.** (Pl. 13, fig. 2.)

Cassidulina carandelli Colom, 1943, Real Soc. española hist. nat. Bol., v. 41, p. 324, pl. 23, figs. 65–67. **M.** (Pl. 13, fig. 4.)

Cassidulina carapitana Hedberg, 1937, Jour. Paleontology, v. 11, p. 680, pl. 92, fig. 6. **M.**

Cassidulina delicata Cushman. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 42, pl. 17, figs. 6, 7. **MR.** (Pl. 18, fig. 10.)

Cassidulina minuta Cushman. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 43, pl. 17, fig. 3. **MR.** (Pl. 18, fig. 9.)

Cassidulina pacifica Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, pt. 3, p. 53, pl. 9, figs. 14–16. **M.** (Pl. 13, fig. 6.)

Cassidulina sagamiensis Asano and Nakamura, 1937, Japanese Jour. Geology and Geography, v. 14, nos. 2, 3, p. 147, pl. 14, fig. 5. **M.** (Pl. 13, fig. 1.)

Cassidulina subglobosa Brady. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 45, pl. 16, fig. 7. **OMR.** (Pl. 13, fig. 3.)

Cassidulina subtumida Cushman. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 45, pl. 16, figs. 5, 6; pl. 17, fig. 1. **M.**

Cassidulina tricamerata Galloway and Heminway, 1941, New York Acad. Sci., Sci. Survey of Porto Rico and Virgin Islands, v. 3, pt. 4, p. 425, pl. 32, fig. 3. **O.** (Pl. 7, fig. 1.)

Cassidulina nov. sp. of Germeraad, 1946, *in* Rutten and Hotz, Geol. Petrol. and Paleont. Results of Explorations in the island of Ceram, ser. 3, Geol., no. 2, p. 72, pl. 4, figs. 11, 12. **M.**

Cassidulina sp. E of Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 298, pl. 77, fig. 9. **M.**

Cassidulina sp. A. **O.**

Globular.

Cassidulina sp. B. **O.**
Flattened, four-chambered.

Cassidulina sp. C. **O.**
Angled.

Cassidulina? sp. D. [Possibly related to the lower Miocene genus *Pseudocassidulinoides* (de Klasz and Rerat, 1963, p. 78).] **O.**
Elongate globular with proportionally large aperture.

Caucasina grata (Parker and Bermudez). *Buliminella grata* Parker and Bermudez, 1937, Jour. Paleontology, v. 11, p. 515, pl. 59, fig. 6. **O.** (Pl. 4, fig. 9.)

Chilostomella cyclostoma Rzehak, 1888, Annalen K. K. Naturh. Hofmuseums, Wien, v. 3, p. 258, pl. 11, fig. 1. **O.** (Pl. 6, fig. 10.)

Chrysalidinella earlandi Cushman, 1945, Cushman Lab. Foram. Research Contr., v. 21, p. 53, pl. 8, fig. 23. **R.**

Chrysalogonium ciperense Cushman and Stainforth?, 1945, Cushman Lab. Foram. Research Spec. Pub. 14, p. 26, pl. 3, fig. 31. **O.**

Chrysalogonium lanceolum Cushman and Jarvis, 1934, Cushman Lab. Foram. Research Contr., v. 10, p. 75, pl. 10, fig. 16. **O.** (Pl. 4, fig. 7.)

Chrysalogonium longicostatum Cushman and Jarvis, 1934, Cushman Lab. Foram. Research Contr., v. 10, p. 74, pl. 10, fig. 12. **EO.**

Chrysalogonium tenuicostatum Cushman and Bermudez, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 27, pl. 5, figs. 3–5. **O.**

Chrysalogonium sp. **O.**
Smooth walled.

Cibicidella variabilis (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 372, pl. 82, fig. 13. **R.**

Cibicides brevoralis Carter, 1958, Victoria Geol. Survey Bull. 55, p. 47, pl. 6, figs. 54–56. **O.**

Cibicides carinatus (Terquem). LeCalvez, 1949, Révision des Foraminifères Lutétiens du Bassin de Paris, II. Rotaliidae et Familles Affines, p. 45, pl. 4, figs. 72–74. **O.** (Pl. 7, fig. 4.)

Cibicides cicatricosus (Schwager). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 371, pl. 91, figs. 25, 26. **MR.**

Cibicides floridanus (Cushman). *Truncatulina floridana* Cushman, 1918, U.S. Geol. Survey Bull. 676, p. 62, pl. 19, fig. 2. **EO.**

Cibicides havanensis Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 28, pl. 3, figs. 1–3. **EO.** (Pl. 7, fig. 5.)

Cibicides lobatulus (Walker and Jacob). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 52, pl. 22, fig. 1. **OMR.**

Cibicides macrocephalus (Gümbel). Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 852, pl. 258, fig. 4. **E.**

Cibicides mayori (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 371, pl. 91, figs. 29, 30. **R.**

Cibicides praecursorius (Schwager). *Discorbina praecursoria* Schwager, 1883, Palaeontographica, v. 30, p. 125, pl. 27 (4), fig. 12. **O.** (Pl. 7, fig. 7.)

Cibicides pseudoungerianus (Cushman). *Truncatulina pseudoungeriana* Cushman, 1922, U.S. Geol. Survey Prof. Paper 129–E, p. 97, pl. 20, fig. 9. *Truncatulina ungeriana* d'Orbigny, sp. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 664, pl. 94, fig. 9. **OMR.**

Cibicides tuxpamensis Cole, 1928, Bull. Am. Paleontology, v. 14, no. 53, p. 219 (19), pl. 1, figs. 2, 3; pl. 3, figs. 5, 6. **E.**

Cibicidina danvillensis (Howe and Wallace)? *Cibicides danvillensis* Howe and Wallace, 1932, Louisiana Geol. Bull. 2, p. 77, pl. 14, fig. 5. **O.**

Clavulina difformis Brady. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 31, pl. 2, fig. 16. **R.** (Pl. 17, fig. 3.)

Conicospirillina semiinvoluta Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 357, pl. 88, fig. 38. **R.**

Cornuspira planorbis Schultze. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 341, pl. 85, fig. 27. **R.**

Cycloclypeus carpenteri Brady. Cushman, Todd, and Post, 1954. U.S. Geol. Survey Prof. Paper 260–H, p. 347, pl. 82, fig. 9. **R.** (Pl. 17, fig. 1.)

Cycloloculina cubensis Cushman and Bermudez, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 61, pl. 11, figs. 15, 16. **O.** (Pl. 7, fig. 6.)

Cymbaloporella tabellaeformis (Brady). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 107, pl. 18, fig. 1. **R.**

Cymbaloporetta bradyi (Cushman). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 108, pl. 18, fig. 2. **R.**

Cymbaloporetta squammosa (d'Orbigny). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 108, pl. 18, fig. 3. **R.**

Darbyella sp. **R.** (Pl. 18, fig. 3.)
The illustrated specimen exhibits a combination of structural features not normally found within a single specimen. The specimen starts out as a close-coiled *Robulus*, involute on both sides, consisting of about eight chambers and having slightly raised limbate curved sutures. In its later development, the specimen becomes progressively more evolute on one side only, and the sutures lose their limbation and become slightly depressed. The most unique feature seems to be the lack of a radiate aperture that is so characteristic of most of the genera in the family Lagenidae. The present specimen clearly shows the slit aperture described in the type species of *Darbyella*. Moreover, through the clear glassy keel it can be seen that each previous aperture consisted of a median slit rather than a series of radial slits, as in *Robulus* or *Lenticulina*. Only a single specimen was found.

Dentalina communis d'Orbigny. *Nodosaria* (D.) *communis* d'Orbigny, Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 504, pl. 62, figs. 19–22. **M.** (Pl. 12, fig. 1.)

Dentalina cooperensis Cushman, 1933, Cushman Lab. Foram. Research Contr., v. 9, p. 8, pl. 1, fig. 17. **O.**

Dentalina mucronata Neugeboren, 1856, Denkschr. Akad. Wiss. Wien, v. 12, p. 83, pl. 3, figs. 8–11. **R.**

Dentalina tauricornis (Schwager). *Nodosaria tauricornis* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 228, pl. 6, fig. 61. **M.**

Dentalina sp. A. **M.** (Pl. 12, fig. 7.)
Costate.

Dentalina sp. B. **O.**
Slender.

Dentalina sp. C. **O.**
Slender with broad dark sutures.

Dentalina sp. D. **O.**
Lobulate.

Dentalina? spp. **EM.**

Discorbis balcombensis Chapman, Parr, and Collins. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 838, pl. 262, fig. 7. **O.**

Eggerella bradyi (Cushman). Cushman, 1937, Cushman Lab. Foram. Research, Spec. Pub. 8, p. 52, pl. 5, fig. 19. **M.**

Ehrenbergina albatrossi Cushman. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 47, pl. 21, figs. 2, 3. **M.** (Pl. 15, fig. 2.)

Ellipsoglandulina labiata (Schwager). *Glandulina labiata* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 237, pl. 6, fig. 77. **EO.**

Ellipsopleurostomella sp. **M.** (Pl. 12, fig. 16.)
Only one complete, one incomplete (see pl. 12, fig. 16), and three fragmentary pieces represent what is probably an undescribed species in this genus. The species is cylindrical and elongate, about 0.9 mm in length and 0.2–0.3 mm in diameter, and the sutures show no indentation on the surface. The initial end is bluntly pointed and tapering. The apertural end is rounded, and the aperture is crescent shaped, having the wall on the concave side of the crescent outline slightly raised above the wall on the convex side. The broken side of the wall in the illustrated specimen permits a view of the internal tube that connects the previous apertures. Most of the sutures are only faintly visible, but it can be seen the several latest sutures are not equatorial but are curving and oblique to the axis of the test. This undescribed species is probably related to *Ellipsopleurostomella stewarti* Cushman and Siegfus from the Eocene and Oligocene Kreyenhagen Shale of California, but it is considerably slenderer and more elongate.

Elphidium advenum (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 345, pl. 86, fig. 30. **R.**

Elphidium crispum (Linné). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 74, pl. 11, fig. 13. **R.**

Elphidium hyalocostatum Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 300, pl. 88, fig. 19. **R.** (Pl. 18, fig. 11.)

Elphidium jenseni (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 346, pl. 86, fig. 32. **R.**

Elphidium simplex Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 346, pl. 86, fig. 33. **R.**

Elphidium striatopunctatum (Fichtel and Moll). Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 288 (table 4), pl. 88, fig. 21. **R.**

Elphidium spp. **OM.**

Enantiomorphina sp. **O.**
A short arched fusiform specimen having indistinct, nonindented sutures that are horizontal on the convex side but make an upside-down-V-pattern on the concave side (referring to the arched axis). In shape the specimen resembles *Nodosarella acus* Cushman and Bermudez, but its radiate aperture and its suture pattern remove it from that species.

Epistomaroides polystomelloides (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 360, pl. 89, fig. 26. **R.**

Epistominella cf. *E. obtusa* (Burrows and Holland). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 365, pl. 90, fig. 19. **R.**

Epistominella rugosa (Phleger and Parker). *Pseudoparrella*(?) *rugosa* Phleger and Parker, 1951, Geol. Soc. America Mem. 46, pt. 2, p. 28, pl. 15, figs. 8, 9. **R.**

Epistominella tubulifera (Heron-Allen and Earland). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 365, pl. 90, fig. 20. **R.**

Eponides duprei ciervoensis Cushman and Simonson. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 838, pl. 260, fig. 7. **O.** (Pl. 6, fig. 7.)

Eponides kiliani (Andreae). *Pulvinulina kiliani* Andreae, 1884, Abh. Geol. Spec.-Karte Elsass-Lothringen, v. 2, pt. 3, p. 163, pl. 11, fig. 1. **O.**

Eponides ocalanus Cushman. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 838, pl. 256, fig. 7. **E.**

Eponides repandus (Fichtel and Moll). Resig, 1962, Cushman Found. Foram. Research Contr., v. 13, p. 55, pl. 14, figs. 1–9. **R.** (Pl. 19, fig. 5.)

Eponides sp. **O.** (Pl. 6, fig. 1.)
A compact tightly coiled form, having seven chambers in the final whorl.

Fissurina alveolata (Brady). *Lagena alveolata* Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 487, pl. 60, figs. 30, 32. **M.**

Fissurina circulum Seguenza, 1862, Descrizione dei Foraminiferi Monotalamici delle Marne Mioceniche del Distretto di Messina, p. 63, pl. 2, fig. 15. **M.** (Pl. 12, fig. 9.)

Fissurina fimbriata (Brady). *Lagena fimbriata* Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 486, pl. 60, figs. 26–28. **O.** (Pl. 4, fig. 8.)

Fissurina formosa (Schwager). *Lagena formosa* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 206, pl. 4, fig. 19. **M.** (Pl. 12, fig. 10.)

Fissurina globosa Bornemann, 1855, Deutsche Geol. Gesell. Zeitschr., v. 7, p. 317, pl. 12, fig. 4. **M.**

Fissurina lagenoides (Williamson). *Entosolenia marginata* Montague var. *lagenoides* Williamson, 1858, On the Recent Foraminifera of Great Britain, p. 11, pl. 1, figs. 25, 26. **O.**

Fissurina spp. **O.**
Unornamented forms; one is nearly circular and has a keel; another has a thickened peripheral band and a protruding apertural end.

Flintina bradyana Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 467, pl. 94, fig. 2; text figs. 38–44. **R.** (Pl. 17, fig. 5.)

Frondicularia robusta Brady var. *repanda* Cushman, 1913, U.S. Natl. Mus. Bull. 71, pt. 3, p. 83, pl. 29, figs. 1, 2. **R.** (Pl. 18, fig. 2.)

Gaudryina triangularis angulata Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 83, fig. 14. **R.**

Gaudryina trullissata Todd, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 83, fig. 15. **R.**

Gaudryina (Siphogaudryina) rugulosa Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 82, fig. 1. **R.**

Gaudryina (Siphogaudryina) siphonifera (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 83, fig. 17. **R.**

Gaudryina (Siphogaudryina) transversaria (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 83, fig. 16. **R.**

Gavelinopsis praegeri (Heron-Allen and Earland). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 18, pl. 8, fig. 1. **R.**

Gypsina globula (Reuss). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 373, pl. 91, fig. 39. **ER.**

Gypsina vesicularis (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 373, pl. 82, fig. 12. **R.**

Gyroidina girardana (Reuss). *Rotalina girardana* Reuss, 1851, Deutsche Geol. Gesell. Zeitschr., v. 3, p. 73, pl. 5, fig. 34. **O.** (Pl. 6, fig. 9.)

Gyroidina lamarckiana (d'Orbigny). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 19, pl. 6, fig. 3. **O?M.**

Gyroidina nitidula (Schwager). *Rotalia nitidula* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 263, pl. 7, fig. 110. **EO.**

Gyroidina soldanii d'Orbigny. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 19, pl. 6, fig. 4. **M.**

Haddonia torresiensis Chapman. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 827, pl. 261, fig. 16. **R.**

Halkyardia bikiniensis Cole, 1954, U.S. Geol. Survey Prof. Paper 260–O, p. 584, pl. 210, figs. 1–5. **EO.**

Hauerina diversa Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 337, pl. 84, figs. 30, 31. **R.**

Hauerina involuta Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 337, pl. 84, figs. 28, 29. **R.**

Hauerina milletti Cushman, 1954, *in* Cushman, Todd, and Post, U.S. Geol. Survey Prof. Paper 260–H, p. 337, pl. 84, fig. 23. **R.**

Hauerina pacifica Cushman, 1917, U.S. Natl. Mus. Bull. 71, pt. 6, p. 64, pl. 21, fig. 2. **R.**

Heterostegina suborbicularis d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 346, pl. 82, figs. 7, 8; pl. 87, fig. 2. **R.**

Hoeglundina elegans (d'Orbigny). *Epistomina elegans* (d'Orbigny), Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 65, pl. 13, fig. 6. **R.**

Homotrema rubrum (Lamarck). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 373, pl. 82, fig. 17; pl. 92, fig. 8; pl. 93, fig. 2. **R.**

Karreriella bradyi (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 135, pl. 16, figs. 6–11. **M.** (Pl. 12, fig. 8.)

