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Smaller Foraminifera from Miyako-jima, Ryukyu

Tunyow Huang

ABSTRACT

The Foraminifera from the so-called Shimajiri Formation of Miyako-jima has been classified into 28 families, 62 genera, and 128 species and subspecies. In general, the Miyako foraminiferal assemblage is a deep-water fauna of the outer shelf area. The sampled formation is judged to be Pliocene in age from the planktonic Foraminifera. All the foraminifers were collected from beds stratigraphically below those exposed on Kikai-jima.

The population of benthonic Foraminifera shows some affinity with the fauna from the Sômachi Formation of Kikai-jima, Japan and with the fauna from the younger Tertiary formations in southern Taiwan (Huang, 1960) and the eastern coastal range of Taiwan (Huang, 1964).

The planktonic foraminiferal fauna is correlative with the Nobori fauna of Shikoku, Japan.

The Yonahama fauna appears to be referable to Banner and Blow's Zone N. 20, and the Nagama is correlated with basal Zone N. 21, based on the simultaneous appearance of *Globorotalia tosaensis*. Thus, the formation on Miyako-jima in this study is considered to be older than the Sômachi Formation of Kikai-jima, Japan (Huang, 1966).

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INTRODUCTION

In this paper, the 128 species and subspecies of smaller Foraminifera recorded and illustrated are from the later Tertiary deposits of Miyako-jima. Miyako-jima is the largest island of the Miyako Group, and is situated in Lat. 24°55'-24°42.6'N. and Long. 125°29'–125°10.1'E., about 360 km east of Taipei, Taiwan, and 240 km southwest of Naha, Okinawa (Fig. 1).

The rock samples used for foraminiferal analysis were collected by Prof. Kiyoshi

Asano during his reconnaissance survey of Miyako-jima late in 1965. The collections were made at three localities in the township of Gusukube Town on the east coast of Miyako-jima.

So far as is known, only a few papers have been published on the smaller Foraminifera of the Ryukyu Islands and this is the first on the foraminiferal fauna from the so-called Shimajiri Formation of Miyako-jima. It is hoped that this contribution will aid in a more satisfactory correlation of the so-called Shimajiri Formation with those on the islands of the southwestern Pacific region.

ACKNOWLEDGEMENTS

The writer expresses his gratitude to Prof. Kiyoshi Asano of the Institute of Geology and Paleontology, Tohoku University, Japan for permission to study some of his collections from Miyako-jima and for his kind guidance and advice; to Prof. Kotora Hatai of the same Institute for reading the manuscript and for his encouragement; to Dr. Yokichi Takayanagi of the same Institute for his kind gift of a foraminiferous sample from the type locality of the Nobori Formation.

Acknowledgement is also made to the Japan Society for the Promotion of Science as part of the Japan-U.S. Cooperative Science Program for partial financial support for this investigation.

METHODS

Two hundred grams of the rock sample was used for the maceration treatment. After maceration, the sample was washed using a 200 mesh standard sieve. The foraminiferal specimens were picked out from the residue remaining on the screen and subjected to study.

STRATIGRAPHY

According to Hanzawa (1935), Miyako-jima consists almost entirely of younger limestone. The bluish-gray mudstone and/or siltstone intermittently cropping out along the base of the sea cliff on the east coast of the island is the oldest of the strata so far as is exposed. The strata with the strike varying from NW-SE to N-S and a westward dip at angles 7°–20°, is equivalent to the Shimajiri Formation of Okinawa according to Hanzawa's (1935) observation. The younger limestone mentioned above overlies with unconformity on the bluish-gray mudstone just mentioned.

FAUNA

The foraminifers were obtained from the bluish-gray mudstone and/or siltstone intermittently cropping out along the base of the sea cliff at Yonahama, or at Nagama and Minehara.

The localities of the samples are shown in Fig. 1, and their position in the local stratigraphic sequence in Fig. 2. The foraminiferal fauna is arranged alphabetically in Table 1.

The Foraminifera from the three areas are composed of calcareous perforate benthonic and planktonic forms. The classification used in this work is according to the recent publication by Loeblich and Tappan (1964). The fauna is represented by 28 families, 62 genera, and 128 species and subspecies, among which the majority are known from the Recent Indo-Pacific.

The abundant and characteristic genera of the benthonic foraminifers in decreasing

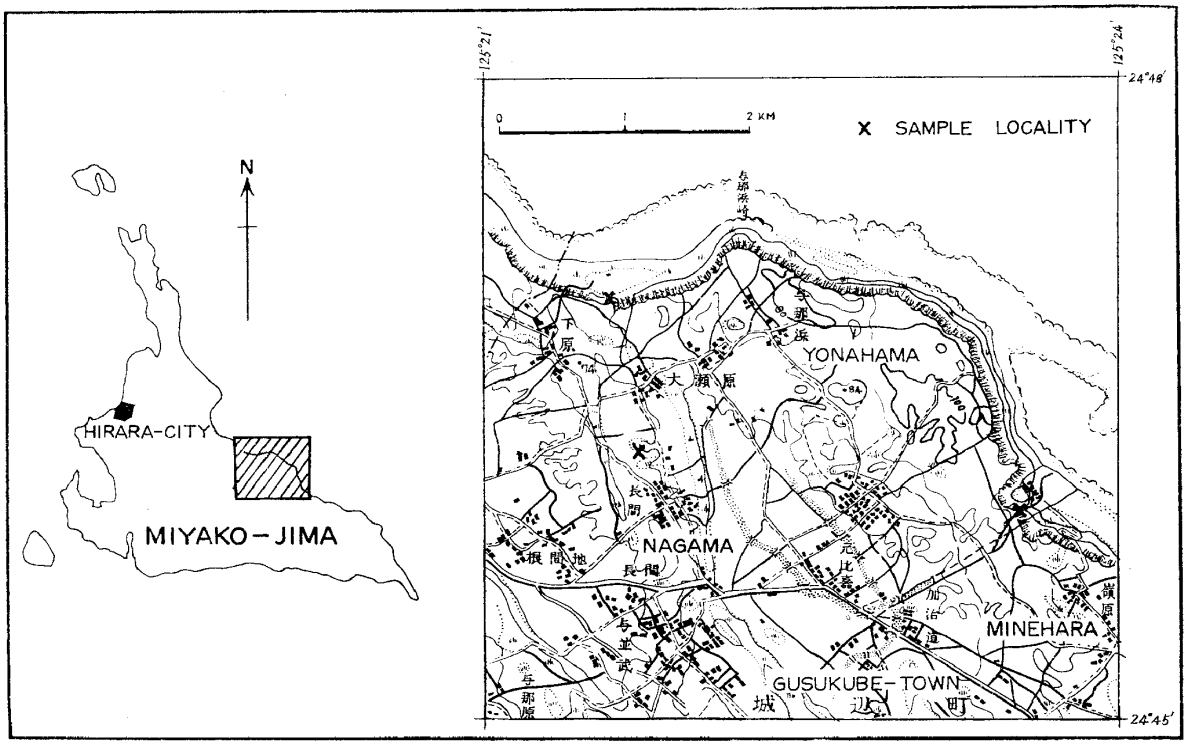

Figure 1. Map showing locations of the area studied, and of the samples.

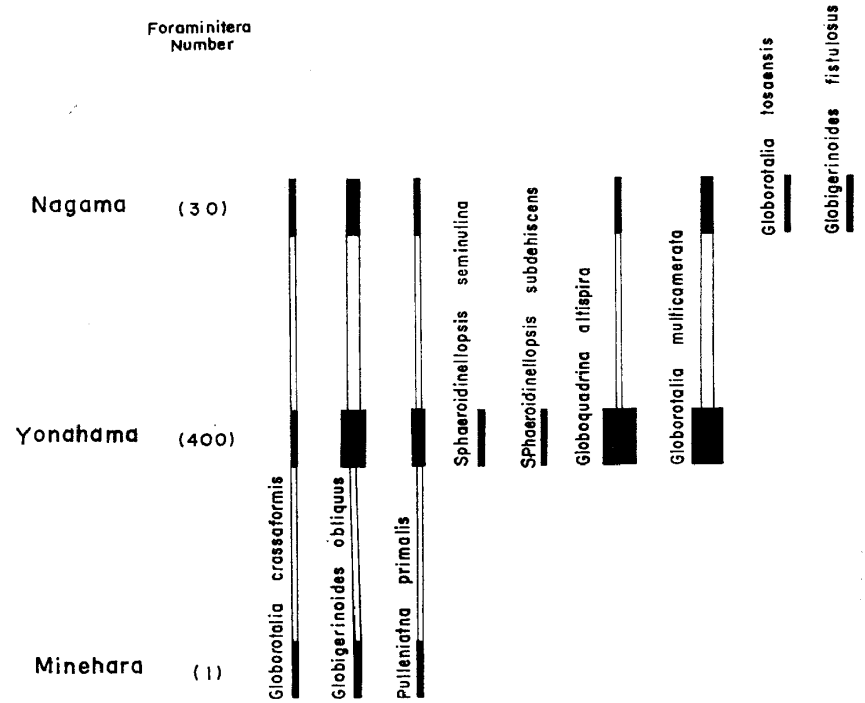

Figure 2. Ranges of some characteristic species and their frequency. The samples are arranged according to their stratigraphic position.

order of abundance, are: *Osangularia, Lenticulina, Nodosaria, Uvigerina, Bulimina,* and *Cibicides.*

There are only a few arenaceous species and individuals in the samples studied. The miliolids are also few in both species and individuals in the samples.

