Smaller Foraminifera From the Late Tertiary Of Southern Okinawa

By L. W. LEROY

SHORTER CONTRIBUTIONS TO GENERAL GEOLOGY

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Treatment of Pliocene and Miocene smaller Foraminifera of southern Okinawa and their general stratigraphic relationships as assemblages

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SMALLER FORAMINIFERA FROM THE LATE TERTIARY OF SOUTHERN OKINAWA

By L. W. LeRoy

ABSTRACT

Of the 333 species of smaller Foraminifera from the Miocene and Pliocene deposits (5,000+ ft thick) of southern Okinawa that are described in this paper, 18 species and 5 varieties are new. The faunas of the Yonabaru Member (Miocene) of the Shimajiri Formation reflect a deep-neritic to bathyal environment with the exception of the upper 1,500± feet which is shallow neritic. The faunas of the overlying Shinzato Member (Miocene or Pliocene) of the Shimajiri represent an open-sea shallow-neritic environment and consist primarily of globigerine forms. The Foraminifera of the Chinen Sand (Pliocene) are very shallow neritic types and as an assemblage differ markedly from those of the Yonabaru and Shinzato. The Naha (Pliocene) Foraminifera, restricted in both genera and species compared to the older units, represent a warm shallow-water environment. Most of the recorded species commonly occur in Recent and late Tertiary sediments of the Central and South Pacific and Indo-Pacific regions.

INTRODUCTION

Okinawa, the largest island of the Ryukyu chain, is between long 127°38′ and 129°20′ E., and lat 26°04′ and 26°52′ N. It is 67 miles long, ranges in width from 2 to 15 miles, is oriented approximately N. 30° E., and is bounded on the east by the Philippine Sea and on the west by the East China Sea (fig. 1).

The island is composed of two major geomorphic provinces. The northern province, representing about three-fourths of the area, has a basement of Paleozoic sedimentary rocks that have been deformed, metamorphosed, and intruded by various igneous types. These rocks produce a rugged matured relief. The southern province, comprising the remaining part of the island, is covered by shales, sandstones, and limestones of Miocene, Pliocene, and Pleistocene age that reflect low hills, broad valleys, and flat-topped, dissected, and faulted limestone plateaus ranging from 380 to 500 feet above sea level. Marine terraces, beaches, and fringing reefs occur intermittently along the coastlines.

The Foraminifera of the late Tertiary deposits of southern Okinawa treated in this paper are based on surface samples collected by members of the U.S. Geological Survey mapping party during 1946–48, and on continuous ditch samples from Yonabaru 1 (total depth, 4,036 ft) and the Katchin Hanto 1 (total depth, 1,900 ft). Both wells were drilled by the U.S. Navy for water. The samples, obtained at 10-foot intervals, were described, plotted, disaggregated through 20- and 150-mesh sieves, and the washed residues were examined for their microfaunal and mineralogical components. From these residues Foraminifera were selected, identified, and checklisted. The illustrated specimens are deposited in the collection of the U.S. National Museum, Washington, D.C.

Because of poor exposures, questionable structural control, and field-time limitations, no continuous surface section was measured or systematically sampled. Therefore, accurate stratigraphic placement of the microfaunas within each of the major stratal units was not possible.

There are 333 species recorded in this paper, of which 18 species and 5 varieties are considered new.

Previous work on the smaller Foraminifera of southern Okinawa is meager. Newton and Holland (1902) listed 36 species from a sandstone near the town of Itoman in southwestern Okinawa. The stratigraphic position of this fauna was not clarified. Hanzawa (1925) recorded 254 species from 9 randomly collected surface samples included within his Shimajiri Group, which unconformably underlies the "raised coral reef formation" (probably in part or total, the Naha, Yontan, and Machinato Limestones of the present paper). Hanzawa's faunas appear to be from the Shinzato and uppermost part of the Yonabaru Members as defined herein.

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FIGURE 1.—Surface sample (field numbers) index map of southern Okinawa.

is given to J. R. Stacy, scientific illustrator of the U.S. Geological Survey, for the detailed illustrations of 275 species. J. D. Spart, also of the Survey, assisted in the illustration program and completed the drawings of 75 species.

STRATIGRAPHY

The Tertiary stratal units of southern Okinawa are summarized in table 1.

TABLE 1.—*Stratigraphic summary of Tertiary deposits of southern Okinawa*

[Modified after MacNeil, 1960]

	Thickness (feet)
Post-Pleistocene:	
Raised beach deposits.	
Pleistocene:	
Ryukyu Group:	
Machinato Limestone	0–100
Yontan Limestone	0–200
Pliocene:	
Naha Limestone	0–200
Chinen Sand	0–50
Rotorbinella chinenensis fauna	
Calcarina fauna	
——————Unconformity——————	
Pliocene or Miocene:	
Shimajiri Formation:	
Shinzato Member	0–200
(*Globorotalia punctulata* fauna)	
————Unconformity—(Major foraminiferal change)	
Miocene:	
Yonabaru Member (base not defined)	4,550±
Loxostomum pacificum fauna	
Nonion nicobarense-Cibicides macneili fauna	
Poorly developed Calcareous fauna [1]	
Arenaceous fauna (*Cyclammina, Schenckiella, Goesella, Ammodiscus, Glomospira,* and *Miliammina*) [1]	

[1] In subsurface below 1,060 ft. in Yonabaru 1.

The Shimajiri Formation includes the Yonabaru and Shinzato Members; the Shinzato represents the younger of the two members.

The Yonabaru, which unconformably underlies the Shinzato, consists mainly of dark-gray shale, sandy shale, siltstone, and fine-grained shaly sandstone and is assigned to the Miocene. The basal limit of this member has not been defined. The lowest deposits of the Yonabaru were penetrated in Yonabaru 1.

The Shinzato Member consists principally of soft light-gray foraminiferal shale and tuff. It lies unconformably below the Chinen Sand where tuff is present. Foraminifera are inconclusive in determining whether this member is late Miocene or Pliocene. On molluscan evidence, MacNeil (1960) assigned it to Miocene or Pliocene. A major micropaleontologic break occurs at the Shinzato-Yonabaru boundary.

The Ryukyu Group (Chinen Sand, Naha, Yontan, and Machinato Limestones) includes deposits of both Pliocene and Pleistocene age (table 1). According to MacNeil (1960) considerable lateral variation is exhibited in the Chinen and Naha part of the section. The Yontan and Machinato Limestones are also nonhomogeneous. At some localities the Chinen Sand is absent because of unconformity relation; in other areas it appears to grade laterally into carbonates similar to those in Naha. Normally the Chinen overlies the Shinzato; locally it is in contact with the Yonabaru as in the Katchin Hanto 1 at a depth of 360 feet.

Because of inadequate surface and subsurface structural control, lack of dip data in the Yonabaru well, poor outcrops, and nondefinition of the base of the Yonabaru Member and possibly older formations, the thickness of the Tertiary sequence of southern Okinawa is undetermined. At least 5,200 feet of section is believed to be involved in the study presented in this paper, provided contemporaneous deformation is nonexistent and stratal dips in the Yonabaru well do not exceed 10°. The relation of the major formational and faunal units is believed to be correct; however, further analyses of the section with better stratigraphic and structural control could modify some of the comments and interpretations here given.

MIOCENE

Miocene strata, represented by the Yonabaru Member of the Shimajiri Formation, are exposed widely in southern Okinawa and consist of alternate shallow- to deep-neritic fine-grained clastic deposits. Only the upper 4,550± feet of the member is treated in this paper.

YONABARU MEMBER OF THE SHIMAJIRI FORMATION

The Yonabaru consists mainly of dark-gray shale containing interbeds of siltstones and fine- to medium-grained sandstones. It is overlain unconformably by tuffs and tuffaceous shales of the Shinzato Member or sandstones of the Chinen. The lower limit of the member and its relation to older deposits is not known. These deposits are complexly faulted according to MacNeil (1960).

The Yonabaru as studied is divided (fig. 2) into four stratigraphically diagnostic foraminiferal assemblages, which from the youngest to the oldest are: (a) *Loxostomum pacificum* fauna (surface), (b) *Nonion nicobarense-Cibicides macneili* fauna (surface and subsurface), (c) poorly developed calcareous fauna (subsurface), and (d) arenaceous fauna (subsurface).

LOXOSTOMUM PACIFICUM FAUNA

This fauna appears to be the youngest of the Yonabaru assemblages; however, further work may place it within the section penetrated in the upper 1,250 feet of

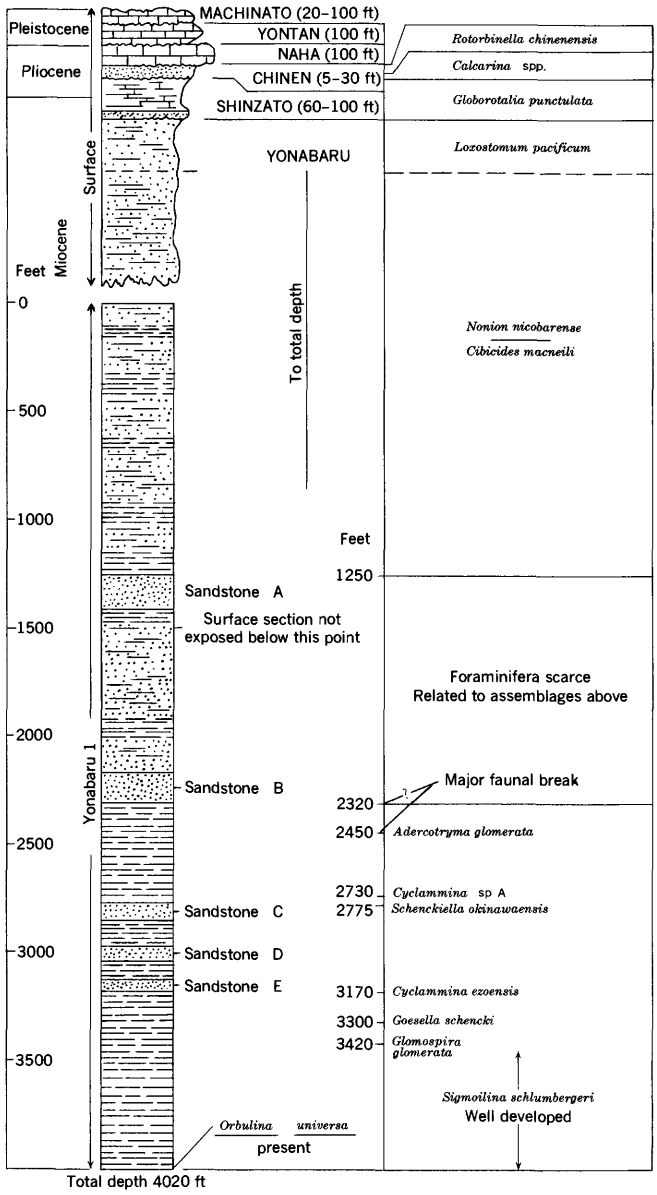

FIGURE 2.—Generalized stratigraphic section of southern Okinawa showing major foraminiferal subdivisions.

the Yonabaru well. That the Foraminifera are shallow-neritic warm-water types is further substantiated by their association with water-worn molluscan fragments, polished rock particles, ostracodes, bryozoan debris, and glauconite. According to MacNeil (1960) the Yonabaru mollusks indicate moderately shallow to moderately deep water—probably not exceeding 300 fathoms for the deeper facies. Unweathered hornblende and feldspar are common in the washed residues.

Foraminifera listed as follows represent an average assemblage of this fauna. Species marked by an asterisk (*) appear to be most diagnostic. C = common, +50 specimens; R = rare, 10–50 specimens; S = scarce, less than 10 specimens.

Amphistegina madagascariensis d'Orbigny ---- R
wanneriana Fischer ---- R
Anomalina bradyi Said ---- R
glabrata Cushman ---- S
**Asterorotalia trispinosa* (Thalmann) ---- S
**Baggina totomiensis* Makiyama ---- S
Bolivinita quadrilatera (Schwager) (large var.) ---- S
Bulimina inflata Seguenza ---- S
Cassidulina inflata LeRoy ---- S
okinawaensis LeRoy, n. sp ---- R
Cibicides macneili LeRoy, n. sp ---- S
pseudoungerianus (Cushman) ---- C
Clavulina yabei akiensis Asano ---- R
Eggerella bradyi (Cushman) ---- S
Elphidium fax bararbense Nicol (small var.) ---- R
Eponides praecintus (Karrer) ---- R
procerus (H. B. Brady) ---- S
subornatus (Cushman) ---- S
**Gaudryina siphonifera* (H. B. Brady) ---- S
Globoquadrina altispira (Cushman and Jarvis) ---- S
Globigerina bulloides d'Orbigny ---- C
dubia Egger ---- R
Globigerinoides triloba immatura LeRoy ---- C
Globorotalia menardii multicamerata Cushman and Jarvis ---- R
tumida (H. B. Brady) (large var.) ---- R
Gyroidina altiformis R. E. and K. E. Stewart ---- R
**Hanzawaia nipponica* Asano ---- C
Hoeglundina elegans (d'Orbigny) ---- R
Lagenonodosaria scalaris (Batsch) ---- R
**Loxostomum pacificum* LeRoy, n. sp ---- C
**Marginulinopsis nozimaensis* (Asano) ---- R
**Neoconobina opercularis* (d'Orbigny) ---- S
pacifica LeRoy, n. sp ---- R
Nodosaria insecta Schwager ---- R
acuminata Hantken var. *uniforminata* LeRoy ---- R
vertebralis (Batsch) var. *albatrossi* ---- S
Nonion pompilioides (Fichtel and Moll) var. *okinawaense* LeRoy, n. var ---- R
Operculina gaimairdi (d'Orbigny) ---- R
Orbulina universa d'Orbigny ---- S
**Planorbulinella larvata* (Parker and Jones) ---- R
Pullenia bulloides (d'Orbigny) ---- R
Quinqueloculina akneriana d'Orbigny ---- R
contorta d'Orbigny ---- S
carinata d'Orbigny ---- S
Rectobolivina bifrons (H. B. Brady) ---- R
**Reussella spinulosa* (Reuss) ---- S
Robulus calcar (Linné) ---- S
**Rotalidium okinawaensis* LeRoy, n. sp ---- R
Rotalia stachi Asano ---- R
Schenckiella communis (d'Orbigny) ---- S
Sigmoilina schlumbergeri A. Silvestri ---- S
Siphogenerina raphanus (Parker and Jones) ---- R
Sphaeroidina bulloides d'Orbigny ---- S
Sphaeroidinella seminulina (Schwager) ---- R
**Spiroloculina communis* Cushman ---- S
Stilostomella lepidula (Schwager) ---- S
**Textularia sagittula* Defrance var. *fistulosa* H. B. Brady ---- S
**Triloculina tricarinata* d'Orbigny ---- S
**Trifarina bradyi* Cushman ---- S
Uvigerina crassicostata Schwager ---- R
striatella Reuss ---- R
**gemmaeformis* Schwager ---- S
peregrina Cushman var. *dirupta* Todd ---- S
**Vaginulina yoshihamaensis* Inoue and Nakaseko ---- S