Karreriella chilostoma (Reuss). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 126, pl. 15, figs. 1–8. **O.**

Karreriella sp. **O.**

A rough-walled specimen having a prominent initial stage and later chambers not as overlapping as in *Karreriella chilostoma* (Reuss) but somewhat separated by depressed sutures. The aperture, although somewhat obscured by matrix, appears to be surrounded by a rather high sharp rim.

Lagena gracilis Williamson. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 344, pl. 86, fig. 18. **M.**

Lagenonodosaria scalaris (Batsch). Asano, 1956, Tōhoku Univ. Sci. Repts., 2d ser. (Geology), v. 27, p. 26, pl. 6, figs. 5–7, 10. **R.**

Laticarinina pauperata (Parker and Jones). Cushman and Todd, 1942, Cushman Lab. Foram. Research Contr., v. 18, p. 15, pl. 4, figs. 1–6. **M.**

Liebusella bradyi (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 169, pl. 20, fig. 22. **R.**

Marginopora vertebralis Blainville. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 348, pl. 82, figs. 5, 6. **R.**

Marginulina costata (Batsch). Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 528, pl. 65, figs. 10–13. **R.**

Marginulina glabra d'Orbigny. Christodoulou, 1960, Palaeontographica, sec. A, v. 115, pts. 1–6, p. 68, pl. 5, fig. 35. **O.**

Massilina durrandi (Millett). *Miliolina durrandi* Millett, 1898, Royal Micros. Soc. Jour., p. 268, pl. 6, figs. 7–10. **R.**

Massilina secans (d'Orbigny). *Miliolina secans* d'Orbigny, sp., Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 167, pl. 6, figs. 1, 2. **R.**

Massilina secans reticulata Heron-Allen and Earland, 1915, Zool. Soc. London Trans., v. 20, p. 582, pl. 45, figs. 1–4. **R.**

Miliolinella australis (Parr). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 334, pl. 84, figs. 3, 4. **R.**

Miliolinella labiosa (d'Orbigny). *Triloculinella labiosa* (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 334, pl. 84, figs. 5, 6. **R.**

Miliolinella oceanica (Cushman). *Triloculina oceanica* Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 54, pl. 12, fig. 3. **R.**

Miliolinella oceanica var. *flintiana* (Cushman). *Triloculina oceanica* Cushman var. *flintiana* Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 55, pl. 12, fig. 4. **R.**

Neoconorbina celsa (Todd). *Discorbis celsa* Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 299, pl. 67, fig. 20. **O.**

Neoconorbina crustata (Cushman). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 15, pl. 2, figs. 2, 3. **R.** (Pl. 18, fig. 12.)

Neoconorbina fulva (Todd). *Discorbis fulva* Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 299, pl. 90, fig. 8. **R.**

Neoconorbina patelliformis (Brady). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 16, pl. 2, fig. 1. **R.**

Neoconorbina tabernacularis (Brady). *Discorbina tabernacularis* Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 648, pl. 89, figs. 5–7. **R.**

Neoconorbina terquemi (Rzehak). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 16, pl. 5, fig. 6. **R.**

Neoconorbina tuberocapitata (Chapman). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 17, pl. 1, figs. 8, 9. **R.**

Neorotalia floscula (Todd and Post). *Rotalia floscula* Todd and Post, 1954, U.S. Geol. Survey Prof. Paper 260–N, p. 561, pl. 200, fig. 5. **E.**

Nodosarella aff. *N. acus* Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 19, pl. 2, figs. 10, 11. **O.**

Nodosarella robusta Cushman, 1943, Cushman Lab. Foram. Research Contr., v. 19, p. 92, pl. 16, fig. 8. **O.**

Nodosarella subcylindrica Cushman, 1943, Cushman Lab. Foram. Research Contr., v. 19, p. 91, pl. 16, figs. 4, 5. **O.**

Nodosaria affinis Reuss? Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 828, pl. 255, fig. 10. **E.**

Nodosaria calomorpha Reuss. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 497, pl. 61, figs. 23–27. **R.** Pl. 18, fig. 4.

Nodosaria consobrina (d'Orbigny). *Dentalina consobrina* d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 46, pl. 2, figs. 1–3. **O.**

Nodosaria equisetiformis Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 231, pl. 6, fig. 66. **M.** (Pl. 12, fig. 6.)

Nodosaria insecta Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 224, pl. 5, figs. 53, 54. **M.**

Nodosaria longiscata d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 32, pl. 1, figs. 10–12. **O.**

Nodosaria skobina Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 225, pl. 5, fig. 56. **M.**

Nodosaria aff. *N. tosta* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 219, pl. 5, fig. 42. **O.**

Nodosaria vertebralis (Batsch). Brady, 1884, *Challenger* Repts., Zoology, v. 9, p. 514, pl. 63, fig. 35; pl. 64, figs. 11–14. **O.**

Nonion boueanum (d'Orbigny). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 12, pl. 3, figs. 7, 8. **R.**

Nonion japonicum Asano, 1938, Geol. Soc. Japan Jour., v. 45, no. 538, p. 593, pl. 15 (4), figs. 1, 2. **R.**

Nonion maoricum (Stache). *Rosalina maorica* Stache, 1864, *Novara* Exped., Geol. Theil, v. 1, sec. 2, p. 282, pl. 24, fig. 32. **EO.** (Pl. 6, fig. 8.)

Nonion micrum Cole, 1927, Bull. Am. Paleontology, v. 14, no. 51, p. 22, pl. 5, fig. 12. **O.**

Nonion pacificum (Cushman). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 25, pl. 6, fig. 25. **R.**

Nonion pompilioides (Fichtel and Moll). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 19, pl. 5, figs. 9–12. **M.**

"*Nonionella*" *minutissima* Todd, 1952, U.S. Geol. Survey Prof. Paper 241, p. 24, pl. 3, fig. 30. **O.**

Nonionella sp. **OM.**

A small (0.23 mm) compressed form, having nine chambers in the final whorl.

Nubeculina divaricata (Brady). Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 48, pl. 11, figs. 5, 6. **R.**

Nubeculina divaricata advena Cushman. Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 49, pl. 11, fig. 8. **R.** (Pl. 17, fig. 2.)

Nuttallides trumpyi (Nuttall). Belford, 1958, Cushman Found. Foram. Research Contr., v. 9, p. 94, pl. 18, figs. 1–13; text figs. 1–3. **E.** (Pl. 1, fig. 4.)

Oolina squamosa catenulata (Williamson). *Entosolenia squamosa* var. *catenulata* Williamson, 1848, Annals and Mag. Nat. History, ser. 2, v. 1, p. 19, pl. 2, fig. 20. **O.**

Oolina n. sp. aff. *O. gibbera* (Buchner). *Lagena gibbera* Buchner, 1940, Nova Acta Leopoldina, Deutschen Akad. Naturf., neue Folge, v. 9, no. 62, p. 423, pl. 3, figs. 48–50. **O.** (Pl. 4, fig. 12.)

Operculina ammonoides (Gronovius). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 346, pl. 87, fig. 1. **R.**

Oridorsalis umbonatus (Reuss). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 23, pl. 6, fig. 2. **EOM.** (Pl. 6, fig. 5; pl. 13, fig. 5.)

Orthomorphina fijiensis (Cushman). *Siphonodosaria fijiensis* Cushman, 1931, Cushman Lab. Foram. Research Contr., v. 7, p. 30, pl. 4, fig. 10. **M.** (Pl. 12, fig. 2.)

Orthomorphina parvula Todd, n. sp. **EOM.** (Pl. 12, fig. 4.)

Test small for the genus, uniserial, straight, cylindrical, circular in transverse section, bluntly rounded at the initial end, produced into a slender neck at the opposite end; chambers few, about six, slightly inflated, overlapping each previous one as added, increasing only slightly in size as added; sutures distinct, slightly depressed; wall smooth, unornamented; aperture terminal, circular, at the end of a long neck, surrounded by a narrow flaring lip. Length as much as 0.5 mm; diameter 0.1 mm.

Holotype, USNM 642256, from Miocene (Tertiary *g*) beds of the Janum Formation at Lujuna Point, northeast coast of Guam, USGS f25805 (Rr 15–1).

This small and delicate species was found in only one sample of the Miocene. In the Eocene and Oligocene of Guam, a similar, possibly related, form is found. It differs mainly by being more tapering, by having a pointed not blunt initial end, by consisting of two or three more chambers, and by having a shorter apertural neck. These specimens are probably not identical with but are possibly related to or ancestral to *Orthomorphina parvula*.

Orthomorphina perversa (Schwager). *Nodosaria perversa* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 212, pl. 5, fig. 29. **M.** (Pl. 12, fig. 5.)

Orthomorphina rohri (Cushman and Stainforth). *Nodogenerina rohri* Cushman and Stainforth, 1945, Cushman Lab. Foram. Research Spec. Pub. 14, p. 39, pl. 5, fig. 26. **E.**

Osangularia culter (Parker and Jones). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 25, pl. 15, fig. 1. **EOM.** (Pl. 13, fig. 7.)

Pararotalia byramensis (Cushman). Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 839, pl. 262, figs. 11, 12. **O.** (Pl. 7, fig. 2.)

Parrina bradyi (Millett). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 342, pl. 85, figs. 31–34. **R.**

Patellina advena var. *altiformis* Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 357, pl. 89, fig. 1. **R.**

Paumotua terebra (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 361, pl. 89, fig. 28. **R.**

Pegidia dubia (d'Orbigny). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 32, pl. 18, fig. 5. **R.** (Pl. 19, fig. 1.)

Peneroplis ellipticus d'Orbigny. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 288 (table 4), pl. 89, fig. 1. **R.**

Peneroplis proteus d'Orbigny. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 288 (table 4), pl. 93, fig. 4. **R.**

Placopsilina? sp. Todd, 1962, U.S. Geol. Survey Prof. Paper 354–H, 1961, p. 187, pl. 22, figs. 3, 4; pl. 25, fig. 5d. **R.** (Pl. 17, fig. 1.)

Planispirinella exigua (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 341, pl. 85, fig. 28. **R.**

Planodiscorbis rarescens (Brady). *Discorbina rarescens* Brady, 1884, *Challenger* Repts., Zoology, v. 9, p. 651, pl. 90, figs. 2, 3. **R.**

Planorbulina acervalis Brady. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 372, pl. 82, fig. 14; pl. 91, figs. 34–36. **R.**

Planorbulinella larvata (Parker and Jones). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 118, pl. 19, fig. 17. **OR.**

Planorbulinoides retinaculatus (Parker and Jones). Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 853, pl. 262, fig. 5; pl. 263, fig. 10. **R.**

Planulina wuellerstorfi (Schwager). *Anomalina wuellerstorfi* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 258, pl. 7, figs. 105, 107. **OM.**

Pleurostomella alternans Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 238, pl. 6, figs. 79, 80. **M.** (Pl. 12, figs. 14, 15.)

Pleurostomella bierigi Palmer and Bermudez, 1936, Soc. cubana hist. nat. Mem., v. 10, no. 5, p. 294, pl. 17, figs. 7, 8. **O.**

Pleurostomella brevis Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 239, pl. 6, fig. 81. **M.**

Pleurostomella cubensis Cushman and Bermudez. *Pleurostomella alazanensis* Cushman var. *cubensis* Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 17, pl. 1, figs. 64, 65. **EO.** (Pl. 4, fig. 11.)

Pleurostomella naranjoensis Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 16, pl. 1, figs. 59, 60. **O.**

Pleurostomella sp. **O.** (Pl. 4, fig. 10.)

A single specimen exhibits closely spaced distinct costae over the initial half of the test. As ornamentation is almost unknown in family Ellipsoidinidae, this specimen seems to be noteworthy.

Polymorphinella pacifica Cushman and Hanzawa. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 344, pl. 86, figs. 23, 24. **R.**

Pullenia bulloides (d'Orbigny). Cushman and Todd, 1943, Cushman Lab. Foram. Research Contr., v. 19, p. 13, pl. 2, figs. 15–18. **OM.**

Pullenia sp. **OM.**

Flattened, four to five chambers.

Pyrgo denticulata (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, fig. 22. **R.**

Pyrgo denticulata var. *striolata* (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, fig. 23. **R.**

Pyrgo murrhina (Schwager). *Biloculina murrhina* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 203, pl. 4, fig. 15. **M.**

Pyrgo sp. **EO.**

Oval in outline and inflated.

Pyrulina labiata (Schwager). *Polymorphina labiata* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 246, pl. 7, fig. 90. **M.**

Quinqueloculina agglutinans d'Orbigny. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 41, pl. 4, fig. 10. **R.** (Pl. 17, fig. 8.)

Besides the typical form of this species, such as specimens illustrated from Saipan (Todd, 1957, pl. 85, fig. 6) and from the Philippines (reference above), there occur a few specimens, similar to the one here illustrated, in which the wall is less rough, the peripheral angles are rounded, and the aperture is filled by a long bladelike tooth, bifid at the tip.

Quinqueloculina anguina var. *arenata* Said. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 332, pl. 83, fig. 21. **R.**

Quinqueloculina apicula Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 422, pl. 88, figs. 1, 2. **R.**

Quinqueloculina berthelotiana d'Orbigny. Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 19, pl. 5, figs. 2–4. **R.**

Quinqueloculina bidentata d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 332, pl. 83, fig. 30 (erroneously given as fig. 31). **R.**

Quinqueloculina bosciana d'Orbigny. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 43, pl. 5, fig. 3. **R.** (Pl. 17, fig. 9.)

Quinqueloculina distorqueata Cushman, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 333, pl. 83, fig. 27. **R.**

Quinqueloculina ferussaci d'Orbigny. Fornasini, 1900, Accad. Sci. Ist. Bologna Mem., ser. 5, v. 8, p. 9, fig. 8. **R.**

Quinqueloculina lamarckiana d'Orbigny, 1839, Foraminifères, *in* de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, p. 189, pl. 11, figs. 14, 15. **MR.**

Quinqueloculina neostriatula Thalmann. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 333, pl. 83, fig. 28. **R.**

Quinqueloculina parkeri (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 333, pl. 83, fig. 23. **R.**

Quinqueloculina poeyana d'Orbigny, 1839, Foraminifères, *in* de la Sagra, Histoire physique, politique et naturelle de l'Île de Cuba, p. 191, pl. 11, figs. 25–27. **R.** (Pl. 17, fig. 4.)

Quinqueloculina polygona d'Orbigny. Todd, 1962, U.S. Geol. Survey Prof. Paper 354–H, 1961, p. 187, pl. 22, fig. 5. **R.**

Quinqueloculina cf. *Q. seminulum* (Linné). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 333, pl. 83, fig. 29. **R.**

Quinqueloculina subarenaria Cushman, 1917, U.S. Natl. Mus. Bull. 71, pt. 6, p. 44, pl. 10, figs. 1, 2. **R.**

Quinqueloculina subcuneata Cushman. *Quinqueloculina crassa* var. *subcuneata* Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 333, pl. 83, fig. 22. **R.** (Pl. 17, fig. 6.)