Table 1. Distribution and abundance of the smaller Foraminifera of Miyako-jima. The frequency of the species in a single counting for each sample is expressed, as follows:
Rare (R): 1–2 specimens Few (F): 3–6 specimens
Common (C): 7–16 specimens Abundant (A): 17 and more specimens

Sample	Minehara	Yonahama	Nagama
Planktonic Foraminifera			
Candeina nitida		R	R
Globigerina bulbosa	R		
Globigerina bulloides	R	F	C
Globigerina diplostoma			R
Globigerina falconensis		F	F
Globigerina foliata		R	F
Globigerina riveroae	R		R
Globigerinita glutinata	R	R	R
Globigerinella siphonifera	R	C	R
Globigerinoides conglobatus		R	R
Globigerinoides cyclostomus		C	A
Globigerinoides elongatus		R	R
Globigerinoides fistulosus			R
Globigerinoides obliquus	R	A	A
Globigerinoides ruber		C	A
Globigerinoides sacculifer		A	C
Globigerinoides trilobus	R	A	A
Globoquadrina acostaensis		F	F
Globoquadrina altispira		A	R
Globoquadrina hexagona		R	R
Globoquadrina humerosa	R	A	F
Globoquadrina venezuelana		A	
Globorotalia crassaformis	R	R	F
Globorotalia menardii	R	A	C
Globorotalia multicamerata		A	C
Globorotalia scitula		R	
Globorotalia tosaensis			F
Globorotalia tumida		F	
Orbulina universa		F	C
Pulleniatina obliquiloculata		A	F
Pulleniatina primalis	R	A	F
Sphaeroidinellopsis seminulina		C	
Sphaeroidinellopsis subdehiscens		C	
Benthonic Foraminifera			
Ammonia cf. *beccarii*		R	
Ammonia ketienziensis angulata	R		
Amphicoryna scalaris		R	
Amphicoryna scalaris sagamiensis		C	
Amphistegina madagascariensis			R
Anomalina bradyi			R
Anomalina colligera		R	
Anomalina globulosa		R	
Anomalina sp.		R	
Austrocolomia sp.		R	
Bolivina hantkeniana		R	
Bolivina robusta		R	
Bolivinita quadrilatera		R	
Bulimina marginata		R	
Bulimina nipponica		F	
Bulimina striata		F	
Cassidulina subglobosa		F	R

Table 1. Continued.

Sample	Minehara	Yonahama	Nagama
Cibicides lobatulus		R	
Cibicides pseudoungerianus		C	
Cibicidoides bradyi		F	
Cibicidoides wuellerstorfi		R	
Cribroparrella cf. *regadana*		R	
Dentalina communis		R	
Dentalina emaciata		R	
Dentalina inflexa		R	
Euuvigerina hispida		R	
Euuvigerina laviculata		F	
Euuvigerina peregrina dirupta		F	
Euuvigerina rustica		F	
Fissurina caribaea		R	
Fissurina laevigata		R	
Fissurina soldia		R	
Fissurina sp. *a*		R	
Fissurina sp. *b*		R	
Florilus japonicum	R	R	R
Gaudryina sp.			R
Gyroidina acuta		F	
Gyroidina altispira		F	
Gyoridina broeckhiana		F	
Gyroidina orbicularis		F	
Guttulina pacifica		R	
Hanzawaia nipponica		R	
Hoeglundina elegans		R	
Karreriella bradyi		F	
Lagena acuticosta		R	
Lagena striata		R	
Laticarinina pauperata		F	
Lenticulina cultrata var.		F	
Lenticulina iota		R	
Lenticulina lucida		R	
Lenticulina melvilli		R	
Lenticulina nikobarensis		R	
Lenticulina peregrina		R	
Lenticulina pseudorotulata		R	
Lenticulina sintikuensis		R	
Marginulinopsis perprocera		R	
Martinottiella communis		F	
Melonis affine		F	F
Melonis pompilioides		R	
Nodosaria fusta		R	
Nodosaria insecta		F	
Nodosaria longiscata		F	F
Nodosaria obliqua		R	
Nodosaria spirostriolata		R	
Nummulites ammonoides		R	
Oolina hexagona		R	
Osangularia bengalensis		F	A
Oridorsalis umbonatus		C	
Orthomorphine jedlitschkai		R	
Plectofrondicularia foliacea		R	
Pleurostomella alternans		R	R
Praeglobobulimina spinoscens		R	
Pseudoeponides japonica		F	
Pullenia bulloides		R	
Pullenia quinqueloba		R	

Table 1. Continued.

Sample	Minehara	Yonahama	Nagama
Pullenia salisburyi		R	
Rectobolivina bifrons		R	
Reussella atlantica	R		
Saracenaria arcuata		R	
Sigmoilopsis schlumbergeri		F	R
Siphogenerina multicostata		R	
Siphonaperta horrida		R	
Siphotextularia flintii		F	
Siphouvigerina proboscidea		F	F
Sphaeroidina bulloides		F	F
Spiroplectammina sagittula		R	
Stilostomella ketienziensis		R	R
Stilostomella hirsuta		R	
Stilostomella lepidula		R	R
Stilostomella verneuili		R	R
Stilostomella sp.		R	
Textularia abbreviata		R	
Textularia crassisepta		R	
Tosaia hanzawai		R	
Valvulineria nipponica		F	

In the assemblages of the foraminifers the planktonic forms are so abundant that they mask the benthonic forms (Fig. 3). Ostracodes, molluscan fragments, and other kinds of organic remains are frequent, thus suggesting that the sediments for the most part, are of moderately deep-water facies.

The foraminiferal assemblage from Yonahama is characterized by the abundant benthonic and planktonic forms among which are found some characteristic lower to middle Pliocene planktonic species (Fig. 2).

On the other hand, the Nagama and Minehara foraminiferal assemblages are characterized by their poor fauna in which occur some characteristic Pliocene planktonic species.

Globorotalia inflata and *Sphaeroidinella dehiscens* are known to occur commonly in deposits of Pliocene age, but they were not observed in the so-called Shimajiri Formation samples.

Most of the planktonic foraminifers in the samples appear to be typical warm-temperate water species; they are abundant in the Yonahama sample (Fig. 2). In the stratigraphically next higher sample studied, from Nagama, planktonic forms are rare, and in the lowest sample of Minehara they are also rare. These changes of frequency of planktonic foraminifers are shown in Fig. 2 and Table 1. It is believed that the differences in the foraminiferal fauna are due to their different environmental conditions.

Thus, at least, it can be said that the sedimentary environment of the so-called Shimajiri Formation on Miyako-jima was deeper in the Yonahama area than in the stratigraphically higher horizon of Nagama and lower horizon of Minehara.

ECOLOGICAL OBSERVATIONS

Little investigation has been attempted on the paleoecology of the Miyako fauna. Although the samples from Miyako-jima yielded a fairly large number of species, the majority are represented by only few individuals. Only about 30 percent of the total fauna occur as common. The assemblages indicate widely diverging bathymetric environments,

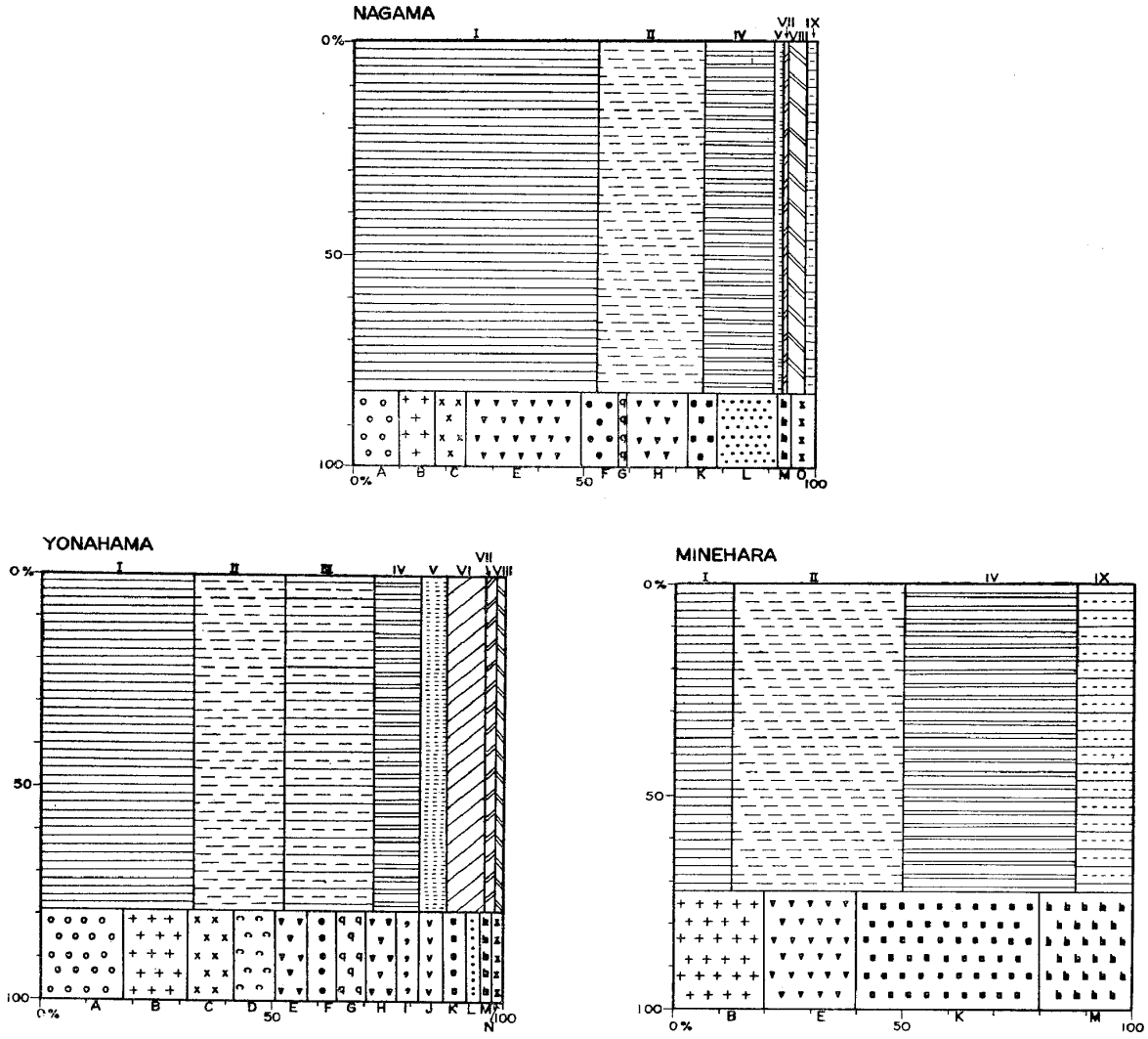

Figure 3. Microfaunal diagram of Minehara, Yonahama, and Nagama. The samples are arranged according to their stratigraphic order, from bottom to top.