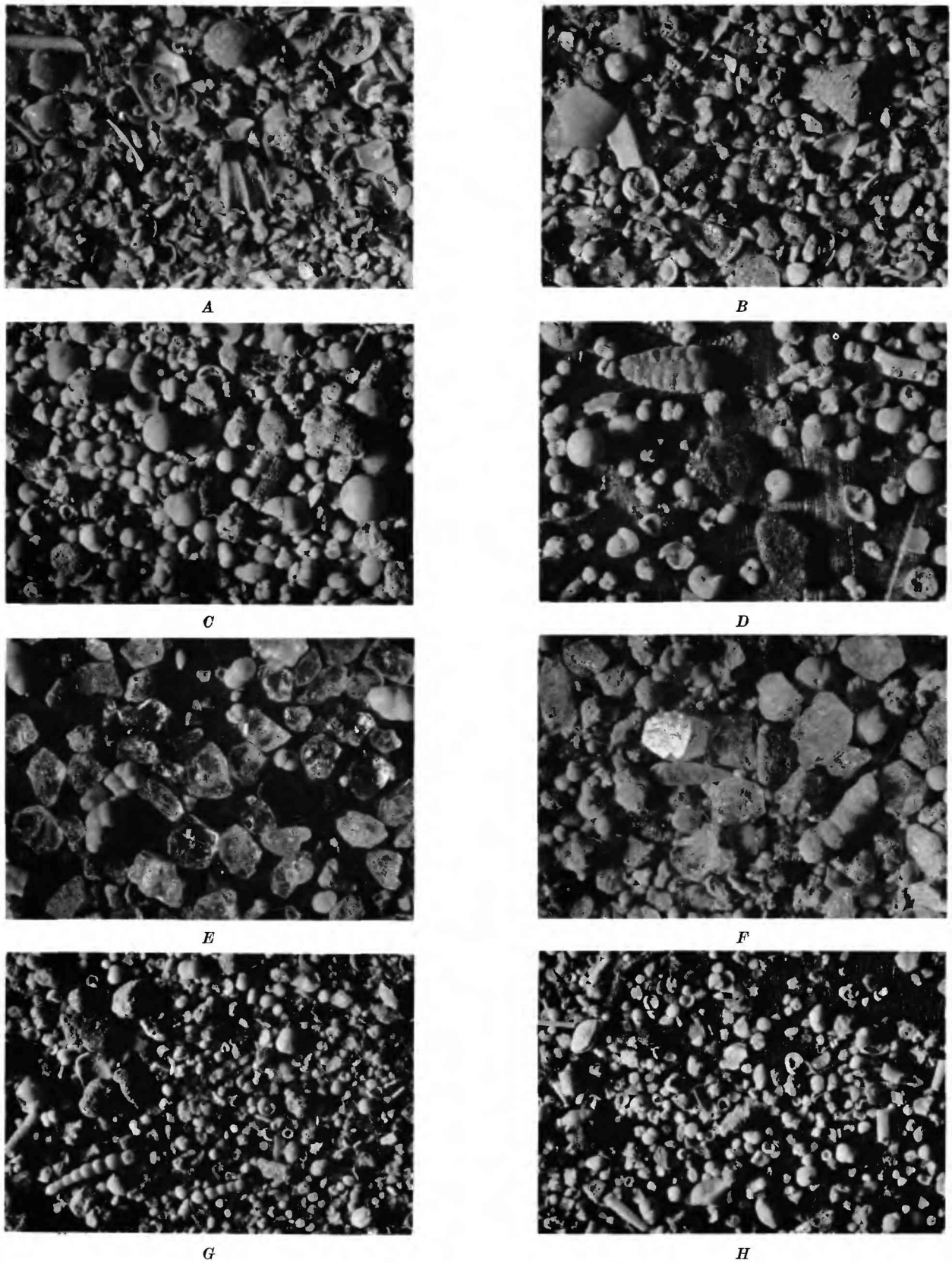

FIGURE 3.—Foraminiferal assemblages, × 10, of stratigraphic units of southern Okinawa. *A, B,* Chinen Sand; shell fragments, bryozoa, and ostracodes common. *C, D,* Globorotalia punctulata fauna of Shinzato Member; mainly planktonic species; *Orbulina universa* common. *E, F, Loxostomum pacificum* fauna of Yonabaru Member; clear grains of feldspar commonly associated with mafic minerals. *G, H, Nonion nicobarense-Cibicides macneili* fauna of Yonabaru Member; restricted variety of Foraminifera; pyrite aggregates common.

Amphistegina madagascariensis d'Orbigny, *A. wanneriana* Fischer, *Asterorotalia trispinosa* (Thalmann), *Eponides praecintus* (Karrer), *Operculina gaimairdi* (d'Orbigny), *Planorbulinella larvata* (Parker and Jones), and *Siphogenerina raphanus* (Parker and Jones) infer that the *Loxostomum pacificum* fauna, for the most part, developed under tropical to subtropical shallow-neritic conditions.

NONION NICOBARENSE-CIBICIDES MACNEILI FAUNA

West of Buckner Bay, sedimentary rock containing this fauna crops out extensively; it is also well represented in the Yonabaru and Katchin Hanto wells between 0 and 1,250 and 360 and 1,675 feet respectively.

The deposits consist principally of dark- to bluish-gray shale and sandy shale with a few thin fine- to medium-grained graywacke-type sandstones. Washed residues contain considerable amounts of pyritized plant remains. The fauna is distinct from that of the overlying *Loxostomum pacificum* assemblage, although a few species are common to both.

Species diagnostic to this fauna are indicated by asterisks (*).

**Bolivina plano-convexa* Cushman and Todd	S
robusta H. B. Brady	C
**Bolivinita quadrilatera* (Schwager) (small var.)	R
**Bolivinopsis hiratai* Uchio	C
**Bulimina gutta* Parr	C
inflata Sequenza	C
**Cibicides macneili* LeRoy, n. sp	C
haidingerii (d'Orbigny) var. *pacificus* (Cushman)	C
pseudoungerianus (Cushman)	C
wuellerstorfi (Schwager)	R
Eggerella bradyi (Cushman)	C
Eponides hyalinus (Hofker)	R
**Globoquadrina altispira* (Cushman and Jarvis)	C
Globigerina bulloides d'Orbigny	C
dubia Egger	C
**Globigerinoides mitra* Todd	S
triloba immatura LeRoy	C
Globorotalia menardii multicamerata Cushman and Jarvis	R
tumida (H. B. Brady) (small var.)	S
Gyroidina cibaoensis Bermudez	R
trincherasensis Bermudez	R
**Hoeglundina elegans* (d'Orbigny)	C
Nodosaria subtertenuata Schwager	C
**Nonion nicobarense* Cushman	C
Orbulina universa d'Orbigny (small var.)	C
**Osangularia bengalensis* (Schwager)	R
Pleurostomella alternans Schwager	R
Pseudoeponides umbonatus (Reuss)	R
Pullenia bulloides (d'Orbigny)	R
Pyrgo murrhina (Schwager)	R
Quinqueloculina akneriana d'Orbigny	R
**Schenckiella communis* (d'Orbigny) *hosoyaensis* (Asano)	C
**Sigmoilina schlumbergeri* A. Silvestri	C
Siphotextularia flintii Cushman var. *pacifica* LeRoy, n. var.	R
Sphaeroidina bulloides d'Orbigny	R
Sphaeroidinella seminulina (Schwager)	C
Spiroloculina circularis Cushman	S
Stilostomella lepidula (Schwager)	C
**Uvigerina peregrina* Cushman var. *dirupta* Todd	C
proboscidea Schwager var. *vadescens* Cushman	R

In addition to the above species, the following were observed in the upper part (0–1,250 ft) of the Yonabaru well.

Amphistegina madagascariensis d'Orbigny	S
Bulimina subaffinis Cushman	S
subcalva Cushman and Stewart	S
Calcarina rustica Todd and Post	S
Cassidulina orientale Cushman	R
pacifica Cushman	C
Chilostomella oolina Schwager	S
Cibicides shinzatoensis LeRoy, n. sp	S
Clavulina yabei akiensis Asano	S
Elphidium fax barbarense Nicol (small var.)	S
Eponides praecintus (Karrer)	S
procerus (H. B. Brady)	S
subornatus (Cushman)	S
Globigerinella aequilateralis (H. B. Brady)	S
Globobulimina pacifica Cushman	S
**Gyroidina neosoldanii* Brotzen	S
Laticarinina pauperata (Parker and Jones)	S
Operculina gaimairdi d'Orbigny	S
Quinqueloculina carinata d'Orbigny	S
Rectobolivina bifrons (H. B. Brady) var. *striatula* (Cushman)	R
Rectuvigerina striata (Schwager)	S
Schenckiella communis (d'Orbigny)	R
Trifarina bradyi Cushman	S
Uvigerina crassicostata Schwager	S
hispida Schwager	R

Microfaunal evidence suggests that the sediments of this part of the Yonabaru accumulated under alternately subtropical shallow- to deep-neritic conditions but in deeper water than that typified by the *Loxostomum pacificum* fauna.

Species absent or rare in this assemblage, but which occur abundantly in the *Globorotalia punctulata* fauna of the Shinzato Member, include:

Anomalina bradyi Said
Bolivina albatrossi Cushman
Bulimina aculeata d'Orbigny
marginata d'Orbigny
yonabaruensis LeRoy, n. sp.
Candeina nitida d'Orbigny
Cibicides fijiensis (Cushman)
okinawaensis LeRoy, n. sp.
Discanomalina japonica Asano
Globigerinoides triloba fistulosa (Schubert)
Globorotalia punctulata (d'Orbigny)
Hyalinea balthica (Schroeter)
Pulleniatina obliquiloculata (Parker and Jones)
Rectobolivina dimorpha (Parker and Jones)
Schenckiella victoriensis (Cushman)
Sphaeroidinella dehiscens (Parker and Jones)
Uvigerina aculeata d'Orbigny
Vagocibicides nipponicus Asano
Vulvulina pacifica Cushman

POORLY DEVELOPED CALCAREOUS FAUNA

This fauna was penetrated in the Yonabaru well between 1,250 and 2,450 feet. The strata in this interval are extremely arenaceous and contain poorly developed foraminiferal assemblages having affinities with the overlying *Nonion nicobarense-Cibicides macneili* fauna. The details of this assemblage could not be determined because of ditch sample contamination.

ARENACEOUS FAUNA

This fauna was penetrated in the Yonabaru 1 between 2,450 and 4,036 feet. Medium-gray shales and several thin graywacke-type sandstones occupy the interval. The top of the fauna marks a conspicuous foraminiferal change within the Yonabaru section (fig. 2) by the prominent introduction of *Adercotryma*, *Cyclammina*, *Schenckiella*, *Goesella*, *Glomospira*, *Ammodiscus*, and *Miliammina*.

Species frequent in this assemblage are listed as follows. Those indicated by an asterisk (*) appear to be stratigraphically restricted.

**Adercotryma glomerata* (H. B. Brady)	C
**Ammodiscus dominicensis* var. *deformis* Bermudez	R
Bolivinopsis hiratai Uchio	R
Bulimina inflata Seguenza	S
subaffinis Cushman	S
**Cyclammina ezoensis* Asano	C
sp. A. LeRoy	R
Eggerella bradyi (Cushman)	R
Globigerina bulloides d'Orbigny	C
dubia Egger	C
Globigerinoides mitra Todd	S
triloba immatura LeRoy	C
**Glomospira glomerata* Höglund	C
**Goesella schencki* Asano	R
Hoeglundina elegans (d'Orbigny)	S
**Miliammina echigoensis* Asano and Inomata	S
Orbulina universa d'Orbigny	R
Pseudoeponides umbonatus (Reuss)	S
Schenckiella communis (d'Orbigny) *hosoyaensis* (Asano)	R
okinawaensis LeRoy, n. sp	R
victoriensis Cushman	R
Sigmoilina schlumbergeri A. Silvestri	C
Sphaeroidinella seminulina (Schwager)	R
Uvigerina hispida Schwager	S
peregrina Cushman var. *dirupta* Todd	R
proboscidea Schwager var. *vadescens* Cushman	R

The microfauna and lithology of this interval suggest the sediments accumulated under deep-neritic to shallow-bathyal conditions. The rock containing this fauna does not crop out in southern Okinawa. The age of these deposits based on the general foraminiferal assemblages is assigned tentatively to the late Miocene, although a middle Miocene allocation would not be unreasonable. The lowest ditch samples in Yonabaru 1 appear to contain large forms of *Orbulina universa* d'Orbigny; therefore, these strata are inferred to lie above the *Orbulina* surface (LeRoy, 1948) which is placed at the base of the middle Miocene in central Sumatra. In the Caribbean region, *Orbulina* extends through the late Oligocene. In the Mediterranean area its lowest extent marks the Oligocene-Miocene boundary. These discrepancies may be due to inaccurate usage of the European terminology in terms of chronological contemporaneity rather than to the time value of the lowest occurrence of this planktonic genus in a continuously deposited deep-sea stratal sequence.

MIOCENE OR PLIOCENE

SHINZATO MEMBER OF THE SHIMAJIRI FORMATION

The Shinzato, assignable to either late Miocene or Pliocene, consists primarily of light- to medium-gray shaly tuff and silty shale lying unconformably above the Yonabaru Member and separated from the overlying Pliocene Chinen Sand or Naha Limestone by an unconformity.

The deposits are characterized by the distinct well-developed foraminiferal fauna listed as follows. Species marked by an asterisk (*) are seemingly diagnostic of the member. A=abundant, more than 100 specimens.