Quinqueloculina sulcata d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 334, pl. 84, figs. 1, 2. **R.**

Quinqueloculina tubus Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 306, pl. 85, fig. 18. **R.**

Rectobolivina bifrons var. *striatula* (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 205, pl. 23, figs. 17, 18. **R.**

Rectoglandulina sp. **O.**

A single small (0.35 mm) specimen consisting of four nearly equal and nonoverlapping chambers and a small apertural chamber.

Reussella pulchra Cushman, 1945, Cushman Lab. Foram. Research Contr., v. 21, p. 34, pl. 6, figs. 11, 12. **R.** (Pl. 18, fig. 6.)

Reussella simplex (Cushman). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 354, pl. 88, figs. 1, 2. **MR.**

Reussella sp. **O.**

Robulus cf. *R. clericii* (Fornasini). Cushman and Todd, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 15, pl. 2, fig. 11. **O.**

Robulus limbosus (Reuss). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 343, pl. 86, fig. 1. **R.**

Robulus orbicularis (d'Orbigny). Asano, 1956, Tōhoku Univ. Sci. Repts., 2d ser. (Geology), v. 27, p. 49, pl. 1, figs. 19–21. **R.** (Pl. 18, fig. 1.)

Robulus rotulus (Stache). *Cristellaria rotula* Stache, 1864, *Novara* Exped., Geol. Theil, v. 1, sec. 2, p. 233, pl. 23, fig. 12. **O.**

Robulus vortex (Fichtel and Moll). Cushman, 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 5, pl. 2, fig. 1. **R.**

Robulus spp. **EOM.**

Unornamented forms.

Rosalina concinna (Brady). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 10, pl. 4, fig. 3. **R.**

Rosalina floridana (Cushman). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 10, pl. 3, figs. 1, 3; pl. 4, fig. 5. **R.**

Rosalina micens (Cushman). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 12, pl. 4, fig. 2. **R.**

Rosalina rugosa d'Orbigny. Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 12, pl. 4, fig. 1. **R.**

Rosalina cf. *R. wrightii* (Brady). *Discorbina Wrightii* Brady, 1881, Annals and Mag. Nat. History, ser. 5, v. 8, p. 413, pl. 21, fig. 2. **O.**

Rosalina sp. **E.**

Rotaliammina mayori Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 342, pl. 85, fig. 36. **R.**

Rotorbinella mira (Cushman). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 18. pl. 8, fig. 2. **R.** (Pl. 18, fig. 13.)

Saccammina sp. *Proteonina* sp. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 328, pl. 83, fig. 1. **R.**

The generic change was necessitated by the demonstration (Loeblich and Tappan, 1955, p. 7, 8) that *Proteonina* is a synonym of *Reophax*.

Sagenina frondescens (Brady). Chapman, 1899, Linnean Soc. Zoology Jour., v. 28, p. 4, pl. 1, figs. 1, 2; pl. 2, figs. 1, 2. **R.** (Pl. 17, fig. 1.)

Saracenaria sp. **O.** (Pl. 4, fig. 2.)

Schlumbergerina alveoliniformis (Brady). Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 49, pl. 6, fig. 11. **R.**

Siphogenerina raphana (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 356, pl. 88, figs. 23, 24. **R.**

Siphogenerina striata (Schwager). *Dimorphina striata* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 251, pl. 7, fig. 99. **OM.** (Pl. 5, fig. 18.)

Siphogenerina? sp. **O.**

Coarsely spinose.

Siphonina tubulosa Cushman. Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 361, pl. 89, figs. 29, 30. **R.**

Siphoninoides echinatus (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 361, pl. 89, figs. 31, 32. **R.**

Sorites marginalis (Lamarck). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 348, pl. 82, fig. 4. **R.**

Sphaeridia papillata Heron-Allen and Earland. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 290 (table 4), pl. 93, fig. 12. **R.**

Sphaeroidina bulloides d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 367, pl. 90, fig. 39. **MR.**

Spirillina decorata Brady. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 356, pl. 88, figs. 32, 33. **R.**

Spirillina denticulogranulata Chapman. Todd, 1962, U.S. Geol. Survey Prof. Paper 354–H, 1961, p. 179 (table 1), pl. 23, fig. 5. **R.**

Spirillina tuberculatolimbata Chapman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 357, pl. 88, fig. 34. **R.**

Spirillina vivipara Ehrenberg. Parker, 1958, Swedish Deep-Sea Exped. Repts., v. 8, Sediment Cores, no. 4, p. 264, pl. 3, fig. 4. **R.**

Spirillina vivipara var. *revertens* Rhumbler. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 357, pl. 88, fig. 30. **R.**

Spirolina acicularis (Batsch). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 348, pl. 87, fig. 6. **R.**

Spirolina arietina (Batsch). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 348, pl. 87, figs. 4, 5. **R.**

Spiroloculina angulata Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 334, pl. 84, figs. 11, 12. **R.**

Spiroloculina caduca Cushman. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 286 (table 4), pl. 87, fig. 10. **R.**

Spiroloculina clara Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper, 260–H, p. 335, pl. 84, fig. 9. **R.**

Spiroloculina communis Cushman and Todd. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 335, pl. 84, fig. 13. **R.**

Spiroloculina eximia Cushman. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 286 (table 4), pl. 87, fig. 12. **R.**

Spiroloculina folium Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 307, pl. 87, fig. 5. **R.**

Spiroloculina foveolata Egger. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 335, pl. 84, fig. 14. **R.**

Spiroloculina hadai Thalmann. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 52, pl. 7, fig. 3. **R.**

Spiroloculina marshallana Todd, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 335, pl. 84, fig. 8. **R.**

Spiroloculina rugosa Cushman and Todd, 1944, Cushman Lab. Foram. Research Spec. Pub. 11, p. 66, pl. 9, figs. 9–13. **R.**

Stilostomella aff. *S. adelinensis* (Palmer and Bermudez). *Ellipsonodosaria? adelinensis* Palmer and Bermudez, 1936, Soc. Cubana Hist. Nat. Mem., v. 10, no. 5, p. 299, pl. 18, fig. 13. **O.**

Stilostomella curvatura (Cushman). *Ellipsonodosaria curvatura* Cushman, 1939, Cushman Lab. Foram. Research Contr., v. 15, p. 71, pl. 12, fig. 6. **O.** (Pl. 4, figs. 5, 6.)

Stilostomella nuttalli (Cushman and Jarvis). *Ellipsonodosaria nuttalli* Cushman and Jarvis, 1934, Cushman Lab. Foram. Research Contr., v. 10, p. 72, pl. 10, fig. 6. **E?O.**

Stilostomella recta (Palmer and Bermudez). *Ellipsonodosaria recta* Palmer and Bermudez, 1936, Soc. Cubana Hist. Nat. Mem., v. 10, no. 5, p. 297, pl. 18, figs. 6, 7. **O.** (Pl. 4, fig. 13.)

Stilostomella subspinosa (Cushman). *Ellipsonodosaria subspinosa* Cushman, 1943, Cushman Lab. Foram. Research Contr., v. 19, p. 92, pl. 16, figs. 6, 7. **EO.**

Stilostomella verneuili (d'Orbigny). Beckmann, 1954, Eclogae geol. Helvetiae, v. 46, no. 2, 1953, p. 372, pl. 21, figs. 39, 40. **EOM.** (Pl. 4, fig. 4; pl. 12, fig. 3.)

Stomatorbina concentrica (Parker and Jones). *Mississippina concentrica* (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 360, pl. 89, fig. 27. **R.** (Pl. 19, fig. 7.)

Stomatorbina torrei (Cushman and Bermudez). *Lamarckina torrei* Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 21, pl. 2, figs. 24–26. **EO.** (Pl. 1, fig. 3.)

Streblus beccarii (Linné). Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 290 (table 4), pl. 91, fig. 3. **R.**

Streblus beccarii tepida (Cushman). Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 290 (table 4), pl. 91, fig. 5. **R.**

Streblus beccarii var. of Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 290 (table 4), pl. 91, fig. 4. **R.** (Pl. 19, fig. 6.)

Svratkina australiensis (Chapman, Parr, and Collins). *Discorbis tuberculata* (Balkwill and Wright) var. *australiensis* Chapman, Parr, and Collins, 1934, Linnean Soc. Zoology Jour., v. 38, no. 262, p. 563, pl. 8, fig. 9. **R.**

Textularia agglutinans d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 328, pl. 83, fig. 2. **R.**

Textularia alveata Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 307, pl. 85, fig. 12. **R.**

Textularia conica d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 329, pl. 83, fig. 4. **R.**

Textularia dupla Todd, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 329, pl. 83, fig. 6. **R.**

Textularia foliacea Heron-Allen and Earland. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 329, pl. 83, fig. 7. **R.**

Textularia foliacea var. *oceanica* Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 329, pl. 83, fig. 8. **R.**

Textularia kerimbaensis Said. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 329, pl. 83, fig. 11. **R.**

Textularia semialata Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 330, pl. 83, fig. 5. **R.**

Tretomphalus concinnus (Brady). Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 292 (table 4), pl. 92, fig. 4. **R.**

Tretomphalus planus Cushman. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 292 (table 4), pl. 92, fig. 3. **R.**

Trifarina bradyi Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 356, pl. 88, fig. 21. **MR.**

Triloculina cf. *T. bassensis* Parr. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 337, pl. 85, fig. 14. **R.**

Triloculina aff. *T. bicarinata* d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 338, pl. 85, fig. 2. **R.**

Triloculina earlandi Cushman, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 338, pl. 85, fig. 3. **R.**

Triloculina incisura Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 308, pl. 86, fig. 18. **R.**

Triloculina involuta Todd, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 338, pl. 85, fig. 4. **R.**

Triloculina irregularis (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 338, pl. 85, fig. 12. **R.**

Triloculina kerimbatica (Heron-Allen and Earland). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 339, pl. 85, figs. 10, 11. **R.**

Triloculina marshallana Todd, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 339, pl. 85, fig. 13. **R.**

Triloculina oblonga (Montagu). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 339, pl. 85, figs. 5–7. **R.**

Triloculina spinata Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 339, pl. 85, fig. 8. **R.**

Triloculina subgranulata Cushman, 1918, Carnegie Inst. Washington Pub. 213, p. 290, pl. 96, fig. 4. **R.** (Pl. 17, fig. 7.)

Triloculina subplanciana Cushman, *in* Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 339, pl. 85, fig. 17. **R.**

Triloculina terquemiana (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, fig. 9. **R.**

Triloculina transversestriata (Brady). Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 288 (table 4), pl. 85, fig. 16. **R.**

Triloculina tricarinata d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, figs. 15, 16. **R.**

Triloculina trigonula (Lamarck). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, fig. 18. **R.**

Triloculina sp. A. **O.**

Compressed and sharp angled.

Triloculina sp. B. **E.**

Plump and rounded.

Uvigerina ampullacea Brady. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 355, pl. 88, fig. 19. **OR.**

Uvigerina porrecta Brady. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 355, pl. 88, figs. 14, 15. **R.**

Uvigerina proboscidea Schwager. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 355, pl. 88, fig. 18. **M.**

Uvigerina proboscidea var. *vadescens* Cushman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 355, pl. 88, fig. 17. **MR.**

Vaginulinopsis sublituus multicamerata (Cushman and Stainforth). *Marginulina sublituus* (Nuttall) var. *multicamerata* Cushman and Stainforth, 1945, Cushman Lab. Foram. Research Spec. Pub. 14, p. 23, pl. 3, figs. 6, 7. **O.** (Pl. 4, fig. 3.)

Vaginulinopsis? sp. **E.**

A heavily costate fragment of the initial stage.

Valvulina davidiana Chapman. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 331, pl. 82, fig. 2. **R.**

Valvulina martii Cushman and Bermudez. Todd and Post, 1954, U.S. Geol. Survey Prof. Paper 260–N, p. 553, pl. 198, fig. 1. **E.**

Valvulineria? sp. **E.**

A single specimen, having five chambers in the final whorl and a distinctly porous wall.

Vertebralina striata d'Orbigny. Graham and Militante, 1959, Stanford Univ. Pub., Geol. Sci., v. 6, no. 2, p. 60, pl. 9, figs. 11, 12. **R.**

Virgulina colei Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 12, pl. 2, figs. 9, 10. **O.**

Virgulina zetina Cole. Cushman, 1937, Cushman Lab. Foram. Research, Spec. Pub. 9, p. 7, pl. 1, figs. 18, 19. **O.** (Pl. 5, fig. 5.)

Vulvulina spinosa Cushman, 1927, Cushman Lab. Foram. Research Contr., v. 3, p. 111, pl. 23, fig. 1. **OM.**

PLANKTONIC SPECIES

Candeina nitida d'Orbigny. Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 370, pl. 91, fig. 15. **MR.** (Pl. 14, fig. 10.)

Cassigerinella chipolensis (Cushman and Ponton). Blow and Banner, *in* Eames, Banner, Blow, and Clarke, 1962, Fundamentals of mid-Tertiary stratigraphical correlation, Cambridge Univ. Press, p. 81, pl. 15, figs. M, N. **O.** (Pl. 8, fig. 3.)

Chiloguembelina cubensis (Palmer). Beckmann, 1957, U.S. Natl. Mus. Bull. 215, p. 89, pl. 21, fig. 21; text fig. 14, figs. 5–8. **O.** (Pl. 8, figs. 1, 4.)

Globigerapsis index (Finlay). *Globigerinoides index* Finlay, 1939, Royal Soc. New Zealand Trans., v. 69, p. 125, pl. 14, figs. 85–88. **E.** (Pl. 2, figs. 1, 2.)

Globigerina ampliapertura Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 108, pl. 22, figs. 4–7. **O.** (Pl. 8, fig. 7.)

Globigerina aff. *G. apertura* Cushman, 1918, U.S. Geol. Survey Bull. 676, p. 57, pl. 12, fig. 8. **M.** (Pl. 14, fig. 5.)

Globigerina conglomerata Schwager. Banner and Blow, 1960. Cushman Found. Foram. Research Contr., v. 11, p. 7, pl. 2, fig. 3. **EOM.** (Pl. 2, fig. 5; pl. 8, fig. 5; pl. 14, fig. 1.)

Globigerina danvillensis Howe and Wallace, 1932, Louisiana Geol. Bull. 2, p. 74, pl. 10, fig. 9. **O.** (Pl. 9, fig. 1.)

Globigerina dissimilis Cushman and Bermudez, 1937, Cushman Lab. Foram. Research Contr., v. 13, p. 25, pl. 3, figs. 4–6. **O.** (Pl. 8, fig. 6.)

Globigerina eggeri Rhumbler. Bradshaw, 1959, Cushman Found. Foram. Research Contr., v. 10, p. 35, pl. 6, figs. 5, 8–10. **R.**

Globigerina gortanii (Borsetti). *Globigerina turritilina* Blow and Banner, *in* Eames, Banner, Blow, and Clarke, 1962, Fundamentals of mid-Tertiary stratigraphical correlation, Cambridge Univ. Press, p. 98, pl. 13, figs. D–G; postscript p. 146. **EO.** (Pl. 2, fig. 3; pl. 10, figs. 6–8.)

Globigerina hexagona Natland. Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1080, pl. 292, fig. 3. **M.** (Pl. 14, fig. 8.)

Globigerina increbescens Bandy, 1949, Bull. Am. Paleontology, v. 32, no. 131, p. 120, pl. 23, fig. 3. **O.** (Pl. 11, fig. 1.)

Globigerina nepenthes Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 301, pl. 78, fig. 7. **M.** (Pl. 14, figs. 6, 7.)

Globigerina opima nana (Bolli). *Globorotalia opima nana* Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 118, pl. 28, fig. 3. **O.** (Pl. 9, figs. 3, 4.)