I: *Globigerinoides*; II: *Globorotalia*; III: *Globoquadrina*; IV: *Globigerina*; V: *Pulleniatina*; VI: *Sphaeroidnellopsis*; VII: *Globigerinella*; VIII: *Orbulina-Candeina*; IX: *Globigerinita*; A: Osangulariidae; B: Nodosariidae; C: Anomalinidae; D: Alabaminidae; E: Buliminidae; F: Uvigerinidae; G: Ataxophragmiidae; H: Bolivinitidae-Eouvigerinidae-Turrilinidae-Sphaeroidinidae; I: Cibicidae; J: Textulariidae; K: Pleurotomellidae-Cassidulinidae-Nonionidae; L: Discorbidae; M: Rotaliidae-Miliolidae; N: Glandulinidae-Polymorphinidae-Ceratobuliminidae; O: Amphisteginidae-Nummulitidae.

and it is quite possible that some of the foraminifers might have been transported from elsewhere by wave or current actions. Therefore, the ecological picture is somewhat marred by the unknown extent of possible contamination. Some poorly-preserved and broken specimens of *Ammonia beccarii*, *Amphistegina*, and *Nummulites* (*Operculina*) were found in the samples from Yonahama and Nagama. The dominant families in the two assemblages are the Osangulariidae, Nodosariidae, Alabaminidae, Anomalinidae, Buliminidae, and Uvigerinidae in both number of species and individuals. Planktonic forms are well represented in all of the samples.

Although emphasis was given to the benthonic foraminifers the planktonic ones were also considered in studying the paleoecology of the so-called Shimajiri Formation

on Miyako-jima. With concern to the paleoecology the under-mentioned matter may be given.

The presence of keeled *Globorotalia* suggests that this area was influenced by warm surface water (Bandy, 1964) during deposition of the strata that yielded it. The presence of abundant planktonic foraminifers indicates an open sea condition of deposition.

Melonis pompilioides, which according to Cushman (1914), is a common species at the depth of about 1800 fathoms (3294 m) in the North Pacific is also known to occur in shallower water (Cushman, 1914); it occurs in the Yonahama assemblage. *Laticarinina pauperata* is also a deep or cool water species.

The foraminiferal assemblages of Nagama and Minehara suggest an environment of rather shallow water compared with that of Yonahama time.

The frequency of the foraminifers of Yonahama and Nagama are quite different. From the available data it appears that the latter may have had more intimate relation with physical change than the former.

It is inferred from the paleoecology of the fauna from the so-called Shimajiri Formation on Miyako-jima that the sedimentary environment of the formation may be classified into two phases, namely, a deep sea in a stable area during Yonahama time and a shallow sea in an unstable condition during Nagama and Minehara time.

The absence of the Miliolidae and Elphidiidae suggests that the environment was not shallow enough to favor their flourishing.

In general, it can be concluded that the formation is composed of sediments deposited in the neritic to upper bathyal zone of an open sea, under the influence of tropical to subtropical temperatures. Similar ecological conditions have been found on the northern Asiatic shelf by Polski (1959). The fauna of his outer shelf-upper bathyal zone has many species in common with the Miyako fauna.

AGE AND CORRELATION

In studying the chronology of the so-called Shimajiri Formation emphasis was given to the planktonic foraminifera.

In the past few years many interesting papers on zonation of the Upper Miocene and Pliocene of tropical regions have been published by Bandy (1963a, b, and 1964), Banner and Blow (1965, and 1967), Bolli and Bermudez (1965), Bolli (1966a), McTavish (1966), and Parker (1967). Comparing these zonations with the planktonic fauna from the so-called Shimajiri Formation on Miyako-jima, the Miyako fauna is referable to Banner and Blow's Zone N. 20 to basal N. 21, based on the coexistence of *Globoquadrina altispira* and *Globorotalia tosaensis* (Parker, 1967, text-fig. 2, p. 121).

From the results of analysis, a marked change is noticed between the Yonahama assemblage and the Nagama assemblage (Fig. 2, and Table 1). In the Yonahama assemblage *Sphaeroidinellopsis seminulina*, *S. subdehiscens*, and *Globoquadrina altispira* are present, while in the upper assemblages of Nagama, they are absent except for *Gq. altispira*. On the contrary, *Globorotalia tosaensis* is not found in the Yonahama assemblage but it occurs in the Nagama assemblage.

In Nagama, the final occurrence of *Gq. altispira* is found in the same sample showing the first occurrence of *Gr. tosaensis*. *Gq. altispira* is abundant at Yonahama.

Parker (1967) described a few instances of short overlap of *Gr. tosaensis* and *Gq. altispira* in the Pacific-Indian Ocean cores and discussed on the ranges of those two species. A rare and interesting instance of a short overlap of *Gr. tosaensis* and *Gq. altispira* is also found in the Nagama fauna in the western Pacific region. The similar occurrence of the overlaping of those two species was found in the sample A–10 of the Nobori Formation

listed by Takayanagi and Saito (1962).

A sample from the planktonic foraminiferal fauna of the Nobori Formation studied by Takayanagi and Saito in 1962 was kindly sent to the writer at his request, for examination. After a study of the Nobori sample, the writer considers that the Miyako assemblage is correlative with the Nobori assemblage.

The more fossiliferous Sômachi Formation of Kikai-jima, Japan which was studied by the writer in 1966 is proved to be younger than the Miyako planktonic foraminiferal fauna. The typical *Globorotalia truncatulinoides* appears in the Sômachi Formation, but without *Gq. altispira*, *Sphaeroidinellopsis seminulina* and *S. subdehiscens*.

Accordingly, the Sômachi planktonic foraminiferal fauna appears to be referable to Banner and Blow's Zone of the uppermost part of N. 21, or possibly basal N. 22.

From comparisons of the planktonic foraminifers, it is believed that the Yonahama fauna is older than the fauna from the Sômachi Formation on Kikai-jima, Japan and the fauna from the Liuchiuhsu Mudstone of southern Taiwan (Huang, 1960), is equivalent to the one from the Shinzato Member of southern Okinawa (LeRoy, 1964).

If emphasis is laid upon the occurrence of *Globorotalia tosaensis*, the Miyako fauna corresponds with Banner and Blow's Zone N. 20 and/or possibly basal N. 21.

FAUNAL REFERENCE LIST

All of the foraminiferal species from Miyako-jima are listed below in alphabetic order. Most of the planktonic forms and some important and interesting or doubtful and unidentified species of benthonic foraminifers are illustrated.

Of the following 128 species and subspecies of Foraminifera distinguished in the samples, taxonomic notes are given for certain species.

All of the types are deposited at the Paleontology Laboratory, Chinese Petroleum Corporation, Miaoli, Taiwan, China.

Benthonic Species

Ammonia cf. *beccarii* (Linnaeus).
Rotalia cf. *beccarii* (Linnaeus), in Asano, 1951, Ills. Cat. Japan Ter. Smaller Forma., pt. 14, p. 12, figs. 93–95. The specimens presumably were displaced from shallow water.

Ammonia ketienziensis angulata (Kuwano) ..... Pl. 12, figs. 8a-b.
Rotalia ketienziensis angulata Kuwano, 1950, Geol. Soc. Japan, Jour., v. 56, no. 657, p. 312, text-figs. 1a-c. The specimens of this species presumably were displaced from shallow water.

Amphicoryna scalaris (Batsch) ..... Pl. 13, fig. 12.
Nautilus scalaris Batsch, 1791, Conch. Seesandes, no. 4, pl. 2, figs. 4a-b.

Amphicoryna scalaris sagamiensis(Asano).
Lagenonodosaria scalaris sagamiensis Asano, 1936, Geol. Soc. Japan, Jour., v. 43, no. 515, p. 613, pl. 30, figs. 6, 7.

Amphistegina madagascariensis d'Orbigny ..... Pl. 13, figs. 32a-b.
d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, no. 5, p. 304.
The specimens are poor in preservation and presumably were displaced from shallow water.

Anomalina colligera Chapman and Parr ..... Pl. 12, fig. 11.
Chapman and Parr, 1937, Austr. Antarct. Exped., 1911–1914, Sci. Rep., ser. C, I, pt. 2, p. 117, pl. 9, fig. 26.

Anomalina bradyi Said ..... Pl. 4, figs. 38a-b.
Said, 1949, Cushman Lab. Foram. Res., Spec. Pub. no. 26, p. 41, pl. 4, fig. 2.

Anomalina globulosa Chapman and Parr ..... Pl. 12, figs. 17a-b.
Chapman and Parr, 1937, Austr. Antarct. Exped. 1911–1914, Sci. Rep., ser. C, I, pt. 2, p. 117.

Anomalina sp. ..... Pl. 12, figs. 19a-b.
This form is very rare and probably represents a new species.