Anomalina bradyi Said	R
**Bolivina albatrossi* Cushman	R
robusta H. B. Brady	C
**spinescens* Cushman	S
Bolivinita quadrilatera (Schwager) (large var.)	S
**Bulimina aculeata* d'Orbigny	R
inflata Seguenza	R
marginata d'Orbigny	S
**Candeina nitida* d'Orbigny	C
**Cassidulina okinawaensis* LeRoy, n. sp	C
orientale Cushman	R
**pacifica* Cushman	C
subglobosa H. B. Brady	C
**Cibicides fijiensis* (Cushman)	R
lobatulus (d'Orbigny)	S
**okinawaensis* LeRoy, n. sp	R
pseudoungerianus (Cushman)	C
wuellerstorfi (Schwager)	R
**Discanomalina japonica* Asano	S
Eggerella bradyi (Cushman)	R
Elphidium fax barbarense Nicol	S
Eponides hyalinus (Hofker)	R
Globigerina bulloides d'Orbigny	A
dubia Egger	A
Globigerinella aequilateralis (H. B. Brady)	R
**Globigerinoides ruber* (d'Orbigny) (large var.)	A
triloba immatura LeRoy	A
fistulosa (Schubert)	R
**Globorotalia tumida* (H. B. Brady) (large var.)	A
menardii multicamerata Cushman and Jarvis	C
praemenardii Cushman and Stainforth	R
**punctulata* (d'Orbigny)	A
Gyroidina cibaoensis Bermudez	S
trincherasensis Bermudez	C

Hoeglundina elegans (d'Orbigny)	R
Hyalinea balthica (Schroeter)	S
Karreriella bradyi (Cushman)	R
Lagenonodosaria scalaris (Batsch)	C
Loxostomum amygdalaeformis (H. B. Brady) var. *iokense* Asano	S
Nonion pompilioides (Fichtel and Moll)	S
pompilioides (Fichtel and Moll) var. *okinawaense* LeRoy, n. var	S
**Orbulina universa* d'Orbigny (large var.)	A
Osangularia bengalensis (Schwager) (large var.)	S
**Patellinella jugosa* (H. B. Brady)	S
Pleurostomella alternans Schwager	R
brevis Schwager	S
Pullenia bulloides (d'Orbigny)	R
**Pulleniatina obliquiloculata* (Parker and Jones)	C
Pyrgo murrhina Schwager	S
**Ramulina globulifera* H. B. Brady	S
**Rectuvigerina striata* (Schwager)	S
Rectobolivina bifrons (H. B. Brady) var. *striatula* (Cushman)	R
dimorpha (Parker and Jones)	S
Rectoglandulina laevigata (d'Orbigny)	S
Rotalidium okinawaensis LeRoy, n. sp	S
Schenckiella victoriensis (Cushman)	S
Sigmoilina schlumbergeri A. Silvestri	R
**Siphonina australis* Cushman	R
Siphotextularia flintii (Cushman) var. *pacifica* LeRoy, n. var	S
**Sphaeroidinella dehiscens* (Parker and Jones)	A
Stilostomella lepidula (Schwager)	C
Trifarina bradyi Cushman	R
**Uvigerina aculeata* d'Orbigny	R
nitidula Schwager	R
proboscidea Schwager var. *vadescens* Cushman	R
**Vagocibicides nipponicus* Asano	S
**Vulvulina pacifica* Cushman	R

Foraminifera of the Shinzato Member appear to have developed under a moderately deep neritic open-sea subtropical to tropical environment. Many species of the middle and late Tertiary and Recent deposits of the Indo-Pacific Islands, as well as those of the late Tertiary of Japan and the Philippines, are well represented in the fauna.

The Shinzato assemblage is designated in this paper as the *Globorotalia punctulata* fauna. The benthonic species are exceptionally well developed as are the planktonic forms *Globigerinoides ruber* (d'Orbigny), *G. triloba fistulosa* (Schubert), *G. mitra* Todd, *Globoquadrina altispira* (Cushman and Jarvis), *Orbulina universa* d'Orbigny, *Candeina nitida* d'Orbigny, *Globorotalia tumida* (H. B. Brady), *G. menardii multicamerata* Cushman and Jarvis, *Pulleniatina obliquiloculata* (Parker and Jones), and *Sphaeroidinella dehiscens* (Parker and Jones). The stratigraphic range of these planktonics should be carefully considered in future biostratigraphic work in the Western, Southern, and Central Pacific, in establishing long-range time correlations within late Tertiary deposits of these regions.

PLIOCENE

CHINEN SAND

The Chinen has a restricted areal distribution in the southeastern part of the island. It rests unconformably on either the Yonabaru or the Shinzato deposits, is overlain unconformably by the Naha Limestone, and consists mainly of bluish-gray to tan fine-grained sandstones and siltstones. In Katchin Hanto 1, the formation was penetrated between 55 and 360 feet and is in unconformable contact with the deepwater *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru Member.

The Foraminifera are varied in both species and genera, many of which, particularly those in the upper part of the formation, are small compared to those in the underlying Shinzato. Several Shinzato forms occur in the lowermost part of the Chinen due to reworking.

Based on well cuttings from Katchin Hanto well and surface samples, and discarding the possibility of reworked species from pre-Chinen strata, the following listed forms occur frequently in the deposit. Those marked by an asterisk (*) seemingly are restricted.

Amphistegina madagascariensis d'Orbigny	R
wanneriana Fischer	S
Angulogerina japonica Asano	S
Anomalina glabrata Cushman	S
Baggina totomiensis Makiyama	S
Bolivina albatrossi Cushman	S
Bolivinita quadrilatera (Schwager) (small var.)	S
Bulimina inflata Seguenza	S
marginata d'Orbigny	S
subaffinis Cushman	S
Buliminoides williamsonianus (H. B. Brady)	R
Calcarina rustica Todd and Post	R
spengleri (Gmelin)	R
Cancris auriculus (Fichtel and Moll)	S
Candeina nitida d'Orbigny	S
Cassidulina orientale Cushman	R
Chilostomella oolina Schwager	S
Cibicides lobatulus (d'Orbigny)	R
pseudoungerianus (Cushman)	S
tenuimargo (H. B. Brady)	S
Ehrenbergina bosoensis var. *decorata* Takayanagi	R
Elphidium fax barbarense Nicol	R
jenseni (Cushman)	R
Eponides praecintus (Karrer)	R
subornatus (Cushman)	R
Globigerina bulloides d'Orbigny	R
dubia Egger	R
Globigerinella aequilateralis (H. B. Brady)	S
Globigerinoides ruber (d'Orbigny)	R
triloba immatura LeRoy	R
Globobulimina pacifica Cushman	S
Globorotalia menardii multicamerata Cushman and Jarvis	R
punctulata (d'Orbigny)	R
tumida (H. B. Brady)	R
Gypsina globula (Reuss)	S

Hanzawaia nipponica Asano	S
Hoeglundina elegans (d'Orbigny)	R
Hyalinea balthica (Schroeter)	S
Lagenonodosaria scalaris (Batsch)	S
Loxostomum amygdalaeforme (H. B. Brady) var. *iokense* Asano	S
Neoconobina opercularis (d'Orbigny)	S
**nakamurai* (Asano)	S
pacifica LeRoy, n. sp	R
Nodosaria insecta Schwager	S
longiscata d'Orbigny	S
Nonion akitaensis (Asano)	S
japonicum (Asano)	S
Operculina gaimairdi d'Orbigny	R
Orbulina universa d'Orbigny	S
Patellinella jugosa (H. B. Brady)	S
Planorbulinella larvata (Parker and Jones)	S
Pulleniatina obliquiolculata (Parker and Jones)	S
Quinqueloculina akneriana d'Orbigny	R
elongata Natland	R
carinata d'Orbigny	C
Rectobolivina bifrons (H. B. Brady) var. *striatula* (Cushman)	S
virgula (H. B. Brady)	S
**Rotorbinella chinenensis* LeRoy, n. sp	C
Rotalidium okinawaensis LeRoy, n. sp	S
Reussella spinulosa (Reuss)	R
Siphogenerina raphanus (Parker and Jones)	R
Siphonina australis Cushman	S
Siphotextularia flintii (Cushman) var. *pacifica* LeRoy, n. var.	S
Sphaeroidina bulloides d'Orbigny	S
Spiroloculina communis Cushman	R
Stilostomella lepidula (Schwager)	S
Streblus beccarii tepida (Cushman)	R
Textularia candeina d'Orbigny	S
sagittula Defrance var. *fistulosa* (H. B. Brady)	S
Trifarina bradyi Cushman	S
Triloculina tricarinata d'Orbigny	S
Uvigerina striatella Reuss	S
proboscidea Schwager var. *vadescens* Cushman	S

Ostracodes, bryozoans, and molluscan fragments are common. The presence of *Amphistegina madagascariensis* d'Orbigny, *A. wanneriana* Fischer, *Calcarina rustica* Todd and Post, *C. spengleri* (Gmelin), *Eponides subornatus* (Cushman), *Gypsina globula* (Reuss), *Hanzawaia nipponica* Asano, *Operculina gaimairdi* d'Orbigny, *Planorbulinella larvata* (Parker and Jones), *Siphogenerina raphanus* (Parker and Jones), and *Streblus beccarii tepida* (Cushman) indicate these sediments accumulated under shallow-water subtropical environments.

Chinen assemblages differ from those of the underlying Shinzato by the absence or poor development of *Anomalina bradyi* Said, *Bulimina aculeata* d'Orbigny, *Cassidulina pacifica* Cushman, *Cibicides fijiensis* (Cushman), *Eggerella bradyi* (Cushman), *Globigerinoides triloba fistulosa* (Schubert), *Globorotalia punctulata* (d'Orbigny), *Karreriella bradyi* (Cushman), *Pullenia bulloides* d'Orbigny, *Pulleniatina obliquiloculina* (Parker and Jones), *Sigmoilina schlumbergeri* A. Silvestri, *Sphaeroidinella dehiscens* (Parker and Jones), *Uvigerina aculeata* d'Orbigny, and *Vulvulina pacifica* Cushman.

NAHA LIMESTONE

The Naha consists of gravel, coarse-grained carbonate sand, bluish-gray shale, argillaceous sand, and sandy to pure hard dense to porous brecciated coral-algal limestone. Recrystallization of the limestone has occurred throughout but to a much greater degree at and near the surface of present exposures. The formation ranges in thickness from 0 to about 200 feet, the latter probably close to its original maximum thickness.

The Naha rests on the Shinzato Member where the Chinen Sand is absent as a result of either unconformity or facies change.

Because of ground-water leaching, the Foraminifera are poorly preserved. Those most common in the formation are:

Amphistegina madagascariensis d'Orbigny	S
Anomalina glabrata Cushman	S
Baggina totomiensis Makiyama	S
Bolivina striatula Cushman	S
Buliminoides williamsonianus (H. B. Brady)	S
Bulimina marginata d'Orbigny	S
Cancris communis Cushman and Todd	S
Calcarina rustica Todd and Post	S
spengleri (Gmelin)	S
Cassidulina pacifica Cushman	S
Cibicides lobatulus (d'Orbigny)	R
pseudoungerianus (Cushman)	S
Clavulina yabei okiensis Asano	S
Cymbaloporetta bradyi (Cushman)	S
Ehrenbergina bosoensis var. *decorata* Takayanagi	S
Elphidium fax barbarense Nicol	R
Eponides margaritiferus (H. B. Brady)	S
praecintus (Karrer)	R
subornatus (Cushman)	R
Globigerina bulloides d'Orbigny	S
dubia Egger	S
Globigerinoides ruber (d'Orbigny)	S
triloba immatura LeRoy	S
Globorotalia menardii multicamerata Cushman and Jarvis	S
tumida (H. B. Brady)	S
Hanzawaia nipponica Asano	S
Loxostomum amygdalaeforme (H. B. Brady) var. *iokiense* Asano	S
Orbulina universa d'Orbigny	S
Planobulinella larvata (Parker and Jones)	R
Quinqueloculina akneriana d'Orbigny	S
carinata d'Orbigny	S
Reussella spinulosa (Reuss)	S
Rotalia stachi Asano	R
Siphogenerina raphanus (Parker and Jones)	R
Streblus beccarii tepida (Cushman)	S
Uvigerina striatella Reuss	S
proboscidea Schwager	S

Coral, algal, bryozoan, and molluscan fragments are common; ostracodes occur in limited numbers. The Naha Limestone appears to contain fewer genera and

species of Foraminifera than the underlying Chinen Sand, but all those occurring in the formation have been observed in the Chinen.

PLEISTOCENE

The Pleistocene deposits are included within the Ryukyu Group that consists of the Yontan and Machinato Limestones.

YONTAN LIMESTONE

This limestone, according to MacNeil (1960), is similar to the Naha but in general is coarser textured. It is highly porous to dense and has a maximum thickness of about 200 feet—average thickness about 40 feet. Intertongues of gravel are numerous. In places (where its lower contact was observed) it rests on Paleozoic rocks, on shales and tuffs of the Shimajiri, or on the Naha. The Foraminifera of this deposit were not studied.

MACHINATO LIMESTONE

This unit consists of foraminiferal sands, conglomerate, and detritus composed of coral and mollusks. The Foraminifera of this deposit are not treated in this paper.

STRATIGRAPHIC SUMMARY OF YONABARU 1

Yonabaru 1, drilled by the U.S. Navy in 1946 in southern Okinawa (fig. 1), penetrated Yonabaru deposits between 0 and 4,036 feet (fig. 4).

LITHOSTRATIGRAPHY

On the basis of controlled ditch cuttings and their washed residues, four major lithologic units were recognized in the well.

Lithologic description of Yonabaru 1

	Depth (feet)
Shale, siltstone, and sandstone, interbedded, sandy. Shale and siltstone are dark gray to medium gray. Sandstone is gray, fine to medium grained, of graywacke to subgraywacke type. Two sandstones (A and B) occur between 1,250 and 1,400 ft and 2,180 and 2,320 ft, respectively. Both beds contain considerable argillaceous matrix, mafic minerals, and dark rock fragments. A thin dark-red shale was found at 2,050 ft	0–2,320
Shale, dark- to medium-gray. The strata in this interval begin the dominantly argillaceous part of the well section	2,320–2,775
Shale and sandstone; consists of dark- to medium-gray shale and fine- to medium-grained graywacke sandstone which occur in approximately equal amounts. The most important sandstones in the interval are designated as C (2,775–2,850 ft), D (2,975–3,030 ft), and E (3,120–3,170 ft)	2,775–3,170
Shale, dark- to medium-gray and a few minor fine-grained thin-bedded sandstones. A dark-red shale, similar to that at 2,050 ft, is present in the lower part (3,780 ft)	3,170–4,036

BIOSTRATIGRAPHY

Only the lower three of the four previously discussed (p. F3) foraminiferal faunas of the Yonabaru Member occur in this well and from youngest to oldest are as follows:

NONION NICOBARENSE-CIBICIDES MACNEILI FAUNA (0–1,250 FT)

The Foraminifera contained in these deposits are well represented by both genera and species and are the same as those that occur in outcrop. The base of the deposit that contains this predominantly calcareous fauna lies approximately at the top (1,250 ft) of sandstone A. The assemblages indicate alternately shallow- and deep-neritic tropical to subtropical conditions of sedimentation. The exact stratigraphic positions of the various assemblages within the interval cannot be placed because of contamination by recirculated cuttings. Shallow-water deposits are suggested by such species as *Amphistegina madagascariensis* d'Orbigny, *Calcarina rustica* Todd and Post, *Eponides praecintus* (Karrer), *E. procerus* (H. B. Brady), *Planorbulinella larvata* (Parker and Jones), and *Peneroplis pertusus* (Forskal). The deeper water deposits are indicated by such forms as *Bolivinopsis hiratai* Uchio, *Bulimina gutta* Chapman and Parr, *B. inflata* Seguenza, *Eggerella bradyi* (Cushman), *Nonion nicobarense* Cushman, *Pseudoeponides umbonatus* (Reuss), and *Uvigerina peregina* Cushman var. *dirupta* Todd.