Globigerina pera Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 301, pl. 70, figs. 10, 11. **E.** (Pl. 2, fig. 4.)

Globigerina sellii (Borsetti). *Globigerina oligocaenica* Blow and Banner, *in* Eames, Banner, Blow, and Clarke, 1962, Fundamentals of mid-Tertiary stratigraphical correlation, Cambridge Univ. Press, p. 88, pl. 10, figs. G, L–N; postscript p. 146. **O.** (Pl. 10, figs. 1–5.)

Globigerina senilis Bandy. *Globigerina ouachitaensis* var. *senilis* Bandy, 1949, Bull. Am. Paleontology, v. 32, no. 131, p. 121, pl. 22, fig. 5. **O.** (Pl. 11, fig. 2.)

Globigerina suteri (Bolli). *Globorotaloides suteri* Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 117, pl. 27, figs. 9–13. **O.** (Pl. 9, fig. 2.)

Globigerina tripartita tapuriensis Blow and Banner, *in* Eames, Banner, Blow, and Clarke, 1962, Fundamentals of mid-Tertiary stratigraphical correlation, Cambridge Univ. Press, p. 97, pl. 10, figs. H–K. **O.** (Pl. 11, fig. 3.)

Globigerina yeguaensis Weinzierl and Applin, 1929, Jour. Paleontology, v. 3, p. 408, pl. 43, fig. 1. **EO.** (Pl. 2, fig. 6; pl. 8, fig. 9.)

Globigerinella aequilateralis (Brady). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 64, pl. 25, figs. 4, 5. **MR.**

Globigerinella danvillensis (Howe and Wallace). *Nonion danvillensis* Howe and Wallace, 1932, Louisiana Geol. Bull. 2, p. 51, pl. 9, fig. 3. **O.** (Pl. 8, fig. 2.)

Globigerinita glutinata (Egger). Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1085. **MR.**

Globigerinoides conglobatus (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 368, pl. 91, fig. 12. **MR.** (Pl. 14, fig. 4.)

Globigerinoides elongatus (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 368, pl. 91, fig. 5. **R.**

Globigerinoides ruber (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 369, pl. 91, fig. 6. **R.**

Globigerinoides sacculifer (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 369, pl. 91, fig. 7. **MR.** (Pl. 14, fig. 3.)

Globigerinoides trilobus (Reuss). Hamilton and Rex, 1959, U.S. Geol. Survey Prof. Paper 260–W, p. 792, pl. 253, figs. 17–19. **O?M.** (Pl. 11, fig. 4.)

Globoquadrina altispira (Cushman and Jarvis). Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 111, pl. 24, figs. 7, 8. **M.** (Pl. 14, fig. 2.)

Globorotalia centralis Cushman and Bermudez. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 268 (table 1), pl. 71, figs. 1, 3. **E.** (Pl. 3, fig. 1.)

Globorotalia fohsi robusta Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 119, pl. 28, fig. 16. **M.** (Pl. 16, fig. 5.)

Globorotalia hirsuta (d'Orbigny). Parker, 1962, Micropaleontology, v. 8, no. 2, p. 236, pl. 5, figs. 10–15; pl. 6, fig. 1. **MR.** (Pl. 16, fig. 2.)

Globorotalia menardii (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 370, pl. 91, fig. 19. **R.**

Globorotalia menardii fijiensis Cushman. *Globorotalia menardii* (d'Orbigny) var. *fijiensis* Cushman, 1934, B. P. Bishop Mus. Bull. 119, p. 136, pl. 17, fig. 5. **M.** (Pl. 15, fig. 8.)

Globorotalia menardii ungulata Bermudez. Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1093, pl. 295, fig. 3. **M.** (Pl. 16, fig. 3.)

Globorotalia menardii-tumida transition form. *Globorotalia* (*Globorotalia*) *menardii-tumida* transition form, Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1092, pl. 294, fig. 2. **M.** (Pl. 16, fig. 1.)

Globorotalia spinuloinflata (Bandy). *Globigerina spinuloinflata* Bandy, 1949, Bull. Am. Paleontology, v. 32, no. 131, p. 122, pl. 23, fig. 1. **E.** (Pl. 3, fig. 2.)

Globorotalia spinulosa Cushman. Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 268 (table 1), pl. 71, fig. 2. **E.** (Pl. 3, fig. 4.)

Globorotalia tumida (Brady). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 370, pl. 91, fig. 21 **MR.** (Pl. 16, fig. 4.)

Globorotalia tumida flexuosa (Koch). Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1094, pl. 294, fig. 4. **M.** (Pl. 16, fig. 6.)

Globorotalia wilcoxensis Cushman and Ponton, 1932, Cushman Lab. Foram. Research Contr., v. 8, p. 71, pl. 9, fig. 10. **E.** (Pl. 3, fig. 3.)

Hantkenina alabamensis Cushman. Todd and Low, 1960, U.S. Geol. Survey Prof. Paper 260–X, p. 850, pl. 259, fig. 14. **E.**

Hantkenina inflata Howe, 1928, Jour. Paleontology, v. 2, p. 14, text fig. 2. **EO.** (Pl. 1, fig. 2; pl. 8, fig. 8.)

Hastigerina pelagica (d'Orbigny). Todd, 1965, U.S. Natl. Mus. Bull. 161, pt. 4, p. 68, pl. 26, fig. 7. **M.** (Pl. 15, fig. 7.)

Orbulina bilobata (d'Orbigny). *Globigerina bilobata* d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 164, pl. 9, figs. 11–14. **M.**

Orbulina suturalis Bronnimann. Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1087, pl. 290, fig. 1. **M.** (Pl. 15, figs. 1, 4.)

Orbulina universa d'Orbigny, 1846, Foraminifères fossiles du bassin de Vienne, p. 22, pl. 1, fig. 1. **MR.**

Pulleniatina obliquiloculata (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 369, pl. 91, fig. 11. **MR.** (Pl. 14, fig. 9.)

Sphaeroidinella dehiscens (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 369, pl. 91, fig. 14. **MR.**

Sphaeroidinella disjuncta Finlay. Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1089, pl. 290, figs. 2, 4. **M.** (Pl. 15, fig. 6.)

Sphaeroidinella kochi (Caudri). Todd, 1964, U.S. Geol. Survey Prof. Paper 260–CC, p. 1088, pl. 289, figs. 5, 6. **M.** (Pl. 15, fig. 3.)

Sphaeroidinella seminulina (Schwager). *Globigerina seminulina* Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 256, pl. 7, fig. 112. **M.** (Pl. 15, fig. 5.)

LIST OF LOCALITIES

For Tertiary localities refer to Tracey and others (1964, pl. 2), and for Recent localities refer to Emery (1962, figs. 14, 37, and 51A).

Eocene (Tertiary *b*)

USGS No.	Field No.	Description of locality
f25817	Ei 4–1	Exposure at connecting road between north and south roads in Naval Ammunition Depot to summit of Mount Alifan.
f25818	Jl 2–1	Ledge outcrop approximately 1½ miles northeast of Yona and from 50 to 100 ft north of the old road between Yona and the abandoned radio station.

Oligocene (Tertiary *c*)

f25813	Hi 6–1	Reyes' Ranch overlooking Mahlac River, about halfway between ranchhouse and valley floor.
f25814, f25815, f25816.	Gj 11–1 Gj 13–1, Gj 14–1.	Intersection of access road with Naval Ammunition Depot 2–AT bunkers area (NAD loop).

Miocene (Tertiary *f* or *g*)

USGS No.	Field No.	Description of locality
f25805	Rr 15–1	Lujuna Point, northeast coast of Guam; tuff bed about 70 ft above sea level.
f25806	Rr 14–1	Lujuna Point, northeast coast of Guam; about 6 ft below Rr 15–1.
f25807	Ts 5–10	Catalina Point, northeast coast of Guam; limestone at base of formation.
f25808	Ts 5–7	Catalina Point, northeast coast of Guam; 50 ft below upper tuff bed.
f25809	Ts 5–6	Catalina Point, northeast coast of Guam; 30 ft below upper tuff bed.
f25810	Ts 5–5	Catalina Point, northeast coast of Guam; 10 ft below upper tuff bed.
f25811	Uu 1–3	Anao Point, northeast coast of Guam; approximately 10 ft below dense white limestone.

Recent

USGS No.	Field No.	Lat N.	Long E.	Depth (feet)
f25696	7	13° 15. 9′	144° 44. 2′	Beach
f25697	26	29. 0	52. 1	Do.
f25698	32	37. 0	53. 9	Do.
f25699	59	30. 3	47. 6	Do.
f25700	63	30. 2	47. 4	Do.
f25701	78	22. 3	38. 9	Do.
f25702	83	34. 6	49. 7	Do.
f25703	86	28. 7	45. 6	Reef
f25704	87	28. 7	45. 5	Do.
f25705	88	28. 7	45. 5	Do.
f25706	89	28. 7	45. 5	Do.
f25707	90	28. 8	45. 5	Do.
f25708	91	28. 8	45. 5	Do.
f25709	92	28. 8	45. 5	Do.
f25710	93	28. 8	45. 5	Do.
f25711	94	28. 9	45. 5	Do.
f25712	95	28. 9	45. 5	Do.
f25713	109	25. 2	47. 0	Beach
f25714	127	25. 2	47. 1	4
f25715	131	25. 1	47. 1	13
f25716	141	25. 0	47. 1	21
f25717	151	25. 0	47. 2	39
f25718	155	25. 0	47. 2	45
f25719	160	25. 0	47. 2	65
f25720	170	24. 9	47. 2	75
f25721	182	24. 9	47. 2	87
f25722	193	21. 3	46. 1	Beach
f25723	200	14. 5	39. 3	Do.
f25724	201	14. 3	39. 1	Do.
f25725	212	14. 7	42. 0	Do.
f25726	213	14. 7	42. 0	Reef
f25727	214	14. 7	42. 0	Do.

Recent

USGS No.	Field No.	Lat N.	Long E.	Depth (feet)
f25728	215	13° 14.7′	144° 42.0′	Reef
f25729	216	14.6	42.0	Do.
f25730	217	14.6	42.0	Do.
f25731	218	14.6	42.0	Do.
f25732	219	14.5	42.0	Do.
f25733	220	14.5	42.0	Do.
f25734	275	25.3	47.1	Do.
f25735	279	25.2	47.2	Do.
f25736	286	25.1	47.3	Do.
f25737	299	25.0	47.0	Do.
f25738	302	24.9	47.1	Do.
f25739	306	24.9	47.2	Do.
f25740	348	15.7	29.8	5
f25741	378	15.0	38.5	21
f25742	422	14.6	39.1	7
f25743	423	14.7	39.1	8
f25744	450	14.4	39.0	4
f25745	451	14.4	39.1	3.5
f25746	462	15.9	39.7	68
f25748	468	15.8	39.8	67
f25749	470	15.8	39.8	90
f25750	472	15.8	39.8	70
f25751	473	15.7	39.8	15
f25752	510	14.8	39.3	9
f25753	523	15.5	39.7	11
f25754	524	15.5	39.6	55
f25755	532	15.8	40.0	Beach
f25756	533	15.8	40.0	2
f25757	537	16.1	39.6	44
f25758	540	15.5	40.2	5
f25759	541	15.4	40.3	Beach
f25760	543	15.3	40.2	1.5
f25761	545	15.4	40.1	2
f25762	546	15.3	40.0	4
f25763	547	15.3	40.0	11
f25764	549	15.3	39.9	9
f25765	551	15.4	39.8	18
f25766	553	15.3	39.7	26
f25767	555	15.3	39.6	38
f25768	556	15.3	39.5	43
f25769	558	15.3	39.4	21
f25770	559	15.3	39.3	6
f25771	561	15.3	39.2	8
f25772	562	15.3	39.2	8
f25773	563	15.3	39.1	3
f25774	577	14.7	41.2	43
f25775	584	14.6	41.3	70
f25776	596	14.9	41.2	38
f25777	602	15.2	41.2	6
f25778	607	16.17	39.28	115
f25779	610A	16.23	39.10	165
f25780	611	16.31	38.97	315
f25781	615	17.33	39.22	37
f25782	644	25.4	47.3	Beach
f25783	645	25.4	47.3	Reef
f25784	649	25.4	47.4	Do.
f25785	652	25.3	47.4	Do.
f25786	653	25.3	47.4	Do.
f25787	660	40.0	50.0	810
f25788	661	39.0	50.4	690

Recent

USGS No.	Field No.	Lat N.	Long E.	Depth (feet)
f25789	662	13° 41.5′	144° 50.3′	1,170
f25790	663	29.8	54.1	972
f25791	664	22.0	47.2	570
f25792	665	15.6	38.3	1,000
f25793	673	25.0	47.1	Reef
f25794	682	25.0	47.1	Do.

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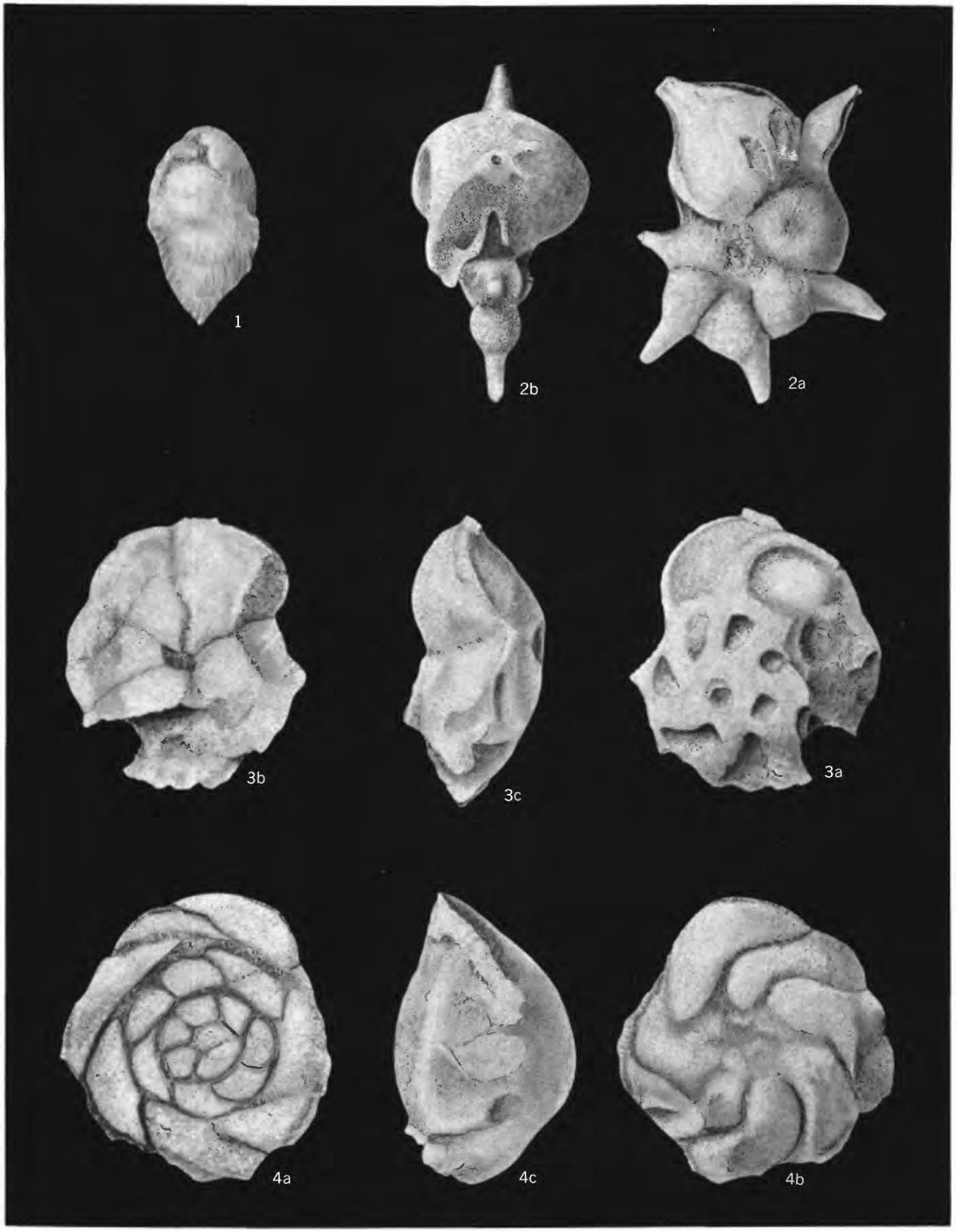