Austrocolomia sp. ..... Pl. 13, fig. 17.
The specimens have round, simple, and no neck aperture. This species is apparently new to science but is not described because of the few specimens.

Bolivina hantkeniana Brady.
Brady, 1881, Quart. Jour. Micr. Sci., 21, p. 58.

Bolivina robusta Brady ..... Pl. 13, fig. 14.
Brady, 1881, Quart. Jour. Micr. Sci., 21, p. 27.

Bolivinita quadrilatera (Schwager).
Textularia quadrilatera Schwager, 1866, Novara Exped., Geol. Theil, v. 2, p. 253, pl. 7, fig. 10.

Bulimina marginata d'Orbigny ..... Pl. 13, fig. 33.
d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 269, no. 4, pl. 12, figs. 10–12.

Bulimina nipponica Asano ..... Pl. 13, fig. 4.
Asano, 1958, Tohoku Univ., Sci. Rep. 2nd ser., v. 29, pt. 4, p. 6-7, pl. 1, figs. 13–15.
Asano described this species from the Recent seas of Japan (1958). There have been numerous forms referred to *Bulimina inflata* Sequenza, some of which should be included under this species. This species in some respects resembles *B. inflata* Sequenza, but is characteristic by different basal view. LeRoy's species (1941, Colorado School of Mines Quart., pt. 2, pl. 1, fig. 5) should be included under this species.

Bulimina striata d'Orbigny.
d'Orbingy, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 269, no. 2.

Cassidulina subglobosa Brady ..... Pl. 13, figs. 15, 27.
Brady, 1881, Quart. Jour. Micr. Sci., n. ser., v. 21, p. 60.

Cibicides lobatulus (Walker and Jacob).
Nautilus lobatulus Walker and Jacob, 1798, Adams Essays, p. 642, pl. 14, fig. 36.

Cibicides pseudoungerianus (Cushman).
Truncatulina pseudoungeriana Cushman, 1922, U.S. Geol. Surv., Prof. Pap., 129-F, p. 97, pl. 20, fig. 9.

Cibicidoides bradyi (Trauth) ..... Pl. 13, figs. 22, 23.
Truncatulina bradyi Trauth, 1918, K. Akad. Wiss. Wien, Math.-Nat. Cl., v. 95, p. 235.
In New Guinea this species occurs in the Uppermost Miocene or Pliocene (Belford, 1966). *Cibicides roertsonianaus haitiensis* figured by Coryell and Rivero (1940, pl. 44, figs. 4a-c, 5, 6) closely resembles this species, and may be a synonym. Taxonomic notes on this species have been discussed by Belford (1966, p. 100–102).

Cibicidoides wuellerstorfi (Schwager) ..... Pl. 13, fig. 26.
Anomalina wuellerstorfi Schwager, 1866, Novara Exped., Geol. Theil, v. 2, p. 258, pl. 7, figs. 105, 107.

Cribroparrella cf. *regadana* ten Dam ..... Pl. 12, figs. 20a-b.
ten Dam, 1948, Jour. Paleont., v. 22, p. 486, pl. 76, figs. 1–3. This species resembles ten Dam's species, but the number of chambers is fewer than *C. regadana*.

Dentalina communis d'Orbigny ..... Pl. 12, fig. 5.
d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 254, no. 35.

Dentalina emaciata Reuss.
Reuss, 1851, Deutsche Geol. Gesell. Zeitschr., v. 3, p. 63, pl. 3, fig. 9.

Dentalina inflexa Reuss.
Reuss, 1866, K. Akad. Wiss. Wien, Math. -Nat. Cl., Denkschr., v. 25, p. 131, pl. 2, fig. 1.

Euuvigerina hispida (Schwager).
Uvigerina hispida Schwager, 1866, Novara Exped., Geol. Theil, v, 2, p. 249, pl. 7, fig. 95.

Euuvigerina laviculata (Coryell and Rivero) ..... Pl. 13, figs. 11, 16.
Uvigerina laviculata Coryell and Rivero, 1940, Jour. Paleont., v. 14, p. 343, pl. 44, fig. 24.

Euuvigerina peregrina dirupta (Todd) ..... Pl. 13, figs. 28, 29.
Uvigerina peregrina dirupta Todd, 1948, Allan Hancock Pacific Exped., v. 6, no. 5, p. 267, pl. 34, fig. 3.

Euuvigerina rustica (Cushman and Edwards) ..... Pl. 13, fig. 36.

Uvigerina rustica Cushman and Edwards, 1938, Contr. Cushman Lab. Foram. Res., v. 14, p. 83, pl. 14,fig. 6.

Fissurina caribaea (Cushman) ..... Pl. 13, fig. 5.
Lagena orbignyana var. *caribaea* Cushman, 1923, U.S. Nat. Mus., Bull. 104, pt. 4, p. 41, pl. 7, figs. 6-9.

Fissurina laevigata Reuss ..... Pl. 13, fig. 8.
See Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Spec. Pub. no. 14, p. 42, pl. 6, fig. 11.

Fissurina solida Sequenza ..... Pl. 13, fig. 2.
Sequenza, 1862, Messina, T. Capra, pt. 2, p. 56, pl. 1, fig. 42.

Fissurina sp. a ..... Pl. 13, fig. 18.
This form is very rare and probably a new species.

Fissurina sp. b ..... Pl. 13, fig. 37.
This form is very rare and also probably a new species.

Florilus japonicum (Asano).
Nonion japonicum Asano, 1938, Geol. Soc. Japan, Jour., v. 45, no. 538, p. 593, pl. 15, figs. 1a-b, 2a-b.

Gaudryina sp. ..... Pl. 12 figs. 18a-b.
This is apparently a new species but is not described because of the few specimens at hand. Somewhat similar forms have been observed in the Pliocene material from southern Taiwan.

Gyroidina acuta Boomgaart ..... Pl. 13, figs. 31a-c.
Gyroidina neosoldani acuta Boomgaart, 1949, Smit and Dontje, Sappemeer, p. 125, pl. 14, figs. 13a-b.

Gyroidina altispira Cushman and Stainforth.
Cushman and Stainforth, 1945, Cushman Lab. Foram. Res., Spec. Pub. no. 14, p. 61, pl. 11, figs. 1a-c.

Gyroidina broeckhiana (Karrer) ..... Pl. 13, figs. 6a-c, 10.
Rotalia broeckhiana Karrer, 1878, Vienna, K. Gerold's Sohn, p. 98, pl. 5, fig. 26.

Gyroidina orbicularis d'Orbigny.
d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 278, Modeles no. 13.

Guttulina pacifica (Cushman and Ozawa).
Sigmoidella pacifica Cushman and Ozawa, 1929, Cushman Lab. Foram. Res., Contr., v. 4, p. 19, pl. 2, fig. 13.

Hanzawaia nipponica Asano.
Asano, 1944, Geol. Soc. Japan, Jour., v. 51, no. 606, p. 99, pl. 4, figs. 1a-b, 2a-b.

Hoeglundina elegans (d'Orbigny).
Rotalia elegans d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 276, no. 54.

Karreriella bradyi (Cushman) ..... Pl. 12, figs. 1, 2, 9, 10.
Gaudryina bradyi Cushman, 1911, U.S. Nat. Mus , Bull., 71, pt. 2, p. 67, figs. 107a-c.
The Miyako material, specimens of which are here figured, are considerably larger than the others, reaching a length of about 2.00 mm. Chang figured (1966, pl. 1, figs. 10–13) *Karreriella* sp. nov.? from Hengchung Peninsula, Taiwan; these specimens may belong to this species. The fossil specimens were found in the Shinzato Member of Southern Okinawa by LeRoy (1964). The Recent specimens are reported from water deeper than 300 m in the Atlantic.

Osangularia bengalensis (Schwager) ..... Pl. 12, figs. 13, 14a-b.
Anomalina bengalensis Schwager, 1866, Novara Exped., Geol. Theil, Bd., 2, Abt. 2, p. 259, pl. 7, fig. 111. This species is most common in the Miyako-jima material.

Lagena acuticosta Reuss ..... Pl. 13, fig. 3.
Reuss, 1861, Sitz. Akad. Wiss. Wien, v. 44, no. 1, p. 305, pl. 1, fig. 4.

Lagena striata (d'Orbigny).
Oolina striata d'Orbigny, 1839, Voyage dans I'Amerique Meridionale, Foraminiferes, t. 5, pt. 5, p. 21, pl. 5, fig. 12.

Laticarinina pauperata (Parker and Jones) ..... Pl. 13, figs. 34, 39.
Pulvinulina repanda var. *menardii* subvar. *pauperata* Parker and Jones, 1865, Philos. Trans., v. 155, p. 395, pl. 16 figs. 50, 51.

A fossil of this species has been recorded by Ishizaki from the Middle Miocene of Kwansai, Sintiku Prefecture, Taiwan. It has been recorded by Cushman, Yabe and Hanzawa from many areas in the western part of the Pacific Ocean. The specimens are frequent in the Yonahama sample.

Lenticulina cultrata (Montfort), var.

See *Robulus* cf. *cultratus* var. Montfort of Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, p. 269, pl. 37, figs. 3, 4, 5–8; pl. 38, figs. 1-3.

Lenticulina iota (Cushman).

Cristellaria iota Cushman, 1923, U.S. Nat. Mus., Bull., 104, pt. 4, p. 111, pl. 29, fig. 2; pl. 30, fig. 1.

Lenticulina lucida (Cushman).

Cristellaria lucida Cushman, 1923, U.S. Nat. Mus., Bull., 104, pt. 4, p. 111, pl. 30, fig. 2.

Lenticulina melvilli (Cushman and Renz).

Robulus melvilli Cushman and Renz, 1941, Contr. Cushman Lab. Foram. Res., v. 17, p. 12, pl. 2, fig. 12.

Lenticulina nikobarensis (Schwager).