Other well-represented species in these deposits are *Bolivinita quadrilatera* (Schwager), *Bulimina subcalva* Cushman and Stewart, *Cibicides pseudoungerianus* (Cushman), *Gyroidina neosoldanii* Brotzen, *Globorotalia tumida* (H. B. Brady), *Hoeglundina elegans* (d'Orbigny), *Schenckiella communis* (d'Orbigny) *hosoyaensis* (Asano), *Nodosaria insecta* Schwager, *N. longiscata* d'Orbigny, *N. tosta* Schwager, *Orbulina universa* d'Orbigny, *Rotalia stachi* Asano, *Sigmoilina schlumbergeri* A. Silvestri, *Sphaeroidinella seminulina* (Schwager), *Stilostomella lepidula* (Schwager), and *Uvigerina proboscidea* Schwager var. *vadescens* Cushman.

POORLY DEVELOPED CALCAREOUS FAUNA (1,250–2,450 FT)

Foraminifera contained in these deposits are similar to those between 0 and 1,250 feet but are restricted in the number of individuals per species because of the arenaceous nature of the section. Many of the recorded species could have resulted from sample contamination from stratigraphically higher levels.

ARENACEOUS FAUNA (2,450–4,036 FT)

A conspicuous microfaunal change occurs in the section at 2,450 feet. Several new arenaceous genera and

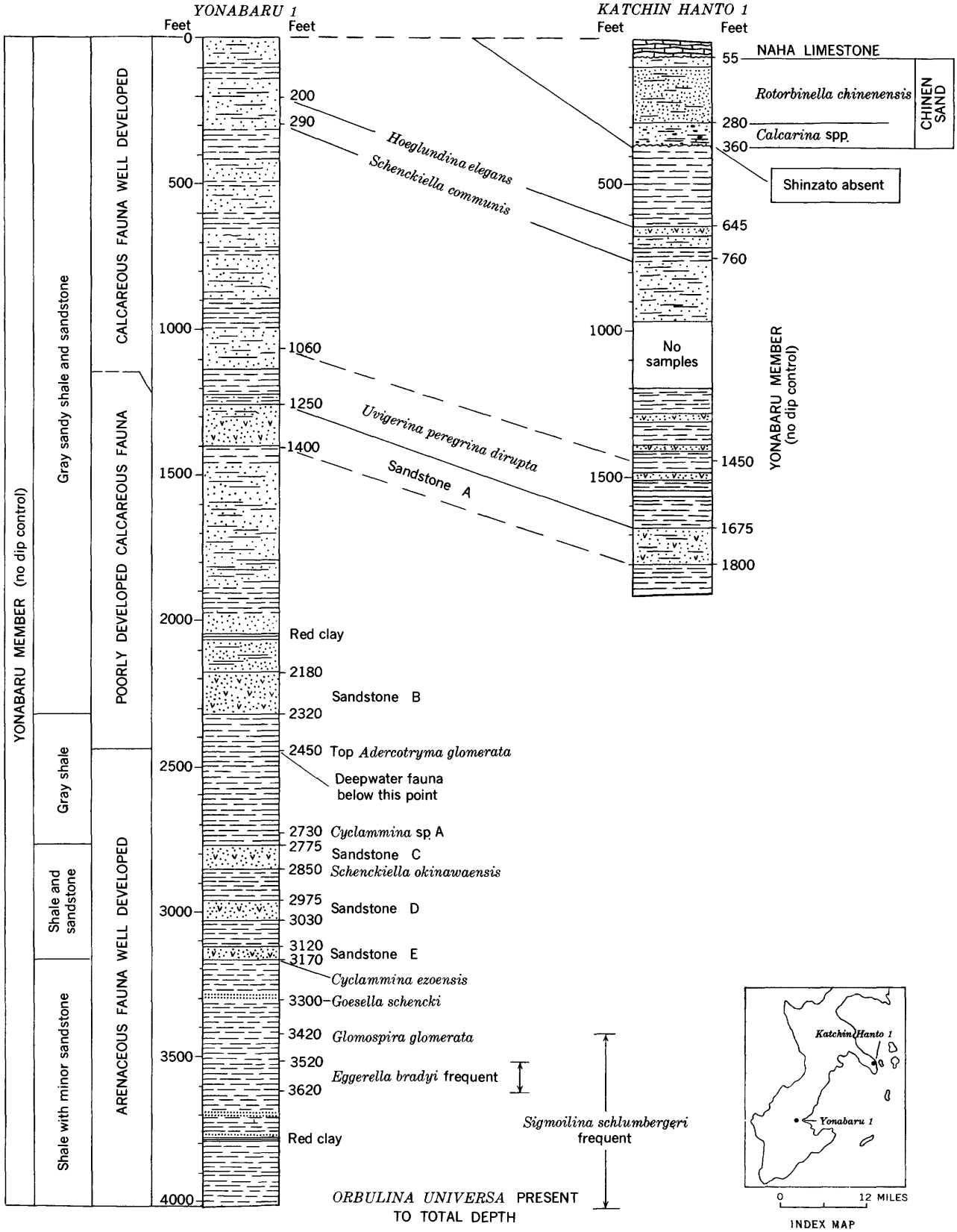

FIGURE 4.—Correlation of Yonabaru 1 and Katchin Hanto 1, southern Okinawa. Total depth of Yonabaru 1 is 4,036 feet and of Katchin Hanto 1, 1,900 feet. Lithologic and faunal units are based on ditch samples.

species are introduced and many of the calcareous forms that were present in the overlying assemblages are absent to very rare.

The upper limits (tops) of the most important arenaceous species below 2,450 feet are given. For further details on the stratigraphic ranges of these species see figure 5.

	Depth (feet)
Adercotryma glomerata (H. B. Brady)	2,450
Cyclammina sp. A LeRoy	2,730
Schenckiella okinawaensis LeRoy, n. sp	2,775
Cyclammina ezoensis Asano	3,170
Goesella schencki Asano	3,300
Glomospira glomerata Höglund	3,420
Ammodiscus dominicensis var. *deformis* Bermudez	3,500
Miliammina echigoensis Asano and Inomata	3,850

The Foraminifera between 2,450 and 4,036 feet indicate a deep-neritic to shallow-bathyal type of environment—much deeper water conditions that seemingly prevailed during deposition of the beds penetrated between 0 and 2,450 feet. This environment is supported also by the argillaceous nature of the section.

The section below 2,450 feet is of special interest from several viewpoints: (a) Most of the lithology is shale (excluding sandstones C, D, and E); (b) the arenaceous Foraminifera are more frequent than in the section above; (c) the strata have not yet been recognized in outcrop in southern Okinawa; (d) both the Foraminifera and lithology suggest a deep-neritic to shallow-bathyal cool-water environment of deposition; and (e) *Orbulina universa* d'Orbigny appears to continue throughout; however, this range may be in error because of recirculated well cuttings.

The vertical distribution of the 11 arenaceous species is shown in figure 5. The highest occurrence of each species is considered reasonably accurate. Their lower limit is questionable because of recirculation of the well cuttings.

STRATIGRAPHIC SUMMARY OF KATCHIN HANTO 1

Katchin Hanto 1, drilled on the Katchin Hanto Peninsula of Okinawa by the U.S. Navy in 1946 (figs. 1, 4), penetrated the following deposits:

	Depth (feet)
Pliocene:	
Naha Limestone	0–55
Chinen Sand	55–360
Rotorbinella chinenensis fauna	
Calcarina fauna	
Unconformity	
Miocene:	
Yonabaru Member of Shimajiri Formation	360–1,900
(*Nonion nicobarense-Cibicides macneili* fauna)	

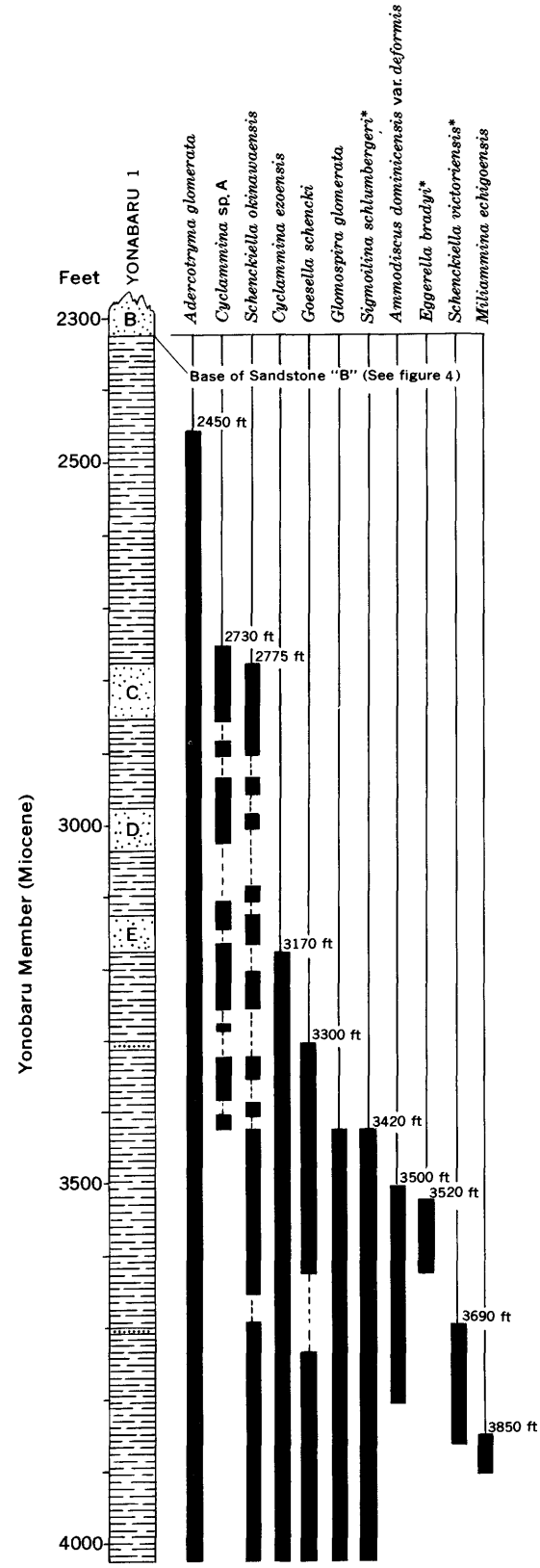

FIGURE 5.—Stratigraphic ranges of some important arenaceous foraminiferal species in the lower part of Yonabaru 1, southern Okinawa; ranges based on residue assemblages of ditch samples; only tops are considered accurate. Asterisk indicates forms stratigraphically higher in total section.

LITHOSTRATIGRAPHY

NAHA LIMESTONE (0–55 FT)

Composed of tan to white soft fine-crystalline fossiliferous porous limestone; the Naha is the youngest stratigraphic unit penetrated. It rests conformably on the Chinen Sand.

CHINEN SAND (55–360 FT)

The Chinen consists of interbedded soft silty shale, shaly siltstone, and fine-grained friable sandstone. Between 280 and 360 feet it is conglomeratic and contains a few beds of hard light-gray calcareous tuffaceous shale.

YONABARU MEMBER OF SHIMAJIRI FORMATION (360–1,900 FT)

The Yonabaru lies unconformably below the Chinen Sand and consists principally of interbedded dark- to medium-gray shale, sandy shale, and soft fine-grained graywacke sandstone; shale predominates over sandstone. Sandstone A, found in Yonabaru 1 between 1,250 and 1,400 feet, was penetrated between 1,675 and 1,800 feet in this well.

The Shinzato fauna was not recognized in cuttings in this well and is absent also in a surface exposure about 1½ miles west-northwest of the well site.

BIOSTRATIGRAPHY

The boundaries of the faunal assemblages in this well correspond to those of the lithic units previously described.

NAHA LIMESTONE (0–55FT)

Foraminifera of the Naha Limestone are only moderately well preserved because of leaching by ground waters and recrystallization. The more common species are: *Amphistegina madagascariensis* d'Orbigny, *Anomalina glabrata* Cushman, *Buliminoides williamsonianus* (H. B. Brady), *Cibicides lobatulus* (d'Orbigny), *Clavulina yabei akiensis* Asano, *Eponides margaritiferus* (H. B. Brady), *Eponides praecintus* (Karrer), *Eponides subornatus* (Cushman), *Globigerina dubia* Egger, *Globigerinoides triloba immatura* LeRoy, *Globigerinoides ruber* (d'Orbigny), *Globorotalia menardii multicamerata* Cushman and Jarvis, *Globorotalia tumida* (H. B. Brady), *Hanzawaia nipponica* Asano, *Orbulina universa* d'Orbigny, *Planorbulinella larvata* (Parker and Jones), *Rotalia stachi* Asano, *Siphogenerina raphanus* (Parker and Jones), and *Uvigerina striatella* (Reuss).

Ostracodes, bryozoans, coral and algal fragments are common and indicate a shallow, warm-water, tropical environment of deposition.

CHINEN SAND (55–360 FT)

The Chinen consists of two foraminiferal assemblages (55–280 and 280–360 ft respectively). These faunas are at considerable variance with each other as well as with those of the overlying Naha and underlying Shinzato and Yonabaru.

Rotorbinella chinenensis fauna (55–280 ft.).—The Foraminifera of this assemblage suggest a shallow-neritic moderately cool water environment. The more persistent forms include: *Anomalina glabrata* (Cushman), *Bolivina robusta* (H. B. Brady), *Bulimina marginata* d'Orbigny, *Cancris auriculus* (Fichtel and Moll), *C. communis* Cushman and Todd), *Cassidulina orientale* Cushman, *Cibicides lobatulus* (d'Orbigny), *Elphidium fax barbarense* Nicol (small), *E. jenseni* (Cushman), *Fissurina* spp., *Globigerina bulloides* d'Orbigny, *G. dubia* Egger, *Globigerinoides ruber* (d'Orbigny), *G. triloba immatura* LeRoy, *Globorotalia menardii* (d'Orbigny), *Hanzawaia nipponica* Asano, *Hyalinea balthica* (Schroeter), *Lagena* spp., *Lagenonodosaria scalaris* (Batsch), *Loxostomum amygdalaeforme* (H. B. Brady) var. *iokense* Asano, *Neoconobina pacifica* LeRoy, *N. opercularis* (d'Orbigny), *N. nakamurai* (Asano), *Nodosaria insecta* Schwager, *N. Longiscata* d'Orbigny, *Nonion japonicum* (Asano), *Patellinella jugosa* (H. B. Brady), *P. inconspicua* (H. B. Brady), *Pulleniatina obliquiloculata* (Parker and Jones), *Quinqueloculina akneriana* d'Orbigny, *Q. elongata* Natland, *Reusella spinulosa* (Reuss), *Rotorbinella chinenensis* LeRoy, *Siphogenerina raphanus* (Parker and Jones), *Stilostomella lepidula* (Schwager), *Streblus beccarii tepida* (Cushman), *Trifarina bradyi* Cushman, *Triloculina tricarinata* d'Orbigny, and *Uvigerina proboscidea* Schwager var. *vadescens* Cushman.