FORAMINIFERA FROM THE EOCENE OF GUAM

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PLANKTONIC FORAMINIFERA FROM THE EOCENE OF GUAM

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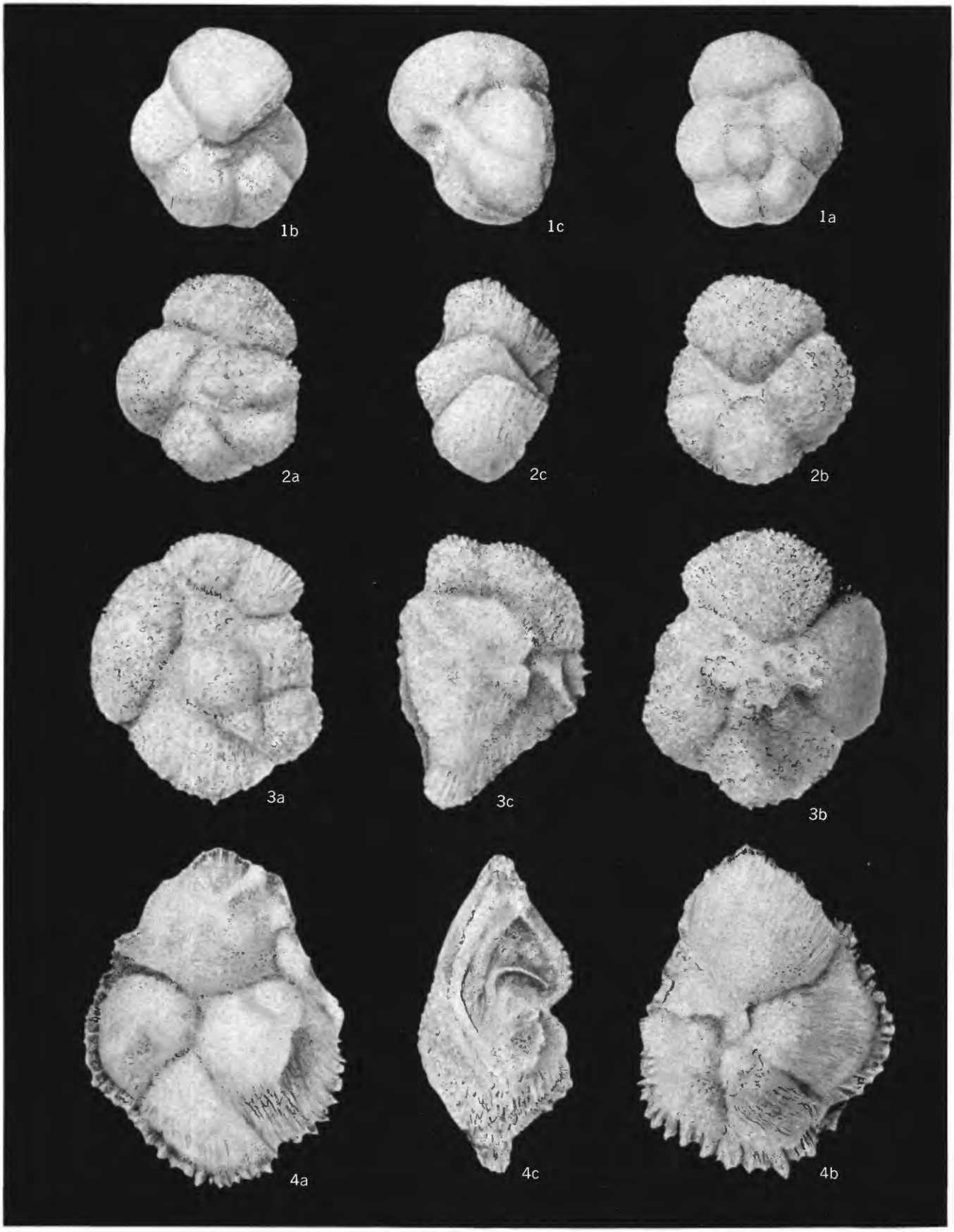

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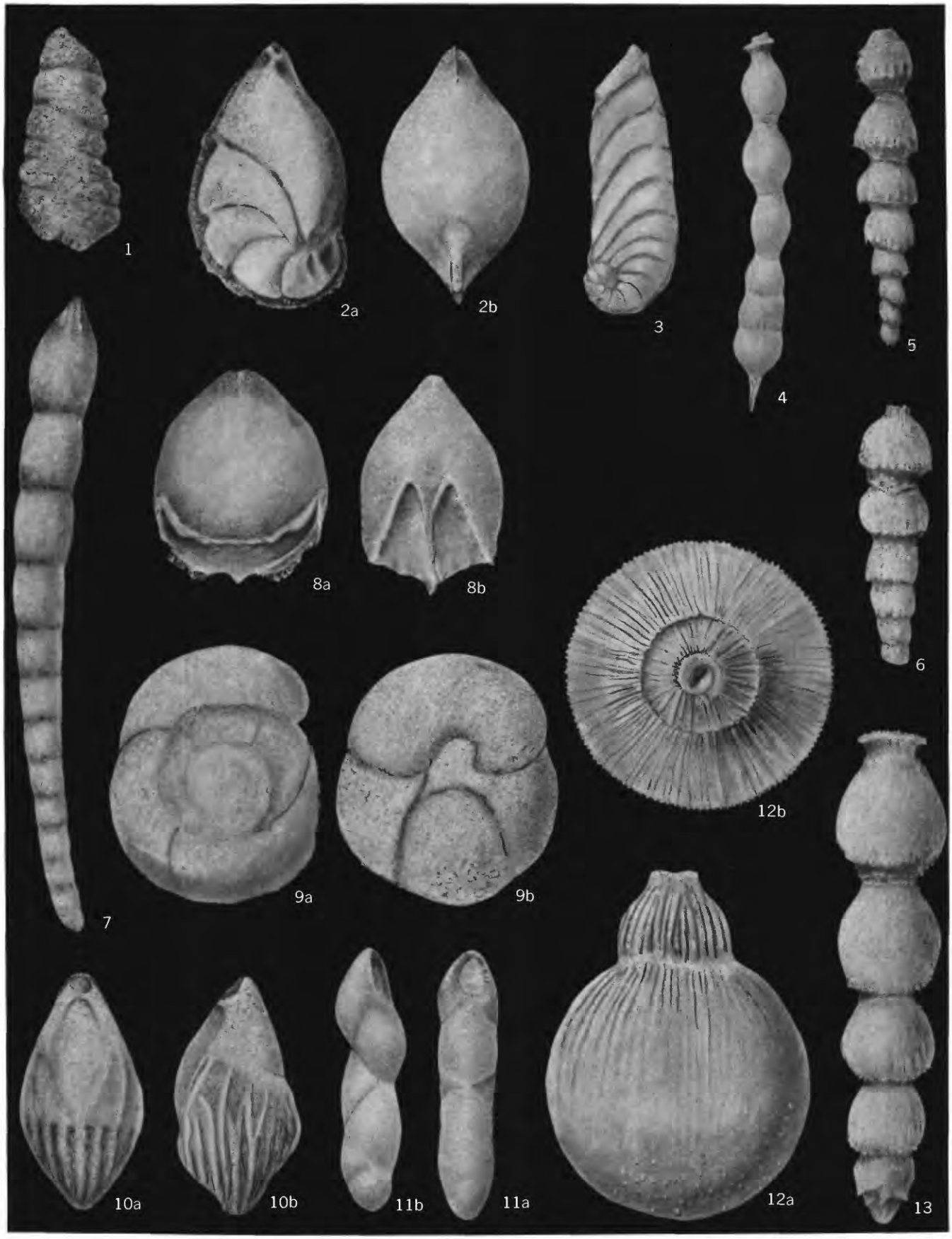

BENTHONIC FORAMINIFERA FROM THE OLIGOCENE OF GUAM

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USNM 642190, × 148.

8. *Bolivina plicatella mera* Cushman and Ponton (p. I 24).
USNM 642191, × 148.

9. *Bolivina* cf. *B. minutissima* Spandel (p. I 24).
USNM 642189, × 148.

10. *Bolivina rhomboidalis* (Millett) (p. I 24).
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USNM 642196, × 148.

12. *Bolivina* aff. *B. tricosta* Cushman and Bermudez (p. I 25).
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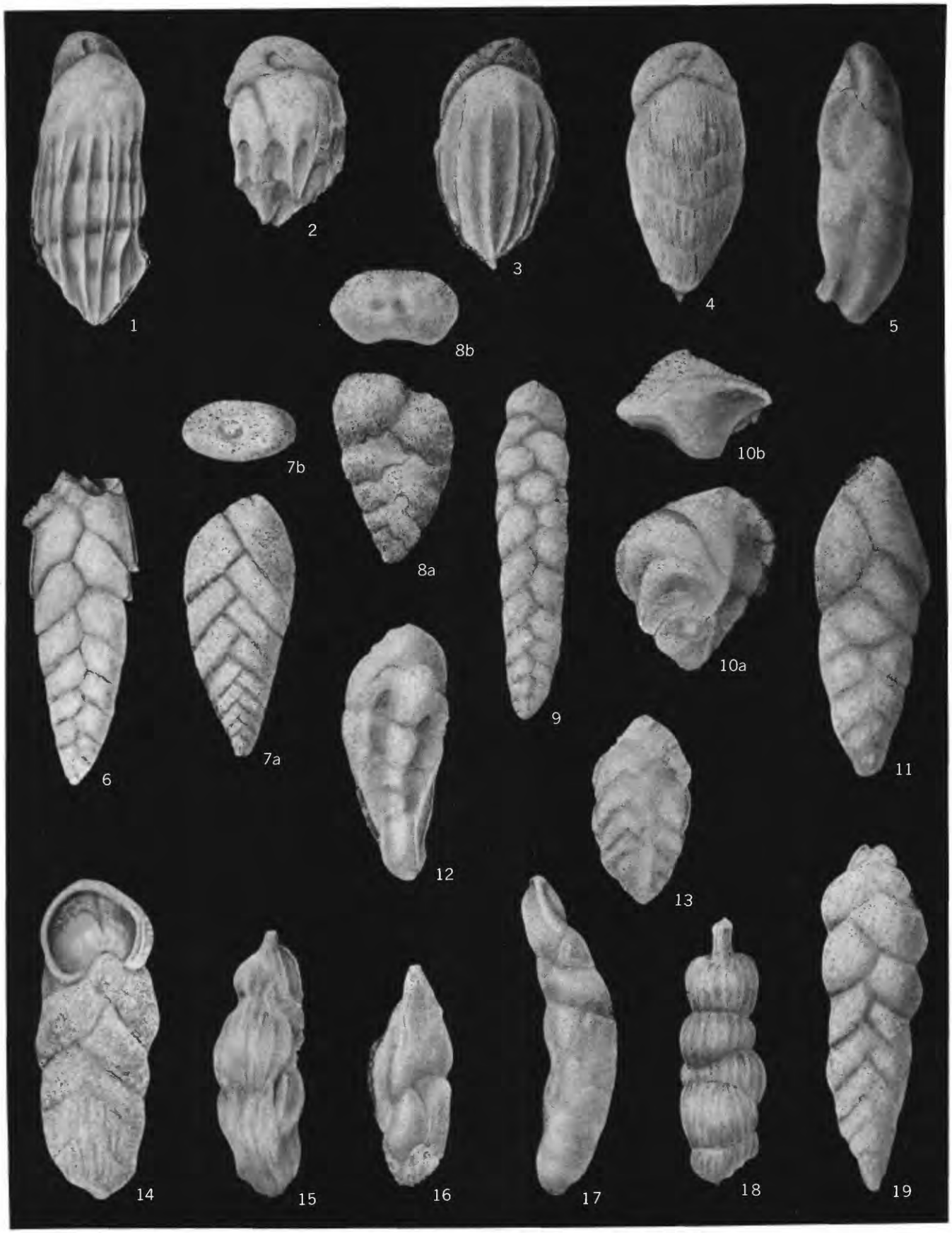

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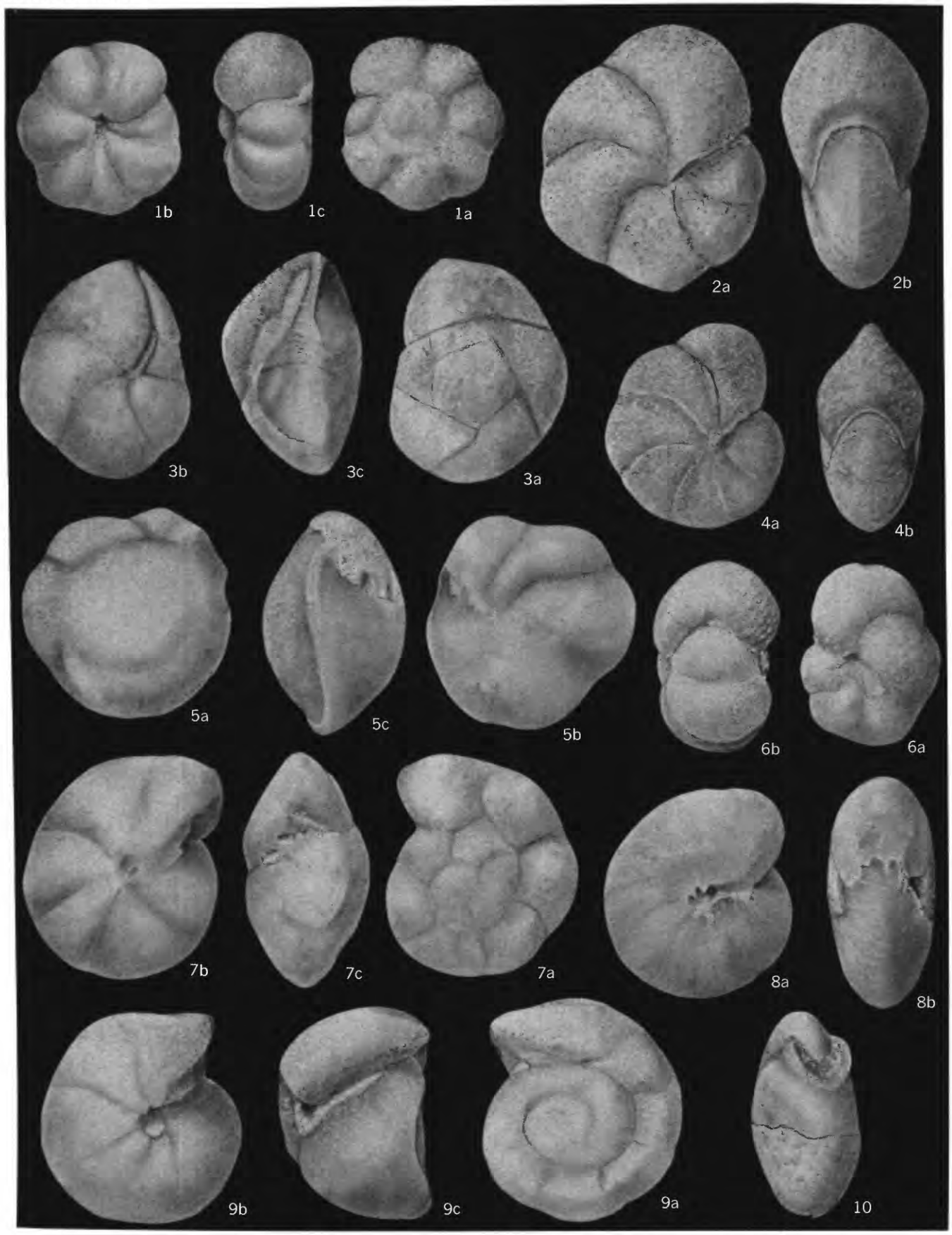
10. *Chilostomella cyclostoma* Rzehak (p. I 26).
USNM 642212, × 27; USGS f25813 (Hi 6–1).