Cristellaria nikobarensis Schwager, 1886, Novara Exped. Geol. Theil, v. 2, p. 243, pl. 6, fig. 87.

Lenticulina peregrina (Schwager) ..... Pl. 13, fig. 35.

Cristellaria peregrina Schwager, 1886, Novara Exped., Geol. Theil, v. 2, p. 245, pl. 7, fig. 89.

Lenticulina pseudorotulata (Asano).

Robulus pseudorotulatus Asano, 1938, Tohoku Univ., Sci. Rep. 2nd ser., v. 19, no. 2, p. 201, pl. 25, figs. 1, 3, 4; pl. 26, fig. 28; pl. 31, figs. 3, 6.

Lenticulina sintikuensis Nakamura ..... Pl. 13, figs. 20a-b.

Nakamura, 1937, Japanese Jour. Geol. Geogr., v. 14, p. 137, pl. 11, figs. 1a-b.

The writer examined the holotype of Nakamura's specimen at the Tohoku University, Japan. The Miyako specimens are very typical and somewhat resemble *Lenticulina nikobarensis* ,but the peripheral keel is blunt, and less sharp compared with *L. nikobarensis*.

Marginulinopsis perprocera (Schwager) ..... Pl. 12, fig. 15.

Schwager, 1866, Novara Exped., Geol. Theil, v. 2, p. 241, pl. 6, fig. 84.

Martinottiella communis (d'Orbigny).

Clavulina communis d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 268, Modeles no. 4.

Melonis affinis (Reuss) ..... Pl. 13, fig. 25.

Nonion affinis Reuss, 1851, Deutsch. Geol. Gesell. Zeitschr., Bd. 3, p. 72, pl. 5, fig. 32.

Melonis pompilioides (Fichtel and Moll) ..... Pl, 12, figs. 7a-b.

Nautilus pompilioides Fichtel and Moll, 1798, Testacea microscopica, p. 31, pl. 2, figs. a-c.

Nodosaria fusta Cushman and Todd.

Cushman and Todd, 1945, Cushman Lab. Foram. Res., Spec. Pub. no. 15, p. 28, pl. 4, figs. 20–22.

Nodosaria insecta Schwager.

Schwager, 1866, Novara Exped. Geol. Theil, v. 2, p. 224, figs. 53, 54.

Nodosaria longiscata d'Orbigny.

d'Orbigny, 1846, Foram. Foss. Bass. Tert. Vienne, p. 32, pl. 1, figs. 10, 12.

Nodosaria obliqua (Linnaeus).

Nautilus obligua Linnaeus, 1758, Syst. Nat., ed. 10, p. 711; see Cushman, 1921, U.S. Nat. Mus., Bull. 100, v. 4, p. 210, pl. 38, fig. 1.

Nodosaria spirostriolata Cushman ..... Pl. 13, fig. 21.

Cushman, 1921, U.S. Nat. Mus., Bull. 100, v. 4, p. 212, pl. 38, fig. 4.

Nummulites ammonoides (Gronovius).

Nautilus ammonoides Gronovius, 1781, Zoolphylacium Gronovianum, p. 282, pl. 19, figs. 5, 6.

Oolina hexagona (Williamson) ..... Pl. 13, fig. 1.

Entosolenia squamosa Montagu var. *hexagona* Williamson, 1848, Ann. Mag. Nat. Hist., ser. 2, v. 1, p. 20, pl. 2, fig. 23.

Oridorsalis umbonatus (Reuss).

Rotalia umbonata Reuss, 1851, Deutsch. Geol. Gesell, Zeitschr., Bd. 3, p. 75, pl. 5, fig. 35.

Orthomorphine jedlitschkai (Thalmann) ..... Pl. 13, fig. 19.
Nodogenerina jedlitschkai Thalmann, 1937, Eclog. Geol. Helv., v. 30, no. 2, p. 341.
The Miyako specimens resemble Brady's species figured on pl. 62, fig. 1 (not fig. 2) in Brady, 1884, Challenger Rept. Zool., v. 9, p. 496.
Plectofrondicularia foliacea (Schwager).
Frondicularia foliacea Schwager, 1866, Novara Exped., Geol. Theil, v. 2, p. 236, pl. 6, fig. 76.
Pleurostomella alternans Schwager ..... Pl. 12, figs. 4a-b.
Schwager, 1866, Novara Exped., Geol. Theil, Bd. 2, Abt. 2, p. 238, fig. 79, (not fig. 80).
Praeglobobulimina spinoscens (Brady).
Bulimina pyrula var. *spinoscens* Brady, 1884, Rep. Voy. Challenger, Zool., v. 9, p. 400, pl. 50, figs. 11, 12.
Pseudoeponides japonicus Uchio.
Uchio, 1950, Japan Assoc. Petr. Technol., Jour., v. 15, no. 4, p. 190, fig. 16.
Pullenia bulloides (d'Orbigny).
Nonionina bulloides d'Orbigny, 1826, Am. Sci. Nat. Hist., ser. 1, t. 7, p. 96–314, pls. 10–17.
Pullenia quinqueloba (Reuss).
Nonionina quinqueloba Reuss, 1851, Deutsch. Geol. Gesell., Zeitschr., Bd. 3, p. 71, pl. 5, fig. 31.
Pullenia salisburyi R.E. and K.E. Stewart ..... Pl. 13, fig. 7.
R.E. and K.E. Stewart, 1930, Jour. Paleont., v. 4, p. 72, pl. 8, figs. 2a-b.
Rectobolivina bifrons (Brady).
Sagrina bifrons Brady, 1881, Quart. Jour. Micr. Sci., 21, p. 64.
Reussella atlantica Cushman.
Cushman,1947, Contr. Cushman Lab. Foram. Res., v. 23, pt. 4, p. 91, pl. 20, figs. 6, 7.
Saracenaria arcuata d'Orbigny ..... Pl. 13, fig. 24.
d'Orbigny, 1846, Foram. Foss. Bass. Tert. Vienne, p. 87, pl. 3, figs. 34–36.
Sigmoilopsis schlumbergeri (Silvestri).
Sigmoilina schlumbergeri Silvestri, 1904, Mem. Pont. Accad. Nuovilincei, v. 22, p. 267.
Siphogenerina multicostata Cushman and Jarvis ..... Pl. 13, fig. 13.
Cushman and Jarvis, 1929, Contr. Cushman Lab. Foram. Res., v. 5, p. 13, pl. 3, figs. 4, 5.
Siphonaperta horrida (Cushman) ..... Pl. 12, fig. 12.
Quinqueloculina horrida Cushman, 1947, Contr. Cushman Lab. Foram. Res., v. 23, pt. 4, p. 88, pl. 19, fig. 1.
Siphotextularia flintii (Cushman) ..... Pl. 12, figs. 16a-b.
Textularia flintii Cushman, 1911, U.S. Nat. Mus., Bull., 71, p. 21, fig. 36.
Siphouvigerina proboscidea (Schwager).
Uvigerina proboscidea Schwager, 1866, Novara Exped., Geol. Theil, v. 2, p. 249, pl. 7, fig. 95.
Sphaeroidina bulloides d'Orbigny ..... Pl. 10, figs. 5, 10.
d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 267, Modeles no. 65.
Spiroplectammina sagittula (Soldani) ..... Pl. 12, figs. 3a-b.
Polymorpha sagittula Soldani, 1791, Testaceographia, v. 1, pt. 2, p. 120, pl. 133, fig. T.
Stilostomella ketienziensis (Ishizaki).
Ellipsonodosaria ketienziensis Ishizaki, 1943, Trans. Nat. Hist. Soc. Taiwan, v. 33, nos. 242-243, p. 684, text-figs. 1, 6, 11.
Many of the specimens are typical of this species.
Stilostomella hirsuta (d'Orbigny).
Nodosaria hirsuta d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 252, Modeles no. 7.
Stilostomella lepidula (Schwager).
Nodosaria lepidula Schwager, 1866, Novara Exped., Geol. Theil, 2, p. 210, pl. 5, figs. 27, 28.
Stilostomella verneuili (d'Orbigny).
Dentalina verneuili d'Orbigny, 1846, Foram. Foss. Bass. Tert. Vienne, p. 48, pl. 2, figs. 7, 8.
Stilostomella sp. ..... Pl. 12, fig. 6.
Textularia abbreviata d'Orbigny.
d'Orbigny, 1846, Foram. Foss. Bass. Tert. Vienne, p. 249, pl. 15, figs. 9–12.
Textularia crassisepta Cushman.
Cushman, 1911, U.S. Nat. Mus., Bull., 71, pt. 2, p. 24, fig. 41.

Tosaia hanzawai Takayanagi ..... Pl. 13, fig. 9.
Takayanagi, 1953, Tohoku Univ., Inst. Geol. Pal., Short Papers, no. 5, p. 30, pl. 4, figs. 7a-b.
The specimens agree well with Takayanagi's description and figures, but are rare.

Valuvulineria nipponica Ishizaki.
Ishizaki, 1944, Trans. Nat. Hist. Soc. Taiwan, v. 34, no. 244, p. 103, pl. 3, figs. 7a-c.

Planktonic Species

Candeina nitida d'Orbigny ..... Pl. 10, figs, 8a-c.
d'Orbigny, 1839, *in* de la Sagra, Hist. Phys. Pol. Nat. Cuba., Foram., p. 108, pl. 2, figs. 27, 28.

Globigerina bulbosa LeRoy ..... Pl. 11, figs. 3a-b.
LeRoy, 1944, Colorado School Mines, Quart., v. 39, no. 3, pt. 1, p. 39, pl. 3, figs. 26, 27.

Globigerina bulloides d'Orbigny ..... Pl. 11, fig. 2.
d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, v. 7, p. 277, Modeles nos. 17, 76.