Bryozoa (flat type), ostracodes, sponge spicules, and molluscan fragments are rather common.

Calcarina fauna (280–360 ft.).—This fauna is a shallow-neritic tropical type and includes, in addition to many species of the overlying *Rotorbinella chinenensis* fauna, the following forms: *Amphistegina madagascariensis* d'Orbigny, *Calcarina rustica* Todd and Post, *C. spengleri* (Gmelin), *Eponides margaritiferus* (H. B. Brady), *Gypsina globula* (Reuss), *Operculina gaimairdi* d'Orbigny, *Rectobolivina bifrons* (H. B. Brady) var. *striatula* (Cushman), and *Textularia sagittula* Defrance var. *fistulosa* (H. B. Brady).

Bryozoa (quadrate types), ostracodes, and molluscan fragments are common and all show considerable attrition.

YONABARU MEMBER OF SHIMAJIRI FORMATION (360–1,900 FT.)

Foraminifera contained in these deposits are similar to those of the *Nonion nicobarense-Cibicides macneili* fauna as developed in the upper part (0–1,250 ft.) of the Yonabaru well. The faunal and lithological boundary

between the Chinen and the Yonabaru is sharp, distinct, and represents a major unconformity that accounts for the absence of *Globorotalia punctulata* fauna (Shinzato) and the *Loxostomum pacificum* fauna.

CORRELATION SUMMARY OF YONABARU AND KATCHIN HANTO WELLS

Yonabaru 1 is located approximately 12 miles southwest of Katchin Hanto 1 (fig. 1). Correlations between the two wells (fig. 4), based on lithological and micropaleontological data from controlled 10-foot cuttings, are given as follows.

	Yonabaru 1 (feet)	Katchin Hanto 1 (feet)
Hoeglundina elegans	200	645
Schenckiella communis	290	760
Uvigerina peregrina var. *dirupta* (top)	1, 060	1, 450
Uvigerina peregrina var. *dirupta* (base)	1, 250	1, 675
Base sandstone A	1, 400	1, 800

The Naha Limestone and Chinen Sand which were penetrated between 0 and 360 feet in Katchin Hanto 1 are absent in the Yonabaru well. The author believes that Katchin Hanto 1 did not penetrate stratigraphically lower than a horizon approximately 1,500 feet below the top of Yonabaru 1.

GENERAL COMMENTS ON THE OKINAWAN AND SOUTH PACIFIC MIDDLE AND LATE TERTIARY MICROFAUNAS

Many of the Foraminifera of the southern Okinawan Tertiary section have been described from Recent and middle to late Tertiary deposits of the Central and South Pacific and Indonesian regions. Brief comments on the affinities of some of these assemblages to those in the Naha, Chinen, Shinzato, and Yonabaru deposits are given here.

The more common Foraminifera of the Naha Limestone include *Amphistegina madagascariensis* d'Orbigny, *Buliminoides williamsonianus* (H. B. Brady), *Eponides praecintus* (Karrer), *E. subornatus* (Cushman), *E. margaritiferus* (Cushman), *Planorbulinella larvata* (Parker and Jones), and *Siphogenerina raphanus* (Parker and Jones). These species are common in the late Tertiary to Recent warm reef limestones of the South and Central Pacific region.

The fauna of the Chinen Sand contains many species that have been recorded in the late Tertiary and Recent deposits of the South and Central Pacific region. It includes such forms as *Amphistegina madagascariensis* d'Orbigny, *Hyalinea balthica* (Schroeter), *Buliminoides williamsonianus* (H. B. Brady), *Bolivina hantkeniana* H. B. Brady, *B. robusta* H. B. Brady, *Candeina nitida* d'Orbigny, *Calcarina rustica* Todd and Post, *C. spengleri* (Gmelin), *Eponides praecintus* (Karrer), *E. subornatus* (Cushman), *Elphidium jenseni* (Cushman), *Operculina gaimairdi* d'Orbigny, and *Rectobolivina bifrons* (H. B. Brady) var. *striatula* (Cushman).

Shinzato faunas are rather uniform in both genera and species and are related closely to those described by LeRoy (1941) from the late Tertiary (Miocene or Pliocene) of the Sangkoelirang Bay area of East Borneo. Koch (1926) recorded a similar fauna from the middle Tertiary of Bulongan, East Borneo. Associated with Koch's fauna, however, were the orbitoides, *Lepidocyclina* cf. *L. angulosa* Provale and *Miogypsina* cf. *M. thecideaeformis* Rutten, which placed the fauna within the Tertiary *f* (Miocene) according to Indonesian chronology.

LeRoy (1944) recorded a Miocene assemblage from west Java in which many species were common to the Shinzato but which contained *Lepidocyclina*. A late Tertiary foraminiferal fauna described (LeRoy, 1941) from Siberoet Island, off the west coast of Sumatra, has much in common with Shinzato assemblages. Schwager's (1866) *Kar Nicobar* fauna, considered as Pliocene by some workers and as Miocene by others, shows a decided affinity to that of the Shinzato.

Many species in the Shinzato were reported by Boomgaart (1949) from the Miocene and Pliocene deposits of Bodjonegoro (Java). Caudri (1934), in her work on the late Tertiary Foraminifera of Soemba, listed several species that occur in common with those from the Shinzato.

Brady (1884) and Cushman (1910–17, 1921) recorded many species from the Recent deposits of the Indo-Pacific and Philippine Sea areas that occur in the Okinawan section.

Cushman and others (1954) reported many Okinawan species from Recent deposits of Bikini and nearby atolls.

The *Loxostomum pacificum* fauna of the Yonabaru Member is a shallow-neritic warm-water assemblage, many species of which have been checklisted from late and middle Tertiary deposits of the South and Central Pacific and adjacent regions.

Several South and Central Pacific species occur in the *Nonion nicobarense-Cibicides macneili* assemblage of the Yonabaru deposits. That part of the Yonabaru between 2,450 and 4,036 feet in the Yonabaru well and characterized by a predominantly arenaceous microfauna cannot be compared by the writer with any known total assemblage of the Indonesian region, although a few species of this interval have been recorded in Tertiary and Recent deposits of this part of the world.

Based on foraminiferal studies of the central Sumatran section and on other investigations of Indonesian

microfaunas, it is believed that the oldest Yonabaru fauna (in Yonabaru 1 at 4,036 ft.) is younger than the pre-*Orbulina* Telisa fauna (Tertiary e–f) of central Sumatra (LeRoy, 1944).

Chang (1954a) listed 47 species from the lower Oligocene of Taiwan (Formosa) including *Globigerina dissimilis* Cushman and Bermudez. This species is common in the upper Oligocene of the West Indies. Since Chang did not observe *Orbulina universa* d'Orbigny, his assemblage is probably older than any fauna thus far found in the southern Okinawan Tertiary.

Todd and others (1954) reported an occurrence from southern Saipan of "an assemblage of smaller Foraminifera that contains distinctive planktonic species in common with the *Globigerinatella insueta* zone (late Oligocene) of the Caribbean Tertiary." This fauna should be considered older than any Tertiary fauna noted in southern Okinawa.

BATHYMETRIC INTERPRETATION OF THE SOUTHERN OKINAWAN SECTION

The bathymetric interpretation of the stratigraphic sequence of the southern Okinawan Tertiary, as based primarily on Foraminifera and lithology, is shown in figure 6. The writer makes no pretense that this interpretation is final as the data on which the study was made are considered incomplete. Only that part of the stratal sequence above the bottom (4,036 ft.) of the Yonabaru well is involved. Below this depth the paleobathymetry of the Tertiary section is not known. Deposits from the deepest water of the Tertiary section that were studied occur in Yonabaru 1, between 2,450 and 4,036 feet. This inference is made on the basis of a predominantly shale section containing the arenaceous Foraminifera *Adercotryma*, *Ammodiscus*, *Cyclammina*, *Eggerella*, *Goesella*, *Miliammina*, *and Schenckiella*. Molluscan fragments and ostracodes were not observed. Above these deposits, both in the well and at the surface, a series of interbedded fine- to medium-grained sandstones and shales contain both shallow- and deep-neritic Foraminifera that constitute the *Nonion nicobarense-Cibicides macneili* fauna. Overlying this assemblage and appearing to represent the youngest deposits of the Yonabaru is the *Loxostomum pacificum* fauna, which includes such shallow-water subtropical to tropical genera as *Amphistegina*, *Asterorotalia*, *Hanzawaia*, *Operculina*, and *Planorbulinella*. This environment is supported also by the presence of abraded molluscan and bryozoan debris, ostracodes, and polished rock fragments.

Following the deposition of the *Loxostomum pacificum* fauna the area submerged and resulted in the accumulation of the medium- to deep-neritic sediments and faunas of the Shinzato Member. Many species of Foraminifera within these sediments are South and Central Pacific warm-water types.

After Shinzato deposition there was gradual shallowing during which time the Chinen Sand and the coral-algal limestones of the Naha, Yontan, and Machinato were laid down.

In summary it may be said that following the deposition of the arenaceous fauna (p. F7) and associated sediments of the Yonabaru, there was an overall progressive but interrupted shallowing of the Tertiary sea across southern Okinawa. The time of greatest shallowing occurred at the start of Chinen deposition.

SYSTEMATIC DESCRIPTIONS

Family RHIZAMMINIDAE

Genus BATHYSIPHON M. Sars, 1872

Bathysiphon arenacea Cushman

Plate 1, figure 7

Bathysiphon arenacea Cushman, 1927, Scripps Inst. Oceanography Bull., tech. ser., v. 1, no. 10, p. 120, pl. 1, fig. 2.

Common in the lower part of the Yonabaru Member which is penetrated by Yonabaru 1 between 2,450 and 4,036 feet. In these deposits it is associated with *Cyclammina*, *Schenckiella*, *Goesella*, *Sigmoilina*, *Eggerella*, and *Miliammina*.

Length 1.10 mm (incomplete).

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

Reophax agglutinatus Cushman

Plate 3, figure 31

Reophax agglutinatus Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 73, pl. 14, figs. 2a, b.

Several specimens were recorded from the shallow-water facies (*Loxostomum pacificum* fauna) of the Yonabaru.

Length 1.93 mm; diameter 0.64 mm.

Family AMMODISCIDAE

Genus AMMODISCUS Reuss, 1861

Ammodiscus dominicensis var. deformis Bermúdez

Plate 1, figure 12

Ammodiscus dominicensis var. *deformis* Bermúdez, 1949, Cushman Lab. Foram. Research Spec. Pub. 25, p. 48, pl. 1, figs. 51, 52.

Occurs sporadically only below 2,450 feet in Yonabaru 1.

Diameter 1.05 mm; thickness 0.14 mm.

Genus GLOMOSPIRA Rzehak, 1888

Glomospira glomerata Höglund

Plate 1, figure 24

Glomospira glomerata Höglund, 1947, Upsala Univ., Zoology, v. 29, p. 130, pl. 3, figs. 8–10, text figure 104 on p. 111.

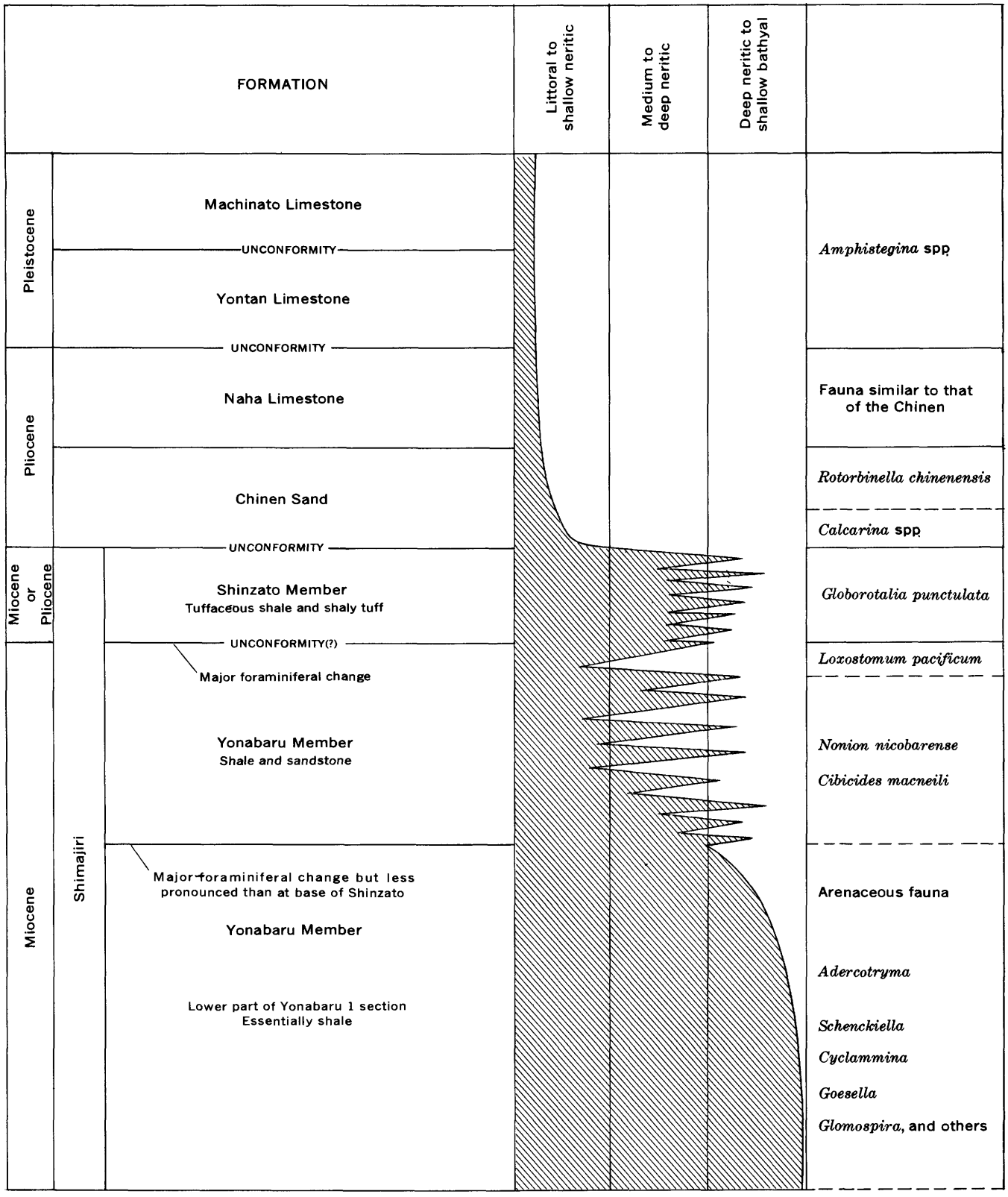

FIGURE 6.—Suggested bathymetric variations of the southern Okinawan section based on benthonic Foraminifera.