BENTHONIC FORAMINIFERA FROM THE OLIGOCENE OF GUAM

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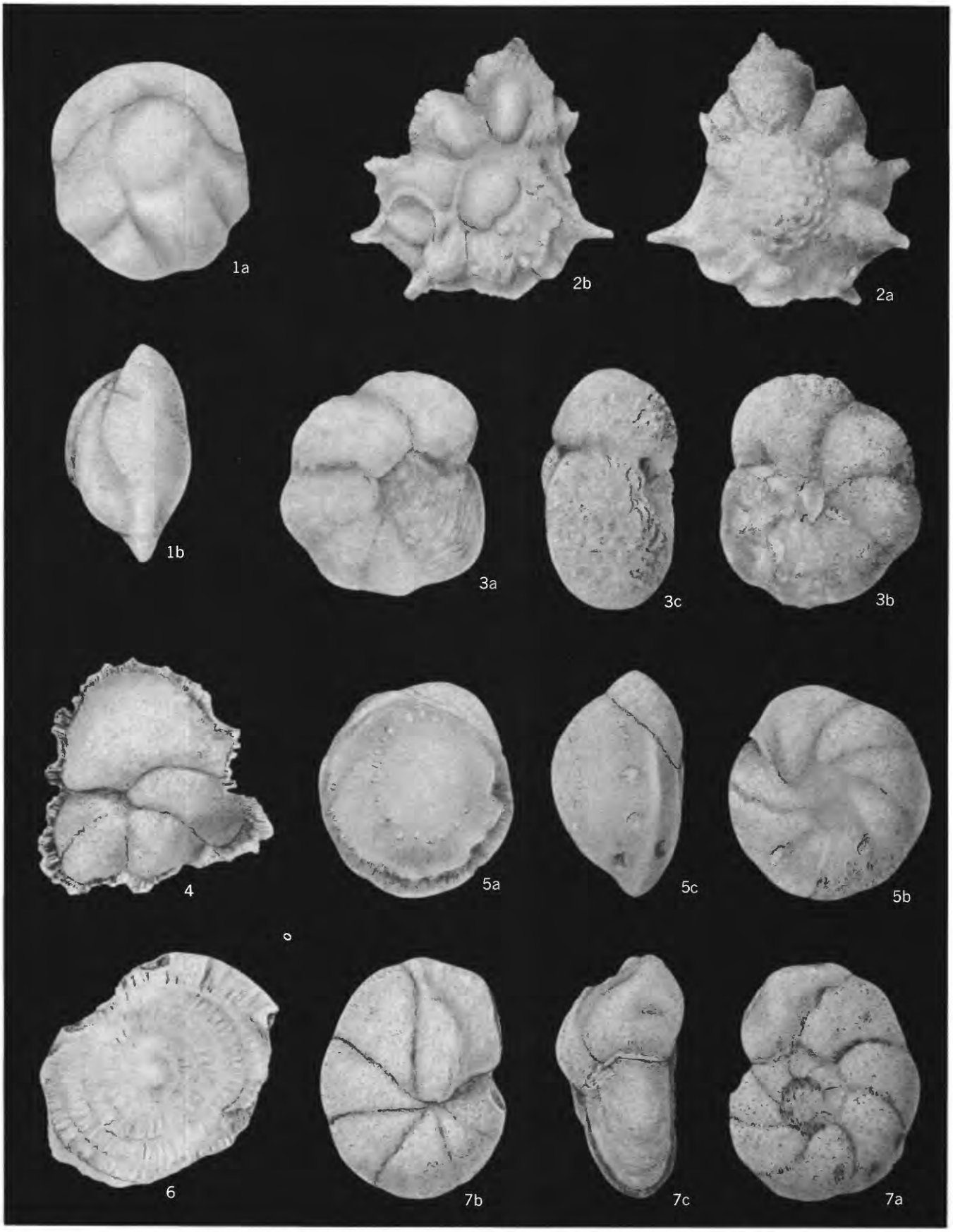

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8. *Hantkenina inflata,* Howe (p. I 34).
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9. *Globigerina yeguaensis* Weinzierl and Applin (p. I 33).
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PLANKTONIC FORAMINIFERA FROM THE OLIGOCENE OF GUAM

PLATE 9

[*a*, Dorsal view; *b*, ventral view; *c*, edge view]

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2. *Globigerina sulcri* (Bolli) (p. I 33). USNM 642227, × 148; USGS f25813 (Hi 6–1).

3, 4. *Globigerina opima nana* (Bolli) (p. I 33).

3. USNM 642245, × 112; USGS f25815 (Gj 13–1).

4. USNM 642226, × 112; USGS f25813 (Hi 6–1).

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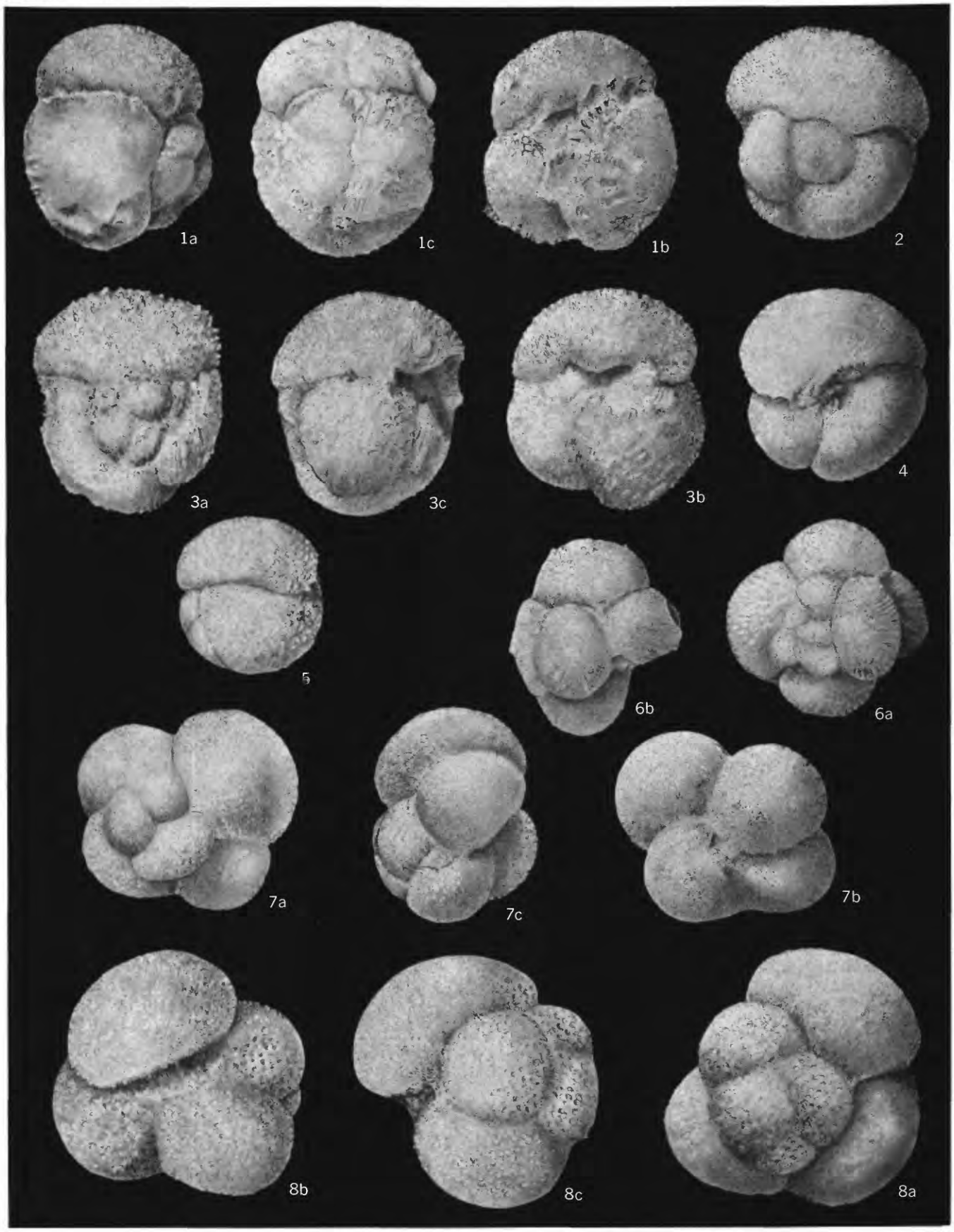
3. USNM 642246, × 56; USGS f25815 (Gj 13–1); *a*, dorsal view; *b*, ventral view; *c*, edge view.
4. USNM 642252, × 56; USGS f25816 (Gj 14–1); ventral view.
5. USNM 642253, × 56; USGS f25816 (Gj 14–1); edge view.

6–8. *Globigerina gortanii* (Borsetti) (p. I 33).

6. USNM 642235, × 66; USGS f25814 (Gj 11–1); *a*, dorsal view; *b*, edge view.
7. USNM 642223, × 112; USGS f25813 (Hi 6–1); *a*, dorsal view; *b*, ventral view; *c*, edge view.
8. USNM 642224, × 88; USGS f25813 (Hi 6–1); *a*, dorsal view; *b*, ventral view; *c*, edge view.



SPECIES OF *GLOBIGERINA* FROM THE OLIGOCENE OF GUAM

PLATE 11

[*a*, Dorsal view; *b*, ventral view; *c*, edge view]

FIGURE 1. *Globigerina increbescens* Bandy (p. I 33).
USNM 642225, × 88; USGS f25813 (Hi 6–1).

2. *Globigerina senilis* Bandy (p. I 33).
USNM 642247, × 88; USGS f25815 (Gj 13–1).

3. *Globigerina tripartita tapuriensis* Blow and Banner (p. I 33).
USNM 642248, × 56; USGS f25815 (Gj 13–1).

4. *Globigerinoides trilobus* (Reuss)? (p. I 33).
USNM 642230, × 93; USGS f25813 (Hi 6–1).

PLANKTONIC FORAMINIFERA FROM THE OLIGOCENE OF GUAM

PLATE 12

FIGURE 1. *Dentalina communis* d'Orbigny (p. I 26).
USNM 642254, × 44; USGS f25805 (Rr 15–1).

2. *Orthomorphina fijiensis* (Cushman) (p. I 29).
USNM 642255, × 88; USGS f25805 (Rr 15–1).

3. *Stilostomella verneuili* (d'Orbigny) (p. I 31).
USNM 642258, × 88; USGS f25805 (Rr 15–1).

4. *Orthomorphina parvula* Todd, n. sp. (p. I 29).
Holotype, USNM 642256, × 148; USGS f25805 (Rr 15–1).

5. *Orthomorphina perversa* (Schwager) (p. I 29).
USNM 642257, × 56; USGS f25805 (Rr 15–1).

6. *Nodosaria equisetiformis* Schwager (p. I 29).
USNM 642296, × 56; USGS f25809 (Ts 5–6).

7. *Dentalina* sp. A (p. I 26).
USNM 642298, × 44; USGS f25808 (Ts 5–7).

8. *Karreriella bradyi* (Cushman) (p. I 28).
USNM 642259, × 44; USGS f25805 (Rr 15–1).

9. *Fissurina circulum* Seguenza (p. I 27).
USNM 642260, × 88; USGS f25805 (Rr 15–1); *a*, front view; *b*, top view.

10. *Fissurina formosa* (Schwager) (p. I 27).
USNM 642261, × 88; USGS f25805 (Rr 15–1).

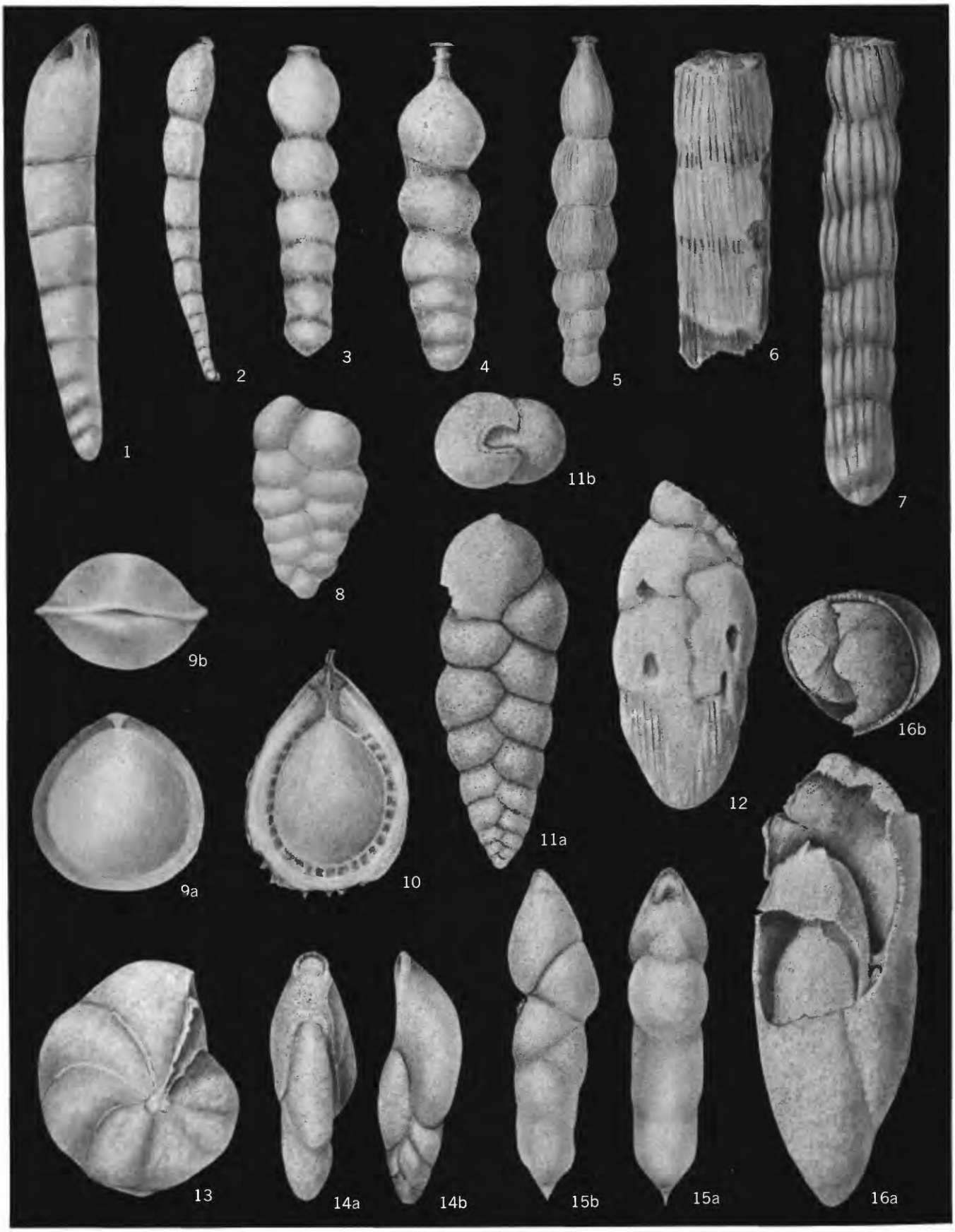
11. *Bolivina silvestrina* Cushman (p. I 24).
USNM 642262, × 88; USGS f25805 (Rr 15–1); *a*, front view; *b*, top view.