Globigerina diplostoma Reuss ..... Pl. 11, fig. 11.
Reuss, 1850, K. Akad. Wiss., Wien, Math. -Nat. Cl., Denksch., v. 1, p. 373, pl. 47, figs. 9, 10; pl. 48, fig. 1.

Globigerina falconensis Blow.
Blow, 1959, Amer. Paleont., Bull., v. 39, no. 178, p. 177, pl. 9, figs. 40a-c, 41.

Globigerina foliata Bolli ..... Pl. 11, figs. 8a-c.
Bolli, 1957, U.S. Nat. Mus., Bull., 215, p. 111, pl. 24, figs. 1a-c.

Globigerina riveroae Bolli and Bermudez ..... Pl. 11, figs. 4a-b.
Bolli and Bermudez, 1965, Asoc. Ven. Geol. Min. Petr., Bol. Inf., v. 8, no. 5, p. 137, pl. 1, figs. 1–3.
This species is easily identified by its globular form, and large, nearly semicircular aperture of the ultimate chamber. The low trochospiral form closely resembles *Globigerina apertura* Cushman.

Globigerinita glutinata (Egger) ..... Pl, 11, figs. 6, 7.
Egger, 1895, Abh. K. Bayer Akad. Wiss., Math-Phys. Kl., 18, 2, p. 271, pl. 13, figs. 19-21.

Globigerinella siphonifera (d'Orbigny) ..... Pl. 11, figs. 16a-b, 17a-b.
Globigerina siphonifera d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, Forma., p. 83, pl. 4, figs. 15–18.

Globigerinoides conglobatus (Brady) ..... P. 11, figs. 10, 24.
Globigerina conglobata Brady, 1879, Quart. Jour. Micr. Sci., n.s., v. 19, p. 286; fig. in 1884, Rept. Voy. Challenger, Zool., v, 9, p. 603, pl. 80, figs. 1–5; pl. 82, fig. 5.

Globigerinoides cyclostomus (Galloway and Wissler) ..... Pl. 11, fig. 13.
Globigerina cyclostoma Galloway and Wissler, 1927, Jour. Paleont., v. 1, no. 1, p. 42, pl. 7, figs. 8a-9c.

Globigerinoides elongatus (d'Orbigny) ..... Pl. 11, fig. 14
Globigerina elongata d'Orbigny, 1826, Ann. Sci. Nat. Paris, ser. 1, v. 7, p. 277.

Globigerinoides fistulosus (Schubert) ..... Pl. 11, figs. 28a-b.
Globigerina fistulosa Schubert, 1910, Geol. Reichsanst., Verh., p. 323, 324, fig. 2.

Globigerinoides obliquus Bolli ..... Pl. 11, figs. 18a-20b.
Bolli, 1957, U.S. Nat. Mus., Bull., 215, p. 113, pl. 25, figs. 9a-10c.

Globigerinoides ruber (d'Orbigny) ..... Pl. 11, fig. 5.
Globigerina rubra d'Orbigny, 1839, in de la Sagra, Hist. Phys. Pol. Nat. Cuba, Foram., p. 82, pl. 4, figs. 12–14. *Globigerinoides helicina* is included in this species.

Globigerinoides sacculifer (Brady) ..... Pl. 11, figs. 21–23, 29–31.
Globigerina sacculifera Brady, 1877, Geol. Mag., n. s., decade 2, v. 4, no. 12, p. 535.

Globigerinoides trilobus (Reuss) ..... Pl. 11, figs. 9, 15.
Globigerina triloba Reuss, 1850, K. Akad. Wiss, Wien, Math-Nat. Denkschr., v. 1, p. 374, pl. 47, figs. 11a-d. The form shown in pl. 2, fig. 9, according Parker (1967, p. 157) is a phylogenetically primitive *G. sacculifer*.

Globoquadrina acostaensis (Blow) ..... Pl. 10, figs. 2a-c.
Globorotalia acostaensis Blow, 1959, Amer. Paleont., Bull., v. 39, no. 178, p. 208–209, pl. 17, figs. 106a-c, 107.

Globoquadrina altispira (Cushman and Jarvis) .....Pl. 10, figs. 13, 16a-c.
Globigerina altispira Cushman and Jarvis, 1936, Contr. Cushman Lab. Foram. Res., v. 12, pt. 1, p. 5, pl. 1, figs. 13a-c, 14.

Globoquadrina hexagona (Natland) .....Pl. 11, figs. 12a-b.
Globigerina hexagona Natland, 1938, Calif. Univ., Scrips Inst. Oceanog., Bull., Tech. ser., v. 4, no. 5, p. 149, pl. 7, fig. 1.

Globoquadrina humerosa (Takayanagi and Saito) .....Pl, 10 figs. 12a-c.
Globorotalia humerosa Takayanagi and Saito, 1962, Tohoku Univ., Sci. Rept., 2nd ser. (Geol.), Spec. Vol., no. 5, p. 78, pl. 28, figs. 1, 2.

Globoquadrina venezuelana (Hedberg) .....Pl. 10, figs. 9a-c.
Globigerina venezuelana Hedberg, 1937, Jour. Paleont., v. 11, no. 8, p. 681, pl. 92, figs. 7a-b.

Globorotalia crassaformis (Galloway and Wissler) .....Pl. 11, figs. 7a-c, 11a-c.
Globigerina crassaformis Galloway and Wissler, 1927, Jour. Paleont., v. 1, p. 41, pl. 7, fig. 12.

Globorotalia menardii (d'Orbigny).
Rotalia menardii d'Orbigny, 1826, Ann. Sci. Nat., Paris, ser. 1, v. 7, p. 273, Modeles no. 10.

Globorotalia multicamerata Cushman and Jarvis .....Pl. 10, figs. 18a-b.
Cushman and Jarvis, 1930, Jour. Paleont., v. 4, no. 4, p. 367, pl. 34, fig. 8.

Globorotalia scitula (Brady) .....Pl. 10, figs. 1, 6a-b.
Pulvinulina scitula Brady, 1884, Roy. Soc. Edinburgh, Proc., v. 11, p. 716; fig. in 1884, Rep. Voy. Challenger, Zool., v, 9, pl. 103, figs. 7a-c.

Globorotalia tosaensis Takayanagi and Saito .....Pl. 10, figs. 3a-c.
Takayanagi and Saito, 1962, Tohoku Univ., Sci. Rept., 2nd ser. (Geol.), Spec. Vol. no. 5, p. 81, 82, pl. 28, figs. 11a-12c.

Globorotalia tumida (Brady) .....Pl. 10, figs. 19a-b.
Pulvinulina menardii var. *tumida* Brady, 1877, Geol. Mag., n. s., dec. 2, v. 4, no. 12, p. 535; fig. in 1884, Rept. Voy. Challenger, Zool., v. 9, p. 692, pl. 103, figs. 4-6.

Orbulina universa d'Orbigny .....Pl, 10, fig. 15.
d'Orbigny, 1839, in de la Sagra Hist. Phys., Pol. Nat. Cuba, Foram., p. 2, pl. 1, fig. 1.

Pulleniatina obliquiloculata (Parker and Jones).
Pullenia sphaeroides var. *obliquiloculata* Parker and Jones, 1865, Roy. Soc. London, Philos. Trans., v. 155, p. 365, 368, pl. 19, fig. 4.

Pulleniatina primalis Banner and Blow .....Pl. 10, figs. 4a-b, 14.
Banner and Blow, 1967, Micropaleontology, v. 13, no. 1, p. 142, pl. 1, figs. 3–8; pl. 3, fig. 2.

Sphaeroidinellopsis seminulina (Schwager) .....Pl. 11, figs. 26, 27a-b.
Globigerina seminulina Schwager, 1866, Novara Exped., Geol. Theil, Bd. 2, Abth. 2, p. 256, pl. 7, fig. 112.

Sphaeroidinellopsis subdehiscens (Blow) .....Pl. 11, figs. 25a-b.
Sphaeroidinella dehiscens subdehiscens Blow, 1959, Amer. Paleont., Bull., v. 39, no. 178, p. 195, pl. 12, figs. 71, 72.