This species is confined to the lower part of the Yonabaru and was found in Yonabaru 1 between 3,420 and 4,036 feet.
Diameter 0.63 mm.

Glomospira gordialis (Parker and Jones) var. diffundens Cushman and Renz

Plate 1, figure 25

Glomospira gordialis (Parker and Jones) var. *diffundens* Cushman and Renz, 1946, Cushman Lab. Foram. Research Spec. Pub. 18, p. 15, pl. 1, fig. 30.

Several specimens of this species were observed in Yonabaru 1 below 3,420 feet.
Diameter 0.40–0.57 mm.

Family LITUOLIDAE
Genus ADERCOTRYMA Loeblich and Tappan, 1952

Adercotryma glomerata (H. B. Brady)

Plate 1, figure 32

Haplophragmium glomeratum H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 309, pl. 34, figs. 15–18.

Common and persistent below 2,450 feet in Yonabaru 1. Most of the specimens are as highly distorted as the one figured.
Diameter 1.00 mm; thickness 0.87 mm.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites subagglutinans Bandy

Plate 1, figures 3, 4

Ammobaculites subagglutinans Bandy, 1949, Bull. Am. Paleontology, v. 32, no. 131, p. 27, pl. 3, figs. 5a, b.

Specimens assignable to this species, originally described from Oligocene of Alabama, were noted occasionally in the Chinen and Shinzato.
Length 1.44 mm; width 0.64 mm.

Ammobaculites aff. A. cylindricus Cushman

Plate 1, figures 5, 6

Only one specimen having an affinity to *A. cylindricus* Cushman (1921, v. 4, p. 92, pl. 17, fig. 5) from the Shinzato was noted. Cushman recorded the form from many dredge stations between 18 and 554 fathoms in the Philippine region.
Length 1.60 mm; width 0.67 mm.

Ammobaculites sp. A. LeRoy

Plate 1, figures 1, 2

Only one specimen of this form was recorded from the Chinen. It appears to be related to *A. yumotoensis* Asano but differs by being somewhat less compressed.
Length 1.50 mm; width 0.33 mm.

Genus CYCLAMMINA H. B. Brady, 1876

Cyclammina sp. A. LeRoy

Plate 13, figures 3, 4

Test small for the genus, much compressed, faintly umbilicate; chambers indistinct, 8–10 in last whorl; sutures almost radial, indistinct; periphery subacute, slightly lobulate; wall finely textured; color generally white.

It may be a young form of *C. ezoensis* Asano; recorded only between 2,730 and 3,420 feet in Yonabaru 1.
Diameter 0.65–0.84 mm; thickness 0.24 mm.

Cyclammina ezoensis Asano

Plate 13, figures 1, 2

Cyclammina ezoensis Asano, 1951, Inst. Geology and Paleontology, Tōhoku Univ., (Short Papers), v. 3, p. 20, pl. 3, figs. 2a, b.

Commonly occurs between 3,170 and 4,036 feet in Yonabaru 1; absent in the upper part of the Yonabaru Member and younger deposits.
Diameter 1.30–1.70 mm; thickness 0.78 mm.

Family TEXTULARIIDAE
Genus TEXTULARIA Defrance, 1824

Textularia acuta Reuss

Plate 1, figures 33, 34

Textularia acuta Reuss, 1850, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., v. 1, p. 381, pl. 49, fig. 1.

Only a few specimens showing an affinity to this species were recorded from the Shinzato assemblages.
Length 0.90 mm; width 0.51 mm; thickness 0.23 mm.

Textularia candeiana d'Orbigny

Plate 2, figures 5, 6

Textularia candeiana d'Orbigny, 1839, *in* De la Sagra, Histoire, physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 143, pl. 1, figs. 25–27.

Scarce in Shinzato and Yonabaru assemblages.
Length 0.76 mm; width 0.55 mm; thickness 0.34 mm.

Textularia sagittula Defrance var. fistulosa H. B. Brady

Plate 1, figures 30, 31

Textularia sagittula Defrance var. *fistulosa* H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 362, pl. 42, figs. 19–22.

Seemingly limited to the lower part of the Chinen Sand.
Length 1.90 mm; width 0.73 mm; thickness 0.42 mm.

Textularia bocki Höglund

Plate 2, figures 1, 2

Textularia bocki Höglund, 1947, Upsala Univ., Zoology, v. 26, p. 171, pl. 12, fig. 6.

Rare in Chinen, Shinzato, and Yonabaru assemblages.
Length 1.00 mm; width 0.62 mm; thickness 0.42 mm.

Textularia lythostrota (Schwager)

Plate 16, figure 16

Plecanium lythostrota Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 194, pl. 4, figs. 4a–c.

Recorded rarely in only the *Nonion nicobarense-Cibicides maceili* fauna of the Yonabaru.
Length 0.67 mm.

Textularia mayeriana d'Orbigny

Plate 16, figures 1, 2

Textularia mayeriana d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 245, pl. 14, figs. 26–28.

Was observed in the Chinen deposits only.
Length 1.87 mm; width 0.92 mm; thickness 0.67 mm.

Genus SIPHOTEXTULARIA Finlay, 1939

Siphotextularia flintii (Cushman) var. pacifica LeRoy, n. var.
Plate 2, figures 3, 4

Differs from the type by showing more overlap of the chambers and by having more angularity of the peripheral margin. Common in the Shinzato and rare in the Yonabaru.
Length 0.60–0.65 mm; width 0.58–0.62 mm; thickness 0.35–0.38 mm.

Genus VULVULINA d'Orbigny, 1826

Vulvulina pacifica Cushman

Plate 3, figures 9, 10

Vulvulina pacifica Cushman, 1932, Cushman Lab. Foram. Research Contr., v. 8, p. 78, pl. 10, figs. 8, 9.

Recorded in restricted numbers in Shinzato assemblages only.
Length 0.98 mm; width 0.85 mm; thickness 0.50 mm.

Family VERNEUILINIDAE
Genus GAUDRYINA d'Orbigny, 1839

Gaudryina solida Schwager

Plate 1, figures 28, 29

Gaudryina solida Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 199, pl. 4, fig. 11.

Observed in limited numbers from the Yonabaru only.
Length 2.00 mm; width 0.96 mm.

Gaudryina karreriana Cushman

Plate 1, figures 26, 27

Gaudryina karreriana Cushman, 1936, Cushman Lab. Foram. Research Spec. Pub. 6, 8, pl. 1, fig. 18.

Several specimens seemingly referable to this species were recorded from the *Loxostomum pacificum* fauna of the Yonabaru. Cushman's illustration of the type is more quadrate in apertural view than the Okinawan forms. Length 1.05 mm; width 0.71 mm.

Gaudryina siphonifera (H. B. Brady)

Plate 1, figure 21

Textularia siphonifera H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 362. pl. 42, figs. 25–29.

Gaudryina siphonifera (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 7, p. 83, pl. 12, figs. 9, 10.

Several typical specimens were recorded from the *Loxostomum pacificum* fauna of the Yonabaru. Length 1.10 mm; width 0.56 mm.

Family VALVULINIDAE
Genus CLAVULINA d'Orbigny, 1826

Clavulina yabei akiensis Asano

Plate 1, figure 11

Clavulina yabei akiensis Asano, 1936, Geol. Soc. Japan Jour., v. 43, no. 519, p. 944, pl. 52, figs. 4, 5.

Common in the *Loxostomum pacificum* fauna of the Yonabaru; rare in the Naha, Chinen, and Shinzato. Many specimens show a much larger early triangular stage than the one figured. Length 1.60 mm; diameter 0.35 mm.

Genus EGGERELLA Cushman, 1933

Eggerella bradyi (Cushman)

Plate 1, figures 13, 14

Verneuilina bradyi Cushman, 1911, U.S. Natl. Mus. Bull. 71, pt. 2, p. 54, figs. 87a, b,

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

Common in Shinzato and Yonabaru assemblages but attains best development in the Yonabaru; widely recorded in the late Tertiary and Recent deposits of the Indo-Pacific region. Length 0.73 mm; width 0.52 mm.

Genus TRITAXILINA Cushman, 1911

Tritaxilina caperata (H. B. Brady)

Plate 16, figures 3, 4

Tritaxia caperata H. B. Brady, 1884, *Challenger* Rept., Zoology, p. 390, pl. 49, figs. 1–17.

Tritaxilina caperata (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 159, pl. 19, figs. 7–12.

Only one specimen was recorded in the Chinen. Length 1.50 mm; diameter 0.60 mm.

Genus GOESELLA Cushman, 1933

Goesella schencki Asano

Plate 1, figure 15

Goesella schencki Asano, 1950, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 4, p. 2, figs. 11–13.

Observed in the Yonabaru 1 below 3,300 feet only. Length 2.10 mm; diameter 0.93 mm.

Genus KARRERIELLA Cushman, 1933

Karreriella bradyi (Cushman)

Plate 1, figures 22, 23

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

Common in Shinzato assemblages and rare in those of the Yonabaru.
Length 0.62 mm; width 0.40 mm.

Genus SCHENCKIELLA Thalmann, 1942

Schenckiella communis (d'Orbigny) hosoyaensis (Asano)

Plate 1, figure 18

Martinottiella communis (d'Orbigny) *hosoyaensis* Asano, 1950, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 4, p. 3, figs. 18, 19.

Persistent in and seemingly confined to the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru.
Length 1.58 mm; diameter 0.26 mm.

Schenckiella communis (d'Orbigny)

Plate 1, figure 17

Clavulina communis d'Orbigny, 1826, Annales sci. nat., v. 7, no. 4, p. 268.

Listerella communis (d'Orbigny). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 148, pl. 17, figs. 4–9.

Rare in Shinzato and Yonabaru assemblages.
Length 2.26 mm; diameter 0.56 mm.

Schenckiella howchini (Cushman)

Plate 1, figure 20

Listerella howchini Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 141, pl. 16, figs. 34, 35.

One incomplete specimen was recorded in the Yonabaru.
Length 1.40 mm; diameter 0.37 mm.

Schenckiella okinawaensis LeRoy, n. sp.

Plate 1, figure 16

Test small for the genus, about four times as long as broad, triserial stage about one-fourth length of test; chambers in triserial part indistinct, only moderately distinct in uniserial stage and when chambers are slightly inflated; sutures slightly depressed; wall white, very fine textured; aperture at end of short slender tube.

This species appears to be similar to *S. bradyana* (Cushman) but differs primarily by being smaller, more compressed, and by having a finer textured surface. It was recorded sporadically below 2,775 feet in the Yonabaru well.
Length 0.63–0.66 mm; diameter 0.17–0.20 mm.

Schenckiella victoriensis (Cushman)

Plate 1, figure 19

Listerella victoriensis Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 146, pl. 16, fig. 25.

A few specimens recorded from the Shinzato deposits; best development in Yonabaru 1 between 3,690 and 3,860 feet.
Length 2.20 mm; diameter 0.30–0.39 mm.

Family SILICINIDAE

Genus MILIAMMINA Heron-Allen and Earland, 1930

Miliammina echigoensis Asano and Inomato

Plate 5, figures 15, 16

Miliammina echigoensis Asano and Inomata, 1952, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, supp. 1, p. 5, figs. 21–24.

Restricted to the Yonabaru; penetrated by Yonabaru 1 below 3,850 feet.
Length 0.49 mm; width 0.21 mm; thickness 0.10 mm.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina tricarinata d'Orbigny

Plate 12, figures 15, 16

Quinqueloculina tricarinata d'Orbigny, 1839, *in* De la Sagra, Histoire, physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 187, pl. 11, figs. 7–9, 13.

Several specimens referable to this species were noted in Chinen and Naha assemblages.
Length 1.10 mm; width 0.71 mm; thickness 0.34 mm.

Quinqueloculina carinata d'Orbigny

Plate 12, figures 19, 20

Quinqueloculina carianta d'Orbigny, 1825, Annales sci. nat., p. 136, type figure by Fornasini, 1905, Mem. R. Accad. Sci. Inst. Bologna, ser. 6, v. 2, pl. 4, fig. 2.

Occurs in limited numbers in Naha, Chinen, Shinzato, and Yonabaru assemblages.
Length 0.70 mm; width 0.60 mm; thickness 0.40 mm.

Quinqueloculina sagamiensis Asano

Plate 12, figures 17, 18

Quinqueloculina sagamiensis Asano, 1936, Geol. Soc. Japan Jour., v. 43, no. 515, p. 612, pl. 30, figs. 5a–c.

Scarce and in Naha and Chinen assemblages only.
Length 1.50 mm; width 1.10 mm; thickness 0.71 mm.

Quinqueliculina reticulata (d'Orbigny)

Plate 12, figures 21, 22

Quinqueloculina reticulata (d'Orbigny). Cushman, 1917, U.S. Natl. Mus. Bull. 71, pt. 6, p. 55, pl. 16, figs. 1–3.

Several specimens were recorded in the *Loxostomum pacificum* fauna of the Yonabaru.
Length 0.84 mm; width 0.70 mm; thickness 0.42 mm.

Quinqueloculina akneriana d'Orbigny

Plate 12, figures 13, 14

Quinqueloculina akneriana d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 290, pl. 18, figs. 16–21.

Most common in Shinzato and Yonabaru assemblages; rare in Naha and Chinen deposits.
Length 0.82 mm; width 0.57 mm; thickness 0.42 mm.

Quinqueloculina contorta d'Orbigny

Plate 12, figures 7, 8

Quinqueloculina contorta d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 298, pl. 20, figs. 4–6.

Several specimens of this species were recorded from the Shinzato.

Length 1.00 mm; width 0.55 mm; thickness 0.35 mm.

Quinqueloculina elongata Natland

Plate 12, figures 11, 12

Quinqueloculina elongata Natland, 1938, Scripps Inst. Oceanography Bull. tech. ser., v. 4, (5), p. 141, pl. 4, fig. 5.

Present in the upper part of the Chinen Sand.

Length 0.37 mm; width 0.18 mm; thickness 0.12 mm.

Quinqueloculina pygmea Reuss

Plate 12, figures 9, 10

Quinqueloculina pygmea Reuss, 1859, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., v. 1, p. 384, pl. 50, fig. 3.

Several specimens occur frequently in some Naha and Chinen assemblages.