12. *Bolivina* aff. *B. sinuata* Galloway and Wissler (p. I 24).
USNM 642263, × 88; USGS f25805 (Rr 15–1).

13. *Astrononion novozealandicum* Cushman and Edwards (p. I 24).
USNM 642268, × 112; USGS f25805 (Rr 15–1).

14, 15. *Pleurostomella alternans* Schwager (p. I 29).
14. USNM 642264, × 88; USGS f25805 (Rr 15–1); *a*, front view; *b*, side view.
15. USNM 642265, × 88; USGS f25805 (Rr 15–1); *a*, front view; *b*, side view.

16. *Ellipsopleurostomella* sp. (p. I 27).
USNM 642266, × 88; USGS f25805 (Rr 15–1); *a*, side view; *b*, top view.



BENTHONIC FORAMINIFERA FROM THE MIOCENE OF GUAM

PLATE 13

FIGURE 1. *Cassidulina sagamiensis* Asano and Nakamura (p. I 25).
USNM 642300, × 112; USGS f25807 (Ts 5–10); *a*, front view; *b*, edge view.

2. *Cassidulina* aff. *C. angulosa* Cushman (p. I 25).
USNM 642271, × 140; USGS f25805 (Rr 15–1); *a*, front view; *b*, edge view.

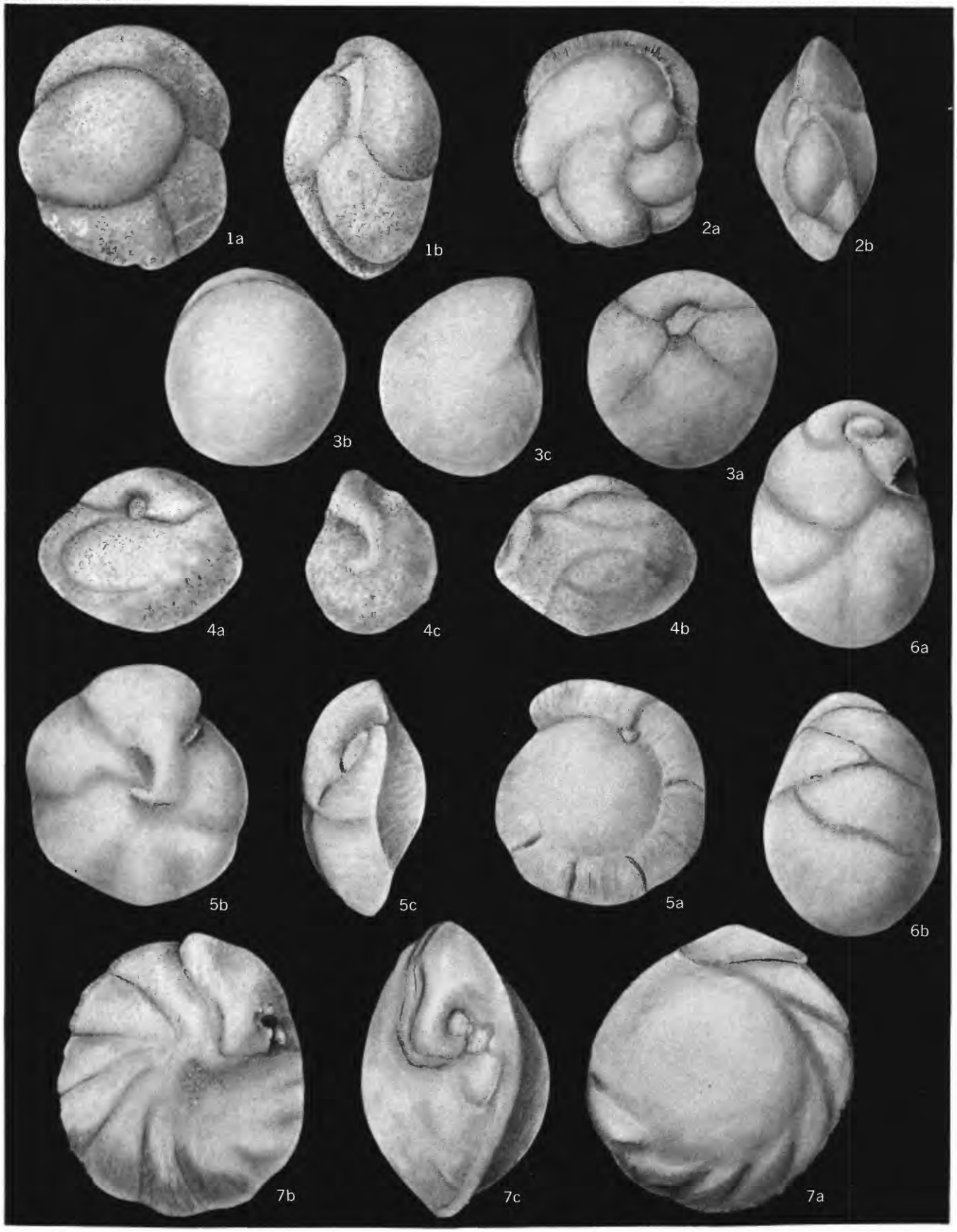
3. *Cassidulina subglobosa* Brady (p. I 25).
USNM 642273, × 66; USGS f25805 (Rr 15–1); *a*, front view; *b*, rear view; *c*, edge view.

4. *Cassidulina carandelli* Colom (p. I 25).
USNM 642299, × 112; USGS f25807 (Ts 5–10); *a*, front view; *b*, rear view; *c*, end view.

5. *Oridorsalis umbonatus* (Reuss) (p. I 29).
USNM 642270, × 88; USGS f25805 (Rr 15–1); *a*, dorsal view; *b*, ventral view; *c*, edge view.

6. *Cassidulina pacifica* Cushman (p. I 25).
USNM 642272, × 88; USGS f25805 (Rr 15–1); *a*, front view; *b*, rear view.

7. *Osangularia culter* (Parker and Jones) (p. I 29).
USNM 642269, × 44; USGS f25805 (Rr 15–1); *a*, dorsal view; *b*, ventral view; *c*, edge view.



CASSIDULINIDAE AND ROTALIIDAE FROM THE MIOCENE OF GUAM

PLATE 14

[All specimens from USGS f25805 (Rr 15-1)]

FIGURE 1. *Globigerina conglomerata* Schwager (p. I 33).
USNM 642278, × 56; *a*, dorsal view; *b*, ventral view; *c*, edge view.

2. *Globoquadrina altispira* (Cushman and Jarvis) (p. I 33).
USNM 642281, × 56; *a*, dorsal view; *b*, side view.

3. *Globigerinoides sacculifer* (Brady) (p. I 33).
USNM 642280, × 44; *a*, dorsal view; *b*, ventral view; *c*, edge view.

4. *Globigerinoides conglobatus* (Brady) (p. I 33).
USNM 642279, × 44.

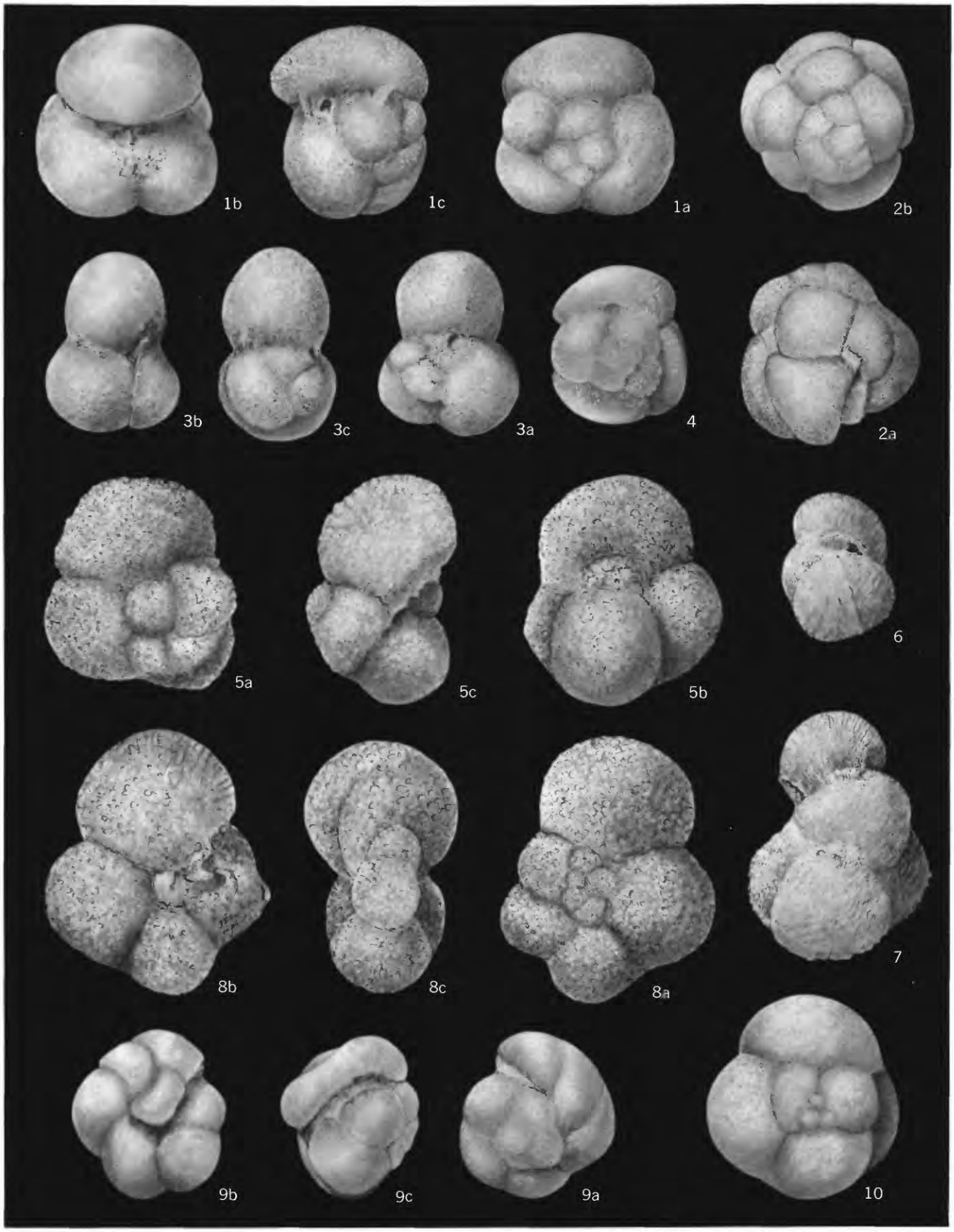
5. *Globigerina* aff. *G. apertura* Cushman (p. I 33).
USNM 642274, × 148; *a*, dorsal view; *b*, ventral view; *c*, edge view.

6, 7. *Globigerina nepenthes* Todd (p. I 33).
6. Immature individual, USNM 642277, × 88.
7. Adult, USNM 642276, × 88.

8. *Globigerina hexagona* Natland (p. I 33).
USNM 642275, × 148; *a*, dorsal view; *b*, ventral view; *c*, edge view.

9. *Pulleniatina obliquiloculata* (Parker and Jones) (p. I 34).
USNM 642285, × 56; *a*, dorsal view; *b*, ventral view; *c*, edge view.

10. *Candeina nitida* d'Orbigny (p. I 33).
USNM 642286, × 148.



PLANKTONIC FORAMINIFERA FROM THE MIOCENE OF GUAM

PLATE 15

[All specimens from USGS f25805 (Rr 15-1); *a*, dorsal view; *b*, ventral view; *c*, edge view]

FIGURES 1, 4. *Orbulina suturalis* Bronnimann (p. I 34).
1. USNM 642283, × 88.
4. USNM 642282, × 56.

2. *Ehrenbergina albatrossi* Cushman (p. I 27).
USNM 642267, × 56.

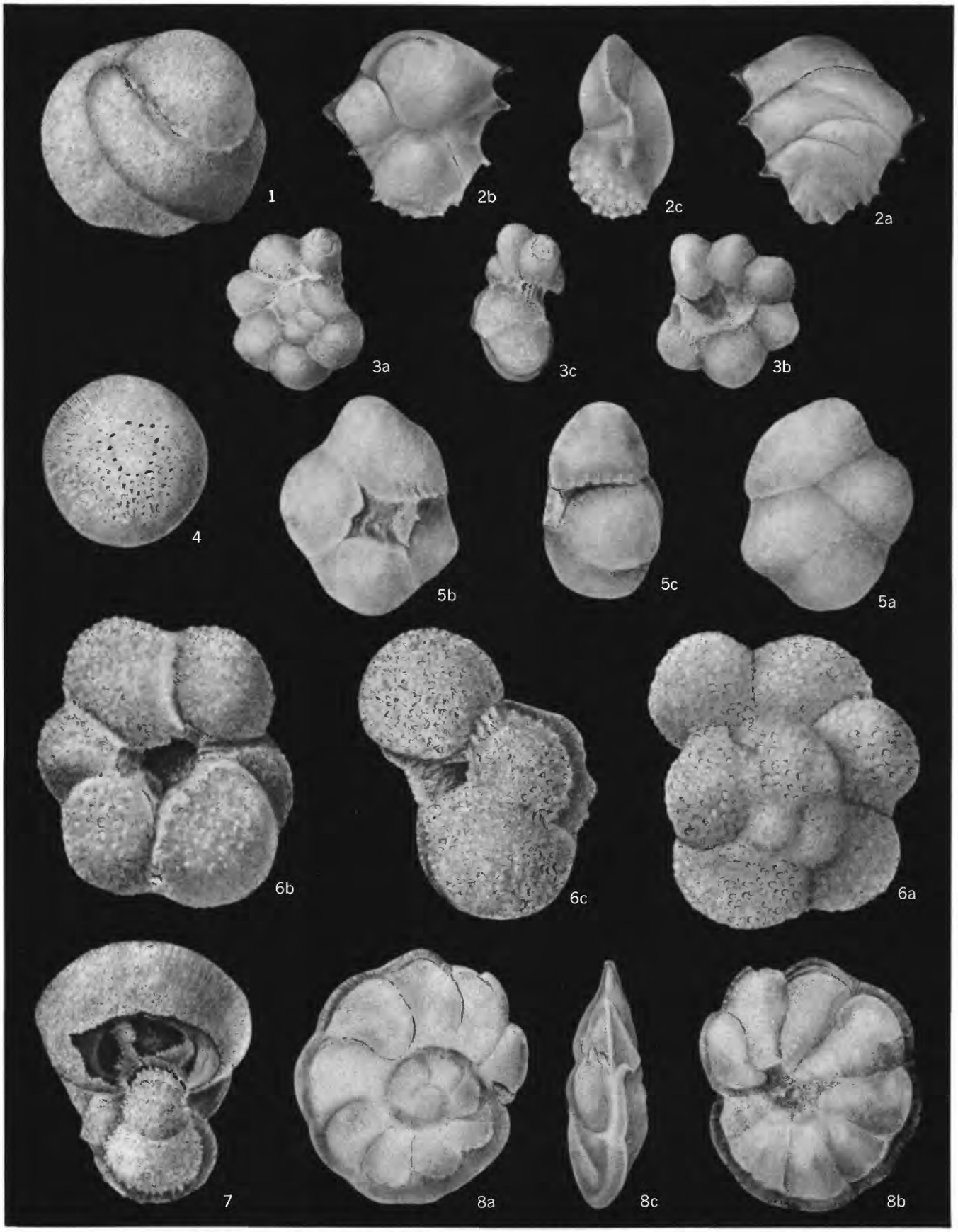
3. *Sphaeroidinella kochi* (Caudri) (p. I 34).
USNM 642288, × 27.