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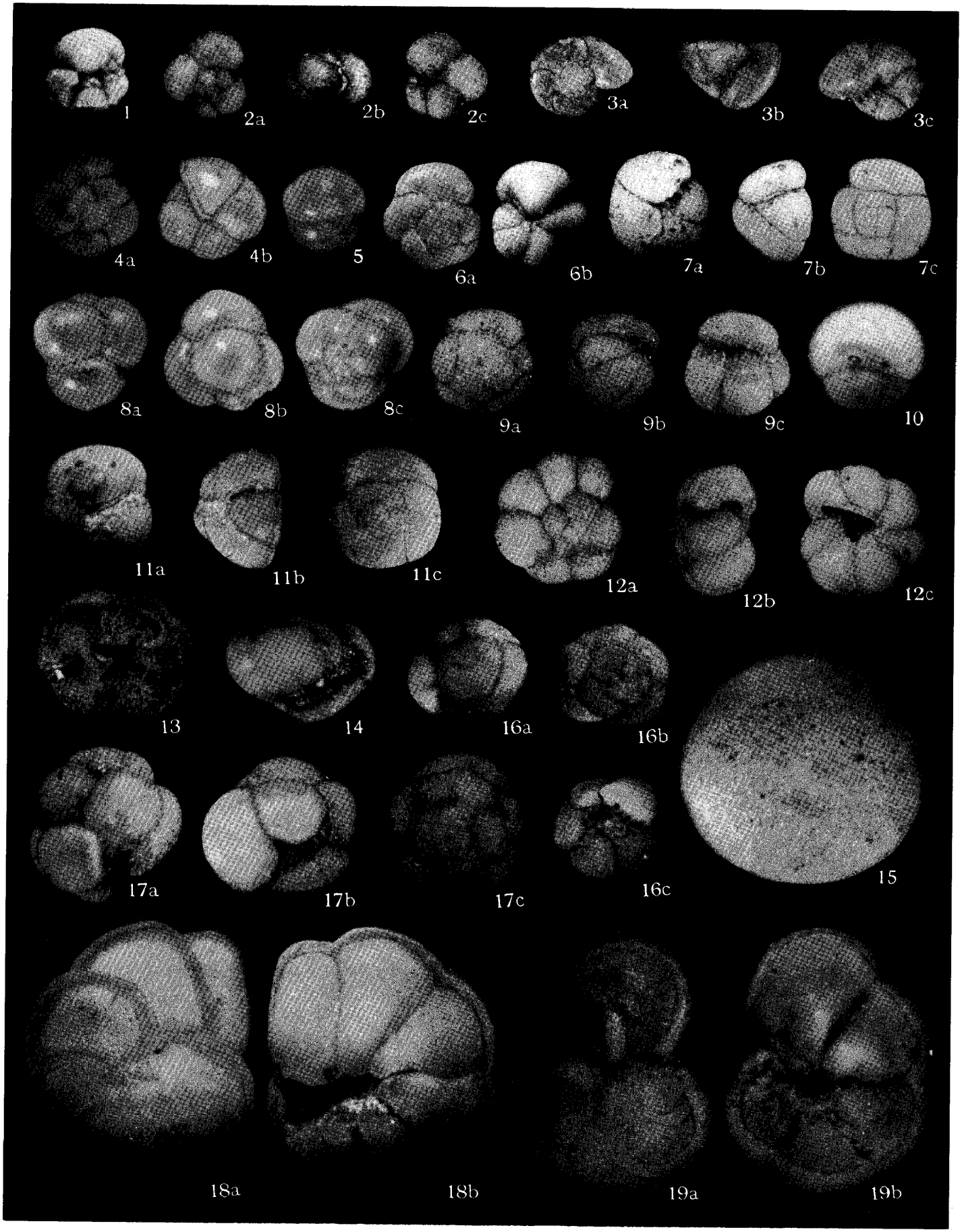
Plate 10

(All figures ×50)

Fig. 1. *Globorotalia scitula* (Brady). From Yonahama.
Figs. 2a-c. *Globoquadrina acostaensis* (Blow). From Yonahama.
Figs. 3a-c. *Globorotalia tosaensis* Takayanagi and Saito. From Nagama.
Figs. 4a-b. *Pulleniatina primalis* Banner and Blow. From Nagama.
Fig. 5. *Sphaeroidina bulloides* d'Orbigny. From Nagama.
Figs. 6a-b. *Globorotalia scitula* (Brady). From Yonahama.
Figs. 7a-c. *Globorotalia crassaformis* (Galloway and Wissler). From Yonahama.
Figs. 8a-c. *Candeina nitida* d'Orbigny. From Nagama.
Figs. 9a-c. *Globoquadrina venezuelana* (Galloway and Wissler). From Yonahama.
Fig. 10. *Sphaeroidina bulloides* d'Orbigny. From Yonahama.
Figs. 11a-c. *Globorotalia crassaformis* (Galloway and Wissler). From Yonahama.
Figs. 12a-c. *Globoquadrina humerosa* (Takayanagi and Saito). From Nagama.
Fig. 13. *Globoquadrina altispira* (Cushman and Jarvis). From Yonahama.
Fig. 14. *Pulleniatina primalis* Banner and Blow. From Yonahama.
Fig. 15. *Orbulina universa* d'Orbigny. From Yonahama.
Figs. 16a-c. *Globoquadrina altispira* (Cushman and Jarvis). From Nagama.
Figs. 17a-c. *Globoquadrina altispira* (Cushman and Jarvis). From Yonahama.
Figs. 18a-b. *Globorotalia multicamerata* Cushman and Jarvis. From Yonahama.
Figs. 19a-b. *Globorotalia tumida* (Brady). From Yonahama.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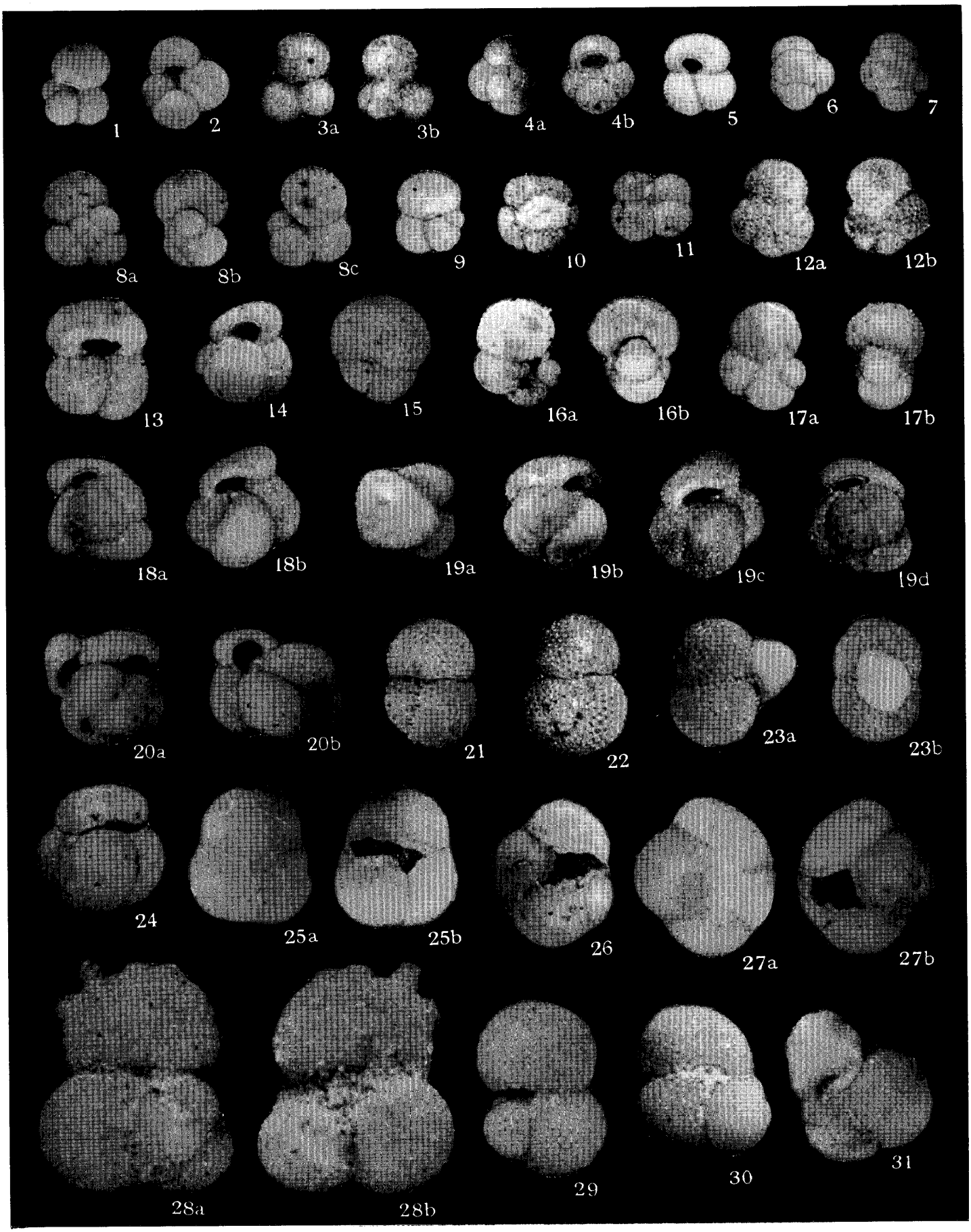
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Plate 11

(All figures ×50)

Fig. 1. *Globigerina foliata* Bolli. From Nagama.
Fig. 2. *Globigerina bulloides* d'Orbigny. From Nagama.
Figs. 3a-b. *Globigerina bulbosa* LeRoy. From Minehara.
Figs. 4a-b. *Globigerina riveroae* Bolli and Bermudez. From Nagama.
Fig. 5. *Globigerinoides ruber* (d'Orbigny). From Nagama.
Fig. 6. *Globigerinita glutinata* (Egger). From Nagama.
Fig. 7. *Globigerinita glutinata* (Egger). From Nagama.
Figs. 8a-c. *Globigerina foliata* Bolli. From Nagama.
Fig. 9. *Globigerinoides trilobus* Reuss. From Nagama.
Fig. 10. *Globigerinoides conglobatus* (Brady). From Nagama.
Fig. 11. *Globigerina diplostoma* Reuss. From Nagama.
Figs. 12a-b. *Globoquadrina hexagona* (Natland). From Yonahama.
Fig. 13. *Globigerinoides cyclostomus* (Galloway and Wissler). From Nagama.
Fig. 14. *Globigerinoides elongatus* (d'Orbigny). From Yonahama.
Fig. 15. *Globigerinoides trilobus* Reuss. From Nagama.
Figs. 16a-b. *Globigerinella siphonifera* (d'Orbigny). From Yonahama.
Figs. 17a-b. *Globigerinella siphonifera* (d'Orbigny). From Yonahama.
Figs. 18a-b. *Globigerinoides obliquus* Bolli. From Nagama.
Figs. 19a-d. *Globigerinoides obliquus* Bolli From Nagama.
Figs. 20a-b. *Globigerinoides obliquus* Bolli. From Yonahama.
Fig. 21. *Globigerinoides sacculifer* (Brady). From Nagama.
Fig. 22. *Globigerinoides sacculifer* (Brady). From Nagama.
Figs. 23a-b. *Globigerinoides sacculifer* (Brady). From Yonahama.
Fig. 24. *Globigerinoides conglobatus* (Brady). From Yonahama.
Figs. 25a-b. *Sphaeroidinellopsis subdehiscens* (Blow). From Yonahama.
Fig. 26. *Sphaeroidinellopsis seminulina* (Schwager). From Yonahama.
Figs. 27a-b. *Sphaeroidinellopsis seminulina* (Schwager). From Yonahama.
Figs. 28a-b. *Globigerinoides fistulosus* (Schubert). From Nagama.
Fig. 29. *Globigerinoides sacculifer* (Brady). From Nagama.
Fig. 30. *Globigerinoides sacculifer* (Brady). From Yonahama.
Fig. 31. *Globigerinoides sacculifer* (Brady). From Yonahama.