Length 0.33 mm; width 0.13 mm; thickness 0.09 mm.

Genus MASSILINA Schlumberger, 1893

Massilina fragilissima (H. B. Brady)

Plate 12, figure 31

Spiroloculina fragilissima H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 149, pl. 9, figs. 12–14.

Observed occasionally in Chinen assemblages only.

Length 0.66 mm; width 0.64 mm; thickness 0.13 mm.

Genus SPIROLOCULINA d'Orbigny, 1826

Spiroloculina circularis Cushman and Todd

Plate 3, figures 23, 24

Spiroloculina circularis Cushman and Todd, 1944, Cushman Lab. Foram. Research Spec. Pub. 11, p. 49, pl. 7, figs. 15, 16.

Observed rarely in the *Nonion nicobarense-Cibicides macneili* deepwater assemblages of the Yonabaru.

Length 0.55 mm; width 0.50 mm; thickness 0.19 mm.

Spiroloculina penglaiensis Jacot

Plate 3, figures 25, 26

Spiroloculina penglaiensis Jacot, 1925, North China Branch Royal Asiatic Soc. Jour., v. 56, p. 76–79, figs. 1, 2.

Rare in the Yonabaru.

Length 1.13 mm; width 1.00 mm; thickness 0.38 mm.

Spiroloculina communis Cushman and Todd

Plate 3, figures 27, 28; plate 16, figures 14, 15

Spiroloculina communis Cushman and Todd, 1944, Cushman Lab. Foram. Research Spec. Pub. 11, p. 63, pl. 9, figs. 4, 5, 7, 8.

Several specimens of this species were recorded from the Chinen and Naha. The length to breadth ratio of the species varies considerably.

Length 0.85 mm; width 0.55 mm; thickness 0.26 mm (pl. 3, figs. 27, 28).

Length 0.92 mm; thickness 0.23 mm (pl. 16, figs. 14, 15).

Genus SIGMOILINA Schlumberger, 1887

Sigmoilina celata (Costa)

Plate 3, figures 21, 22

Spiroloculina celata Costa, 1855, Mem. Acad. Sci. Napoli, v. 2, p. 126, pl. 1, fig. 14, (1857).

Sigmoilina celata (Costa). Cushman, 1946, Cushman Lab. Foram. Research Contr., v. 22, pt. 2, p. 36, pl. 5, figs. 23–29.

Several specimens assignable to this species were recorded from the Shinzato deposits only.

Length 0.80 mm; width 0.53 mm; thickness 0.32 mm.

Sigmoilina miocenica Cushman

Plate 3, figure 34

Sigmoilina miocenica Cushman, 1930, Cushman Lab. Foram. Research Contr., v. 5, p. 81, pl. 12, figs. 12–14.

Very rare in Okinawan assemblages.

Length 0.60 mm; width 0.33 mm; thickness 0.09 mm.

Sigmoilina schlumbergeri A. Silvestri

Not illustrated

Sigmoilina schlumbergeri A. Silvestri, 1904, Mem. Pont. Accad. Nuovi Lincei, v. 22, p. 267.

Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 449.

Rare in the *Nonion nicobarense-Cibicides macneili* fauna. Common in Yonabaru 1 below 3,410 feet; a few specimens in the Shinzato.

USGS loc. f11531 (FSM–45, Yonabaru).

USNM 625396

Sigmoilina tenuis (Czjzek)

Plate 16, figures 32, 33

Sigmoilina tenuis (Czjzek). Cushman, 1946, Cushman Lab. Foram. Research Contr., v. 22, pt. 2, p. 32, pl. 5, figs. 13–15.

Several specimens were observed in Shinzato assemblages only.

Length 0.42 mm; thickness 0.07 mm.

Genus TRILOCULINA d'Orbigny, 1826

Triloculina tricarinata d'Orbigny

Plate 3, figures 32, 33

Triloculina tricarinata d'Orbigny, 1826, Annales sci. nat., v. 7, p. 299; Modèles 94.

Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, figs. 15, 16.

Rather common in the *Loxostomum pacificum* fauna of the Yonabaru; rare in the Chinen.

Length 0.60 mm; width 0.37 mm.

Triloculina trigonula (Lamarck)

Plate 16, figures 30, 31

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

Very rare and recorded in the Chinen deposits only.
Length 0.48 mm; width 0.37 mm.

Genus CRUCILOCULINA d'Orbigny, 1839

Cruciloculina striata Loeblich and Tappan

Plate 12, figures 23, 24

Cruciloculina striata Loeblich and Tappan, 1957, U.S. Natl. Mus. Bull. 215, p. 234, pl. 74, figs. 13–16.

Test small, roundly triangular in cross section, slightly longer than broad, sutures distinct; wall with many low closely spaced striae; aperture cruciform to dendritic.

Observed in limited numbers in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru.
Length 0.70 mm; width 0.55 mm; thickness 0.45 mm.

Genus MILIOLINELLA Wiesner, 1931

Miliolinella inflata LeRoy, n. sp.

Plate 12, figures 36, 37

Test broadly elliptical in apertural view, about as wide as long; chambers distinct, highly inflated and strongly overlapping; sutures distinct, slightly depressed; periphery broadly rounded; wall smooth; aperture crescent shaped, broad, with well-developed rim.

Differs from *M. australis* (Parr) by exhibiting a broader and more rounded peripheral margin and by showing a thicker apertural rim.

Very rare in Yonabaru assemblages.
Length 0.50 mm; width 0.47 mm; thickness 0.40 mm.

Miliolinella australis (Parr)

Plate 12, figures 27, 28

Quinqueloculina australis Parr, 1932, Royal Soc. Victoria Proc., pt. 1, v. 44, p. 7, pl. 1, fig. 8.

Observed in limited numbers in Yonabaru assemblages only.
Length 1.00 mm; width 1.00 mm; thickness 0.62 mm.

Genus PYRGO Defrance, 1824

Pyrgo affinis (d'Orbigny)

Plate 12, figures 25, 26

Biloculina affinis d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 265, pl. 16, figs. 1–3.

Very rare in Chinen assemblages.
Length 0.55 mm; width 0.41 mm; thickness 0.33 mm.

Pyrgo depressa (d'Orbigny)

Plate 12, figures 29, 30

Biloculina depressa d'Orbigny, 1826, Annales sci. nat., v. 7, p. 298. Modèles 94.
Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 469, pl. 96, figs. 2a, b.

Occurs in limited numbers in Shinzato and Yonabaru assemblages.
Length 0.90 mm; width 0.90 mm; thickness 0.42 mm.

Pyrgo murrhina (Schwager)

Plate 12, figures 32, 33

Biloculina murrhina Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 203, pl. 4, figs. 5a–c.
Cushman, 1932, U.S. Natl. Mus. Bull. 161, pt. 1, p. 64, pl. 15, figs. 1–3.

Rarely recorded in Chinen assemblages only.
Length 0.47 mm; width 0.49; thickness 0.31 mm.

Pyrgo subsphaerica (d'Orbigny)

Plate 12, figures 34, 35

Biloculina subsphaerica d'Orbigny, 1839, *in* De la Sagra, Histoire, physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 162, pl. 8, figs. 25–27.

Very scarce in Yonabaru assemblages.
Length 0.95 mm; width 0.81 mm; thickness 0.80 mm.

Family OPHTHALMIDIIDAE
Genus CORNUSPIRA Schultze, 1854

Cornuspira involvens (Reuss), var.

Plate 1, figures 8, 9

Operculina involvens Reuss, 1849, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr. v. 1, p. 370, pl. 45, fig. 20.
Cornuspira involvens (Reuss). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 389, pl. 77, figs. 3, 4.

This deeply depressed form is exceedingly rare in the Shinzato and Yonabaru. The specimens show considerable variation in the degree of inflation of the evolute tube.
Diameter 0.71 mm.

Family LAGENIDAE
Genus ROBULUS Monfort, 1808

Robulus vortex (Fichtel and Moll)

Plate 4, figures 7, 8

Nautilus vortex Fichtel and Moll, 1803, Testacea microscopia, p. 33, pl. 2, figs. e–i.
Cristellaria vortex (Fichtel and Moll). H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 548, pl. 69, figs. 14–16.

Several specimens were observed in Yonabaru assemblages only.
Diameter 1.00 mm; thickness 0.50 mm.

Robulus yabei (Asano)

Plate 4, figure 13

Planularia yabei Asano, 1938, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 19, pt. 2, p. 205, pl. 24, fig. 6.

Very scarce in Chinen only.
Diameter 0.90–1.45 mm; thickness 0.53 mm.

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Robulus costatus (Fichtel and Moll)

Plate 4, figure 9, 10

Nautilus costata Fichtel and Moll, 1803, Testacea microscopia, p. 47, pl. 4, figs. g–i.
Cristellaria costata (Fichtel and Moll). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 239, pl. 46, fig. 4; pl. 47, fig. 1.

Noted in limited numbers and restricted to Shinzato assemblages.
Diameter 0.70–1.00 mm; thickness 0.36 mm.

Robulus costata (Fichtel and Moll) var. multicostatus (Cushman)

Plate 4, figures 11, 12

Cristellaria costata (Fichtel and Moll) var. *multicostata* Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 240, pl. 47, figs. 2, 3.

One specimen referable to this species was recorded from the Shinzato.
Diameter 0.92 mm; thickness 0.48 mm.

Robulus calcar (Linné)

Plate 4, figures 14, 15

Nautilus calcar Linné, 1767, Syst. Nat., ed. 12, p. 1162, no. 272; (Gmelin's) ed. 13, p. 3370, no. 2.
Robulus calcar (Linné). Cushman, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 12, pl. 2, fig. 6.

Several specimens recorded from the Shinzato and the shallow-water facies of the Yonabaru.
Diameter 0.54 mm; thickness 0.33 mm.

Robulus sp. A LeRoy

Plate 16, figures 23, 24

Very rare in the Shinzato; too few specimens to permit accurate identification or designation of a new species. Generally five noninflated chambers; sutures narrow, flush with surface, slightly curved; periphery with very narrow limbate keel.
Diameter 0.87 mm; thickness 0.50 mm.

Robulus sp. B LeRoy

Plate 16, figures 25, 26

Test compressed, somewhat uncoiled; generally 7–8 chambers, noninflated, enlarging only gradually as added; sutures flush or faintly recessed, slightly curved; periphery with narrow flange.
Diameter 0.90–1.20 mm.

Robulus inornatus (d'Orbigny)

Plate 16, figures 37, 38

Robulina inornata d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 102, pl. 4, figs. 25, 26.

A few specimens were found in Shinzato and Yonabaru assemblages.
Diameter 0.97 mm; thickness 0.46 mm.

Robulus polygonatus (Franke)

Plate 16, figures 17, 18

Cristellaria (Lenticulina) polygonata Franke, 1936, Preuss. Geol. Landesanstalt, Abh., Berlin, new ser., No. 169, p. 118, pl 12. figs. 1, 2,

Several specimens referable to this species were recorded in the Shinzato deposits.
Diameter 0.69–0.82 mm; thickness 0.32 mm.

Robulus himiensis Chiji and Nakaseko

Plate 16, figures 12, 13

Robulus himiensis Chiji and Nakaseko, 1950, Geol. Soc. Japan Jour., pt. 3, v. 56, no. 663, text fig. on p. 520.

Very rare in Shinzato and Yonabaru assemblages.
Diameter 1.00 mm; thickness 0.50 mm.

Genus LENTICULINA Lamarck, 1804

Lenticulina peregrina (Schwager)

Plate 4, figures 5, 6

Cristellaria peregrina Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 245, fig. 89.

Very rare in the shallow-water deposits of the Yonabaru.
Length 1.20 mm; width 0.83 mm; thickness 0.53 mm.

Genus MARGINULINOPSIS Silvestri, 1904

Marginulinopsis nozimaensis (Asano)

Plate 5, figure 12

Marginulina nozimaensis Asano, 1938, Tōhoku Imp. Univ. Sci. Repts., 2d ser., v. 19 (2), p. 210, pl. 28, figs. 19–21; pl. 30, figs. 13, 14.

Recorded only in the *Loxostomum pacificum* fauna of the Yonabaru in limited numbers.
Length 2.30 mm (incomplete); width 0.71 mm.

Marginulinopsis perprocera (Schwager)

Plate 5, figure 10

Cristellaria perprocera Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 241, pl. 6, fig. 84.
Marginulina perprocera (Schwager). Cushman and Todd, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 19, pl. 3, fig. 10.

Found rarely in and restricted to Shinzato assemblages.
Length 1.50 mm (incomplete); width 0.27 mm.

Genus MARGINULINA d'Orbigny, 1826

Marginulina striatula Cushman

Plate 5, figure 11

Marginulina striatula Cushman, 1913, U.S. Natl. Mus. Bull. 100, v. 4, p. 255, pl. 41, fig. 2.

Very rare in Okinawa assemblages.
Length 0.50 mm; width 0.23 mm.

Marginulina glabra d'Orbigny

Plate 16, figure 29

Marginulina glabra d'Orbigny. H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 527, pl. 65, figs. 5, 6.

Only rarely found in deepwater Yonabaru assemblages.

Length 1.00 mm.

Genus DENTALINA d'Orbigny, 1826

Dentalina jarvisi Cushman and Todd

Plate 15, figure 27

Dentalina jarvisi Cushman and Todd, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 22, pl. 3, fig. 22.

Several specimens were observed in the upper part of the Yonabaru.

Length 1.30 mm.

Dentalina recta (Schwager)

Plate 15, figure 30

Nodosaria recta Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 216, pl. 5, fig. 35.

Rare in Shinzato and Yonabaru deposits.

Length 1.87 mm (incomplete).

Dentalina reussi Neugeboren

Plate 15, figure 22

Dentalina reussi Neugeboren, 1856, K. Akad. Wiss., Math.-naturwiss. Kl., Abth. 2, v. 12, p. 85, pl. 3, figs. 6, 7, 17.

Very rare and recorded only in Shinzato assemblages.

Length 1.20 mm.

Dentalina advena (Cushman)

Plate 15, figure 31

Nodosaria advena Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 79, pl. 14, fig. 12.

Very rare and sporadic in Shinzato and Yonabaru assemblages.

Length 1.70 mm.

Dentalina obliqua (Linné)

Plate 15, figure 19

Nodosaria obliqua (Linné). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 210, pl. 38, fig. 1.

Several specimens were recorded from the Shinzato only. It is common in Recent deposits of the Philippine Sea area.

Length 1.78 mm.

Dentalina semilaevis Hantken

Plate 15, figure 32

Dentalina semilaevis Hantken. Bermúdez, 1949, Cushman Lab. Foram. Research Spec. Pub. 25, p. 144, pl. 9, fig. 43.

One specimen of this species was observed in the Shinzato. Seemingly not present in the Chinen or Yonabaru.

Length 1.50 mm.