5. *Sphaeroidinella seminulina* (Schwager) (p. I 34).
USNM 642289, × 56.

6. *Sphaeroidinella disjuncta* Finlay (p. I 34).
USNM 642287, × 88.

7. *Hastigerina pelagica* (d'Orbigny) (p. I 34).
USNM 642284, × 88.

8. *Globorotalia menardii fijiensis* Cushman (p. I 33).
USNM 642290, × 56.



CASSIDULINIDAE, GLOBIGERINIDAE, AND GLOBOROTALIIDAE FROM THE MIOCENE OF GUAM

PLATE 16

[*a*, Dorsal view; *b*, ventral view; *c*, edge view]

FIGURE 1. *Globorotalia menardii-tumida* transition form (p. I 33).
USNM 642292, × 44; USGS f25805 (Rr 15–1).

2. *Globorotalia hirsuta* (d'Orbigny) (p. I 33).
USNM 642295, × 56; USGS f25805 (Rr 15–1).

3. *Globorotalia menardii ungulata* Bermudez (p. I 33).
USNM 642291, × 180; USGS f25805 (Rr 15–1).

4. *Globorotalia tumida* (Brady) (p. I 33).
USNM 642297, × 56; USGS f25809 (Ts 5–6).

5. *Globorotalia fohsi robusta* Bolli (p. I 33).
USNM 642294, × 88; USGS f25805 (Rr 15–1).

6. *Globorotalia tumida flexuosa* (Koch) (p. I 33).
USNM 642293, × 44; USGS f25805 (Rr 15–1).

SPECIES OF *GLOBOROTALIA* FROM THE MIOCENE OF GUAM

PLATE 17

[*a*, Side view; *b*, apertural view]

FIGURE 1. *Saçenina frondescens* (Brady) (slender threads) and *Placopsilina*? sp. (arenaceous tubes) attached to a fragmentary specimen of *Cycloclypeus carpenteri* Brady (p. I 26, I 29, and I 31).
USNM 642328, × 10; USGS f25791 (Guam 664).

2. *Nubeculina divaricata advena* Cushman (p. I 29).
USNM 642303, × 27; USGS f25748 (Guam 468).

3. *Clavulina difformis* Brady (p. I 26).
USNM 642302, × 27; USGS f25744 (Guam 450).

4. *Quinqueloculina poeyana* d'Orbigny (p. I 30).
USNM 642307, × 112; USGS f25754 (Guam 524).

5. *Flintina bradyana* Cushman (p. I 27).
USNM 642308, × 44; USGS f25754 (Guam 524).

6. *Quinqueloculina subcuneata* Cushman (p. I 30).
USNM 642301, × 66; USGS f25740 (Guam 348).

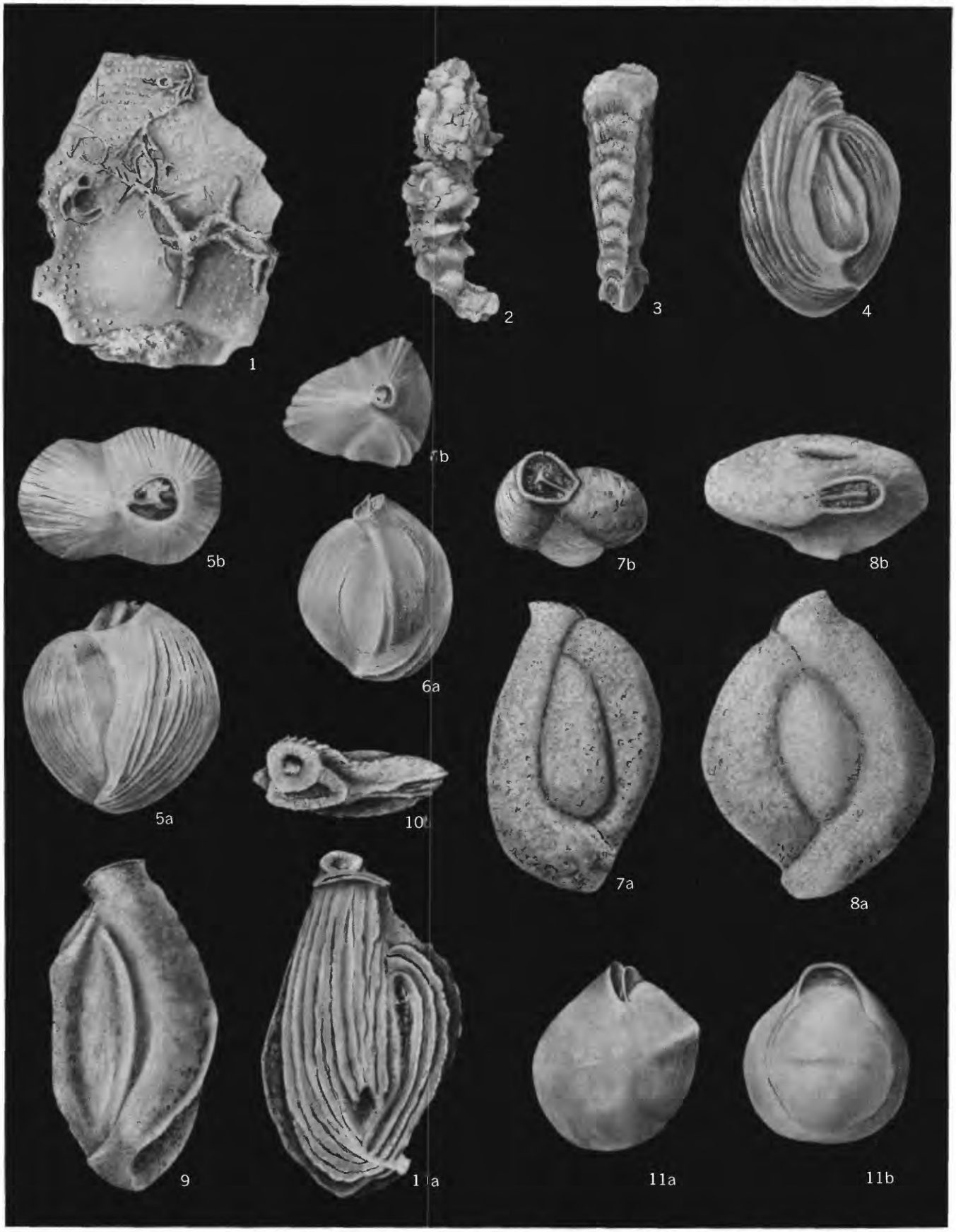
7. *Triloculina subgranulata* Cushman (p. I 32).
USNM 642304, × 56; USGS f25749 (Guam 470).

8. *Quinqueloculina agglutinans* d'Orbigny (p. I 30).
USNM 642310, × 56; USGS f25765 (Guam 551).

9. *Quinqueloculina bosciana* d'Orbigny (p. I 30).
USNM 642311, × 112; USGS f25768 (Guam 556).

10. *Articulina* sp. (p. I 24).
USNM 642321, × 88; USGS f25790 (Guam 663).

11. *Biloculinella globula* (Bornemann) (p. I 24).
USNM 642315, × 56; USGS f25789 (Guam 662).



HYPERAMMINIDAE, PLACOPSILINIDAE, VALVULINIDAE, AND MILIOLIDAE FROM RECENT SEDIMENTS AROUND GUAM

PLATE 18

FIGURE 1. *Robulus orbicularis* (d'Orbigny) (p. I 30).
USNM 642316, × 56; USGS f25789 (Guam 662); *a*, side view; *b*, edge view.

2. *Frondicularia robusta* Brady var. *repanda* Cushman (p. I 27).
USNM 642329, × 27; USGS f25791 (Guam 664).

3. *Darbyella* sp. (p. I 26).
USNM 642322, × 34; USGS f25790 (Guam 663); *a*, side view; *b*, edge view showing slit aperture.

4. *Nodosaria calomorpha* Reuss (p. I 28).
USNM 642323, × 66; USGS f25790 (Guam 663).

5. *Astacolus planulatus* Galloway and Wissler (p. I 24).
USNM 642317, × 27; USGS f25789 (Guam 662); *a*, side view; *b*, edge view.

6. *Reussella pulchra* Cushman (p. I 30).
USNM 642331, × 88; USGS f25791 (Guam 664).

7. *Astacolus bradyi* (Cushman) (p. I 24).
USNM 642320, × 44; USGS f25789 (Guam 662); *a*, side view; *b*, edge view.

8. *Bolivina hantkeniana* Brady (p. I 24).
USNM 642330, × 56; USGS f25791 (Guam 664); *a*, side view; *b*, edge view.

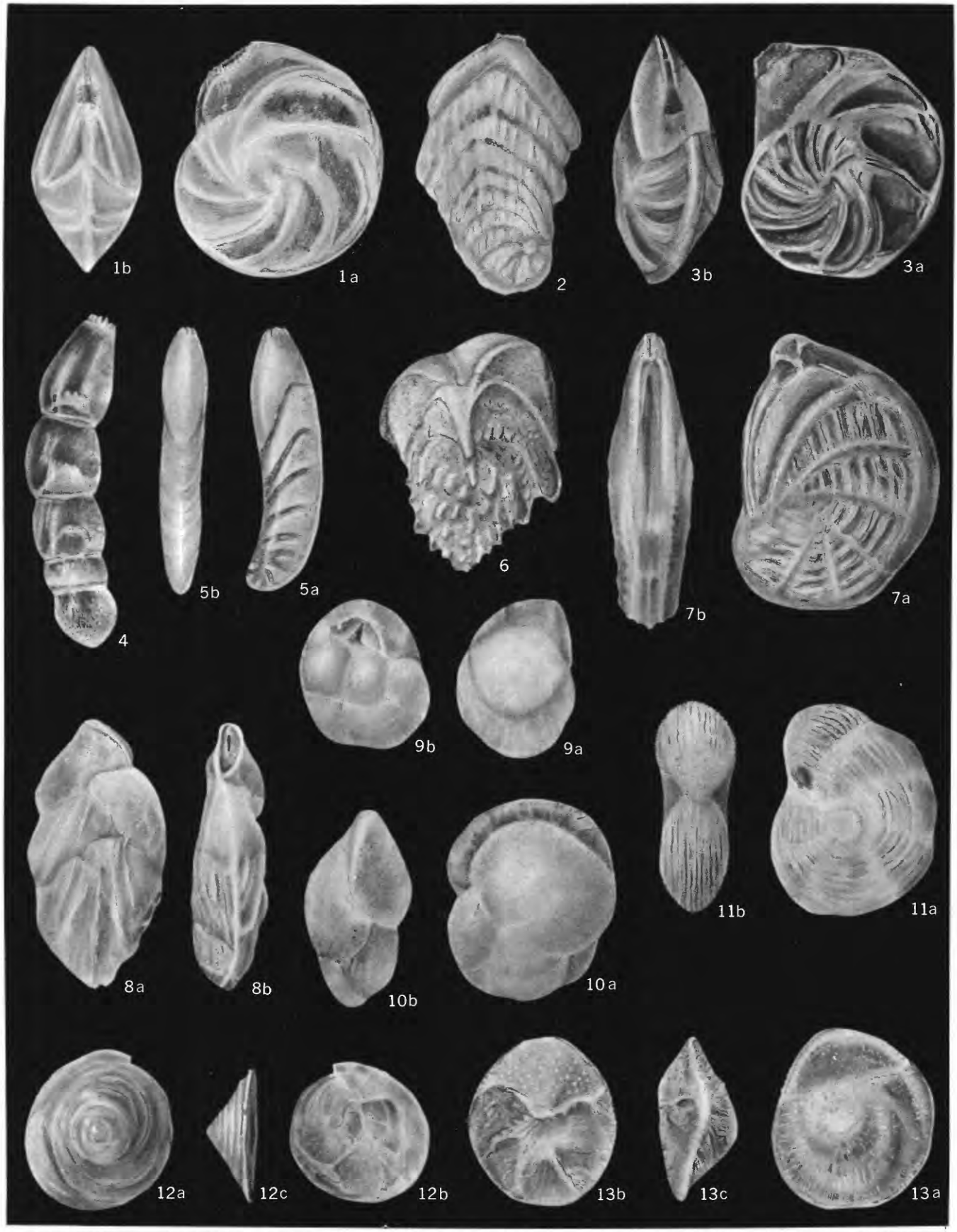
9. *Cassidulina minuta* Cushman (p. I 25).
USNM 642327, × 112; USGS f25790 (Guam 663); *a*, apertural view; *b*, edge view.

10. *Cassidulina delicata* Cushman (p. I 25).
USNM 642326, × 148; USGS f25790 (Guam 663); *a*, apertural view; *b*, edge view.

11. *Elphidium hyalocostatum* Todd (p. I 27).
USNM 642305, × 88; USGS f25750 (Guam 472); *a*, side view; *b*, edge view.

12. *Neoconorbina crustata* (Cushman) (p. I 28).
USNM 642324, × 66; USGS f25790 (Guam 663); *a*, dorsal view; *b*, ventral view; *c*, edge view.

13. *Rotorbinella mira* (Cushman) (p. I 31).
USNM 642313, × 44; USGS f25781 (Guam 615), *a*, dorsal view; *b*, ventral view; *c*, edge view.



LAGENIDAE, BULIMINIDAE, ELPHIDIIDAE, DISCORBIDAE, AND CASSIDULINIDAE FROM RECENT SEDIMENTS AROUND GUAM

PLATE 19

[*a*, Dorsal view; *b*, ventral view; *c*, edge view]

FIGURE 1. *Pegidia dubia* (d'Orbigny) (p. I 29).
USNM 642319, × 32; USGS f25789 (Guam 662).

2. *Cancris sagra* (d'Orbigny) (p. I 25).
USNM 642309, × 88; USGS f25757 (Guam 537).

3. *Bronnimannia haliotis* (Heron-Allen and Earland) (p. I 25).
USNM 642314, × 88; USGS f25788 (Guam 661).

4. *Baggina totomiensis* Makiyama (p. I 24).
USNM 642332, × 44; USGS f25791 (Guam 664).

5. *Eponides repandus* (Fichtel and Moll) (p. I 27).
USNM 642312, × 27; USGS f25779 (Guam 610A).

6. *Streblus beccarii* var. of Todd 1957 (p. I 32).
USNM 642306, × 88; USGS f25752 (Guam 510).

7. *Stomatorbina concentrica* (Parker and Jones) (p. I 31).
USNM 642325, × 56; USGS f25790 (Guam 663).

8. *Anomalina coronata* Parker and Jones (p. I 24).
USNM 642318, × 44; USGS f25789 (Guam 662).

PEGIDIIDAE, ROTALIIDAE, AND ANOMALINIDAE FROM RECENT SEDIMENTS AROUND GUAM

Geology and Hydrology of Guam, Mariana Islands

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UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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[Letters designate the separately published chapters]