Plate 12

(All figures ×50, except as indicated)

Figs. 1a-b. *Karreriella bradyi* (Cushman). From Yonahama. ×20.
Figs. 2a-b. *Karreriella bradyi* (Cushman). From Yonahama. ×20.
Figs. 3a-b. *Spiroplectammina sagitula* (Soldani). From Yonahama. ×20.
Figs. 4a-b. *Pleurostomella alternans* Schwager. From Yonahama.
Fig. 5. *Dentalina communis* d'Orbigny. From Yonahama. ×20.
Fig. 6. *Stilostomella* sp. From Yonahama.
Figs. 7a-b. *Melonis pompilioides* (Fichtel and Moll). From Yonahama.
Figs. 8a-b. *Ammonia ketienziensis angulata* (Kuwano). From Minehara.
Figs. 9a-b. *Karreriella bradyi* (Cushman). From Yonahama.
Figs. 10a-b. *Karreriella bradyi* (Cushman). From Yonahama.
Fig. 11. *Anomalina colligera* Chapman and Parr. From Yonahama.
Fig. 12. *Siphonaperta horrida* (Cushman). From Yonahama.
Fig. 13. *Osangularia bengalensis* (Schwager). From Yonahama.
Figs. 14a-b. *Osangularia bengalensis* (Schwager). From Yonahama.
Fig. 15. *Marginulinopsis perprocera* (Schwager). From Yonahama.
Figs. 16a-b. *Siphotextularia flintii* (Cushman). From Yonahama.
Figs. 17a-b. *Anomalina globulosa* Chapman and Parr. From Yonahama.
Figs. 18a-b. *Gaudryina* sp. From Yonahama.
Figs. 19a-b. *Anomalina* sp. From Yonahama.
Figs. 20a-b. *Cribroparrella* cf. *regadana* ten Dam. From Yonahama.

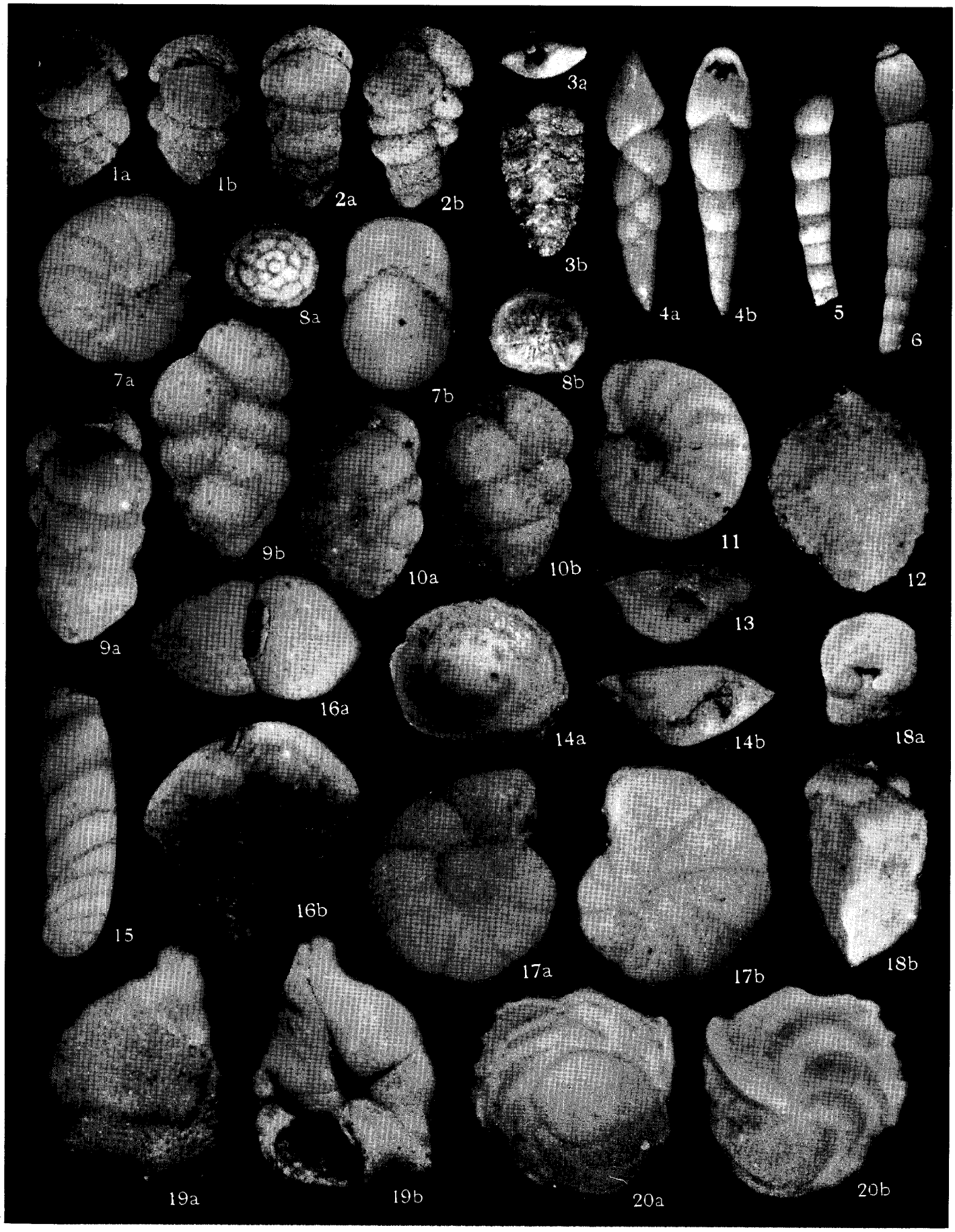
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Plate 13

(All figures ×50, except as indicated)

Fig. 1. *Oolina hexagona* (Williamson). From Yonahama.
Fig. 2. *Fissurina solida* Seguenza. From Yonahama.
Fig. 3. *Lagena acuticosta* Reuss. From Yonahama.
Fig. 4. *Bulimina nipponica* Asano. From Yonahama.
Fig. 5. *Fissurina caribaea* (Cushman). From Yonahama.
Figs. 6a-c. *Gyroidina broeckhiana* (Karrer). From Yonahama.
Fig. 7. *Pullenia salisburyi* R.E. and K.E. Stewart. From Yonahama.
Fig. 8. *Fissurina laevigata* Reuss. From Yonahama.
Fig. 9. *Tosaia hanzawai* Takayanagi. From Yonahama.
Fig. 10. *Gyroidina broeckhiana* (Karrer). From Yonahama.
Fig. 11. *Euuvigerina laviculata* (Coryell and Rivero). From Yonahama. ×20.
Fig. 12. *Amphicoryna scalaris* (Batsch). From Yonahama.
Fig. 13. *Siphogenerina multicostata* Cushman and Jarvis. From Yonahama.
Fig. 14. *Bolivina robusta* Brady. From Yonahama.
Fig. 15. *Cassidulina subglobosa* Brady. From Yonahama.
Fig. 16. *Euuvigerina laviculata* (Coryell and Rivero). From Yonahama. ×20.
Fig. 17. *Austrocolomia* sp. From Yonahama.
Fig. 18. *Fissulina* sp. a. From Yonahama.
Fig. 19. *Orthomorphina jedlitschkai* (Thalmann). From Yonahama.
Figs. 20a-b. *Lenticulina sintikuensis* Nakamura. From Yonahama.
Fig. 21. *Nodosaria spirostriolata* Cushman. From Yonahama. ×20.
Figs. 22a-c. *Cibicidoides bradyi* (Trauth). From Yonahama.
Figs. 23a-c. *Cibicidoides bradyi* (Trauth). From Yonahama.
Fig. 24. *Saracenaria arcuata* d'Orbigny. From Yonahama.
Fig. 25. *Melonis affinis* (Reuss). From Yonahama.
Fig. 26. *Cibicidoides wuelerstorfi* (Schwager). From Yonahama.
Fig. 27. *Cassidulina subglobosa* Brady. From Yonahama.
Fig. 28. *Euuvigerina peregrina dirupta* Todd. From Yonahama.
Fig. 29. *Euuvigerina peregrina dirupta* Todd. From Yonahama.
Fig. 30. *Globobulimina pyrula spinescens* (Brady). From Yonahama.
Figs. 31a-c. *Gyroidina acuta* Boomgaart. From Yonahama.
Figs. 32a-b. *Amphistegina madagascariensis* d'Orbigny. From Yonahama.
Fig. 33. *Bulimina marginata* d'Orbigny. From Yonahama.
Fig. 34. *Laticarinina pauperata* (Parker and Jones). From Yonahama. ×20.
Fig. 35. *Lenticulina peregrina* (Schwager). From Yonahama.
Fig. 36. *Euuvigerina rustica* Cushman and Edwards. From Yonahama.
Fig. 37. *Fissurina* sp. b. From Yonahama.
Figs. 38a-b. *Anomalina bradyi* Said. From Yonahama.
Fig. 39. *Laticarinina pauperata* (Parker and Jones). From Yonahama.