Dentalina communis d'Orbigny

Plate 15, figure 28

Nodosaria (*Dentalina*) *communis* d'Orbigny, 1826, Annales sci. nat., v. 7, p. 254.

Rare in Shinzato and Yonabaru assemblages.

Length 2:10 mm.

Dentalina emaciata Reuss

Plate 15, figure 34

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

Noted in limited numbers from only the Shinzato.

Length 2.82 mm.

Genus RECTOGLANDULINA Loeblich and Tappan, 1955

Rectoglandulina radicula (Linné)

Plate 15, figure 24

Nodosaria radicula (Linné). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 190, pl. 34, fig. 4.

Sporadic in Shinzato and Yonabaru assemblages.

Length 1.05 mm.

Rectoglandulina tornata (Schwager)

Plate 15, figure 11

Nodosaria tornata Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 223, pl. 5, fig. 51.

Several specimens assignable to this species were recorded from the Shinzato.

Length 0.95 mm.

Rectoglandulina ambigua (Neugeboren)

Plate 15, figure 8

Nodosaria ambigua Neugeboren, 1856, K. Akad. Wiss., Math.-naturwiss. Kl., Abth. 2, v. 12, p. 71, pl. 1, figs. 13–16.

Recorded rarely from the Yonabaru only.

Length 0.83 mm.

Rectoglandulina laevigata (d'Orbigny)

Plate 14, figures 29, 30

Nodosaria (*Glandulina*) *laevigata* d'Orbigny, 1826, Annales sci. nat., v. 7, p. 252, pl. 10, figs. 1–3.

Rather common in the Shinzato and rare in the Yonabaru.

Length 0.73 mm; diameter 0.50 mm.

Genus NODOSARIA Lamarck, 1812

Nodosaria tosta Schwager

Plate 15, figure 1

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

Rare in the Shinzato but rather persistent in the Yonabaru.

Length 2.50 mm.

Nodosaria acuminata Hantken var. uniforminata LeRoy

Plate 15, figure 21

Nodosaria acuminata Hantken var. *uniforminata* LeRoy, 1944, Colorado School Mines Quart., v. 39, no. 3, p. 80, pl. 1, fig. 21.

Scarce in Shinzato assemblages.
Length 1.11 mm.

Nodosaria crassitesta Schwager

Plate 15, figure 25

Nodosaria crassitesta Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 224, pl. 5, fig. 55.

A few specimens were recorded only from the Yonabaru Member.
Length 1.80 mm.

Nodosaria longiscata d'Orbigny

Plate 15, figure 23

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

In limited numbers in Shinzato and Yonabaru assemblages.
Length 2.54 mm.

Nodosaria? aff. N.? exilis Schwager

Plate 15, figure 2

Several specimens having an affinity to *N. exilis* Schwager (1866, pl. 5, p. 223, fig. 52) were recorded in Shinzato assemblages.
Length 1.50 mm.

Nodosaria hirsuta (d'Orbigny)

Plate 15, figure 3

Nodosaria hirsuta d'Orbigny, 1826, Annales sci. nat., v. 7, p. 252.

Observed in limited numbers only in Shinzato assemblages.
Length 1.93 mm.

Nodosaria subtertenuata Schwager

Plate 15, figure 5

Nodosaria subtertenuata Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 235, pl. 6, fig. 74.

Common in the upper part of the Yonabaru; very rare and sporadic in the Shinzato.
Length 1.93 mm.

Nodosaria hispidula Cushman

Plate 15, figure 4

Nodosaria lepidula Schwager var. *hispidula* Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 203, pl. 36, fig. 7.

Rare in Yonabaru and Shinzato assemblages.
Length 1.44 mm.

Nodosaria tympaniplectiformis Schwager

Plate 15, figure 6

Nodosaria tympaniplectiformis Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 215, pl. 5, fig. 34.

Several specimens were recorded from the Shinzato only.
Length 0.60 mm.

Nodosaria pupa Karrer

Plate 15, figure 10

Nodosaria pupa Karrer, 1878, K. Gerold's Sohn, Wien, Osterreich, p. 89, pl. 5, fig. 9.

Very rare and noted only in Yonabaru assemblages.
Length 0.78 mm.

Nodosaria hochstetteri Schwager

Plate 15, figure 7

Nodosaria hochstetteri Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 214, pl. 5, fig. 32.

Several specimens appearing to be typical of this species were recorded from the Shinzato.
Length 1.45 mm.

Nodosaria hochstetteri Schwager var. spinicosta Koch

Plate 16, figure 5

Nodosaria hochstetteri Schwager var. *spinicosta* Koch, 1923, Eclogae geol. Helvetiae, v. 18, no. 2, p. 351, fig. 5.

Rare in Shinzato assemblages only.
Length 1.30 mm (incomplete).

Nodosaria fistuca Schwager

Plate 15, figure 9

Nodosaria fistuca Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 216, pl. 5, fig. 36.

Very rare in Shinzato and Yonabaru assemblages.
Length 0.59 mm.

Nodosaria insecta Schwager

Plate 15, figure 14

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

Rare in Shinzato and Yonabaru assemblages.
Length 1.74 mm.

Nodosaria spirostriolata Cushman

Plate 15, figure 13

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

Rare in Shinzato assemblages and occurs rather frequently in Yonabaru assemblages.
Length 2.66 mm.

Nodosaria pyrula d'Orbigny var. longi-costata Cushman

Plate 15, figure 18

Nodosaria pyrula d'Orbigny var. *longi-costata* Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 188, pl. 33, figs. 8, 9.

Rare and recorded in the Shinzato only.
Length 1.34 mm (incomplete).

Nodosaria vertebralis (Batsch) var. albatrossi Cushman

Plate 15, figure 12

Nodosaria vertebralis (Batsch) var. *albatrossi* Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 87, pl. 15, fig. 1.

A few specimens were noted in Naha, Chinen, Shinzato, and Yonabaru assemblages.
Length 2.38 mm.

Nodosaria setosa Schwager

Plate 15, figures 15, 16

Nodosaria setosa Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 218, pl. 5, fig. 40.

Recorded only in Yonabaru assemblages in limited numbers.
Length 1.52 mm (15); Length 1.25 mm (16).

Nodosaria soluta (Reuss)

Plate 15, figure 17

Nodosaria soluta (Reuss). Cushman, 1921, U.S. Natl. Mus Bull. 100, v. 4, p. 192, pl. 34, figs. 5, 6.

Rare and scattered in the Chinen, Shinzato, and Yonabaru.
Length 1.18 mm.

Nodosaria scabriuscula Costa

Plate 16, figure 6

Nodosaria scabriuscula Costa, 1856, Acad. Pont Napoli, Atti, v. 7, pt. 2, p. 140, pl. 16, fig. 1.

A few specimens recorded in the deep-water faunas of the Yonabaru.
Length 0.58 mm (incomplete).

Genus SARACENARIA Defrance, 1824

Saracenaria latifrons (H. B. Brady)

Plate 3, figure 36

Cristellaria latifrons H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 544, pl. 68, fig. 19.

Very rare and recorded only from Shinzato assemblages.
Length 0.90 mm.

Saracenaria italica Defrance

Plate 3, figures 29, 30

Cristellaria italica (Defrance). H. B. Brady, 1884, *Challenger* Rept. Zoology, v. 9, p. 544, pl. 68, figs. 17, 18, 20–23.

Scarce in Shinzato and Yonabaru assemblages.
Length 1.07 mm.

Saracenaria angularis Natland

Plate 16, figures 19, 20

Saracenaria angularis Natland, 1938, Scripps Inst. Oceanography Bull., tech. ser., v. 4, no. 5, p. 143, pl. 5, figs. 1, 2.

Found in limited numbers in the Shinzato only. This form may be a variant of *S. italica* Defrance.
Length 0.94 mm.

Genus VAGINULINA d'Orbigny, 1826

Vaginulina tenuis (Bornemann)

Plate 3, figure 13

Cristellaria tenuis Bornemann. H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 535, pl. 66, figs. 21–23.

Observed rarely in Yonabaru assemblages only.
Length 1.56 mm.

Vaginulina yoshihamaensis Inoue and Nakaseko

Plate 3, figures 11, 12

Vaginulina yoshihamaensis Inoue and Nakaseko, 1951, Geol. Soc. Japan Jour., v. 57, no. 664, p. 10, fig. 2.

Seemingly restricted to the shallow-water *Loxostomum pacificum* fauna of the Yonabaru.
Length 1.40 mm; width 0.53 mm; thickness 0.43 mm.

Genus LAGENA Walker and Jacob, 1798

Lagena sulcata (Walker and Jacob) var. spirata Bandy

Plate 13, figures 32, 38

Lagena sulcata (Walter and Jacob) var. *spirata* Bandy, 1949, Bull. Am. Paleontology, v. 32, no. 131, p. 57, pl. 7, fig. 18.

The Okinawan forms are closely related to this variety. There is considerable variation in outline and density of costae as shown by the figured specimens.

Rare and found in Chinen assemblages only.
Length 0.29 mm; diameter 0.16 mm (fig. 32). Length 0.50 mm; diameter 0.34 mm (fig. 38).

Lagena hystrix Reuss

Plate 13, figure 47

Lagena hystrix Reuss, 1862, Akad. Wiss. Wien, Math.-naturwiss. Kl., Denkschr., v. 46, Abt. 1, p. 335, pl. 6, figs. 80a, b.

Very rare and noted in Shinzato assemblages only.
Length 0.59 mm; diameter 0.34 mm.

Lagena striata (d'Orbigny) var. toddi LeRoy, n. var.

Plate 13, figure 39

This variety differs from *L. striata* (d'Orbigny) var. *intermedia* Rzehak by lacking a basal spine and by being more spherical. It rarely occurs in the Okinawan assemblages. This variety is named for Ruth Todd of the U.S. Geological Survey.
Length 0.56–0.58 mm; diameter 0.35–0.38 m.

Lagena aspera Reuss

Plate 13, figure 29

Lagena aspera Reuss. Cushman, 1913, U.S. Natl. Mus. Bull. 71, pt. 3, p. 16, pl. 16, fig. 1.

This hispid species rarely occurs in the Yonabaru.
Length 0.73 mm; diameter 0.56 mm.

Lagena advena Cushman

Plate 14, figure 1

Lagena advena Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 6, pl. 1, fig. 4.

Several specimens were recorded from the Yonabaru only. The neck of the figured specimen is broken. Length 0.51 mm; diameter 0.36 mm.

Lagena intermedia Hada

Plate 13, figure 41

Lagena intermedia Hada, 1936, Sapporo Nat. Hist. Soc., Trans., Japan, v. 14, p. 244, fig. 4.

Only one specimen assignable to this species was recorded from the Yonabaru.
Length 0.60 mm; diameter 0.24 mm.

Lagena laevis (Montagu) var. baggi Cushman and Gray

Plate 13, figure 33

Lagena laevis (Montagu) var. *baggi* Cushman and Gray, 1946, Cushman Lab. Foram. Research Spec. Pub. 19, p. 18, pl. 3, figs. 26, 27.

Noted in limited numbers only Chinen and Shinzato assemblages.
Length 0.30 mm; diameter 0.15 mm.

Lagena williamsoni (Alcock)

Plate 13, figure 40

Lagena williamsoni (Alcock). Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 61, pl. 11, figs. 8, 9.

The Okinawan specimens appear identical to this species from the Atlantic as figured by Cushman. Very scarce in all the Okinawa assemblages.
Length 0.31 mm; diameter 0.21 mm.

Lagena striata (d'Orbigny) var. semistriata Williamson

Plate 13, figure 46

Lagena striata (d'Orbigny) var. *semistriata* Williamson, 1848, London, Annals and Mag. Nat. History, ser. 2, v. 1, p. 14, pl. 1, figs. 9, 10.

The Okinawan specimens show considerable variation in length. The figured specimen is more bulbous than the average but appears to be related to this species. Very rare and recorded only from the Shinzato.
Length 0.27 mm; diameter 0.22 mm.

Lagena sulcata (Walker and Jacob) var. spicata Cushman and McCulloch

Plate 13, figure 45

Lagena sulcata (Walker and Jacob) var. *spicata* Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 360, pl. 48, figs. 3–7.

The figured specimen is close to Cushman and McCulloch's figure 6a, b. Both show several rings around the elongate neck. Rare and found only in Chinen assemblages.
Length 0.25 mm; diameter 0.17 mm.

Lagena elongata (Ehrenberg)

Plate 13, figure 36

Lagena elongata (Ehrenberg). Cushman, 1923, U.S. Natl. Bull. 104, pt. 4, p. 15, pl. 3, fig. 4.

Recorded from the Chinen deposits in limited numbers.
Length 0.88 mm; diameter 0.12 mm.

Lagena distoma Parker and Jones

Plate 13, figure 35

Lagena distoma Parker and Jones, 1864, Linnean Soc. London Trans., v. 24, pt. 3, p. 467, pl. 48, fig. 6.

Very rare in Shinzato and Yonabaru assemblages.
Length 0.74 mm; diameter 0.13 mm.

Lagena striato-punctata Parker and Jones var. bulbosa LeRoy, n. var.

Plate 13, figure 34

Differs from the type by being more bulbous and by having a stout basal spine. It is easily identified by the many minute punctations along the base of the costae.

Occurs only in the Shinzato assemblages in limited numbers.
Length 0.47 mm; diameter 0.28 mm.

Genus OOLINA d'Orbigny, 1839

Oolina squamosa (Montagu) var. apiciglabra (Ten Dam and Reinhold)

Plate 13, figure 42

Lagena squamosa (Montagu) var. *apiciglabra* ten Dam and Reinhold, 1941, Netherlands Geol. Stichting, Meded., Haarlem, ser. c, sec. 5, no. 1, p. 48, pl. 2, fig. 11; pl. 6, fig. 5.

Several specimens were recorded from the Chinen only.
Length 0.27 mm; diameter 0.19 mm.

Oolina squamosa (Montagu) var. scalariformis (Williamson)

Plate 13, figure 43

Entosolenia squamosa (Montagu) var. *scalariformis* (Williamson), 1848, London, Annals and Mag. Nat. Hist., ser. 2, v. 1, pl. 2, figs. 21, 22.

Very rare in Shinzato and Yonabaru assemblages.
Length 0.29 mm; diameter 0.23 mm.

Oolina globosa (Montagu) var. setesa (Earland)

Plate 13, figure 44

Lagena globosa (Montagu) var. *setesa* Earland, 1934, Univ. Press, Cambridge, England, v. 10, p. 150, pl. 6, fig. 52.

Very scarce and occurs only in the Yonabaru deposits.
Length 0.37 mm; diameter 0.33 mm.

Oolina gracilis Williamson var. meridionalis (Wiesner)

Plate 13, figure 37

Lagena gracilis Williamson var. *meridionalis* Wiesner, 1931, Die Foraminiferen der deutschen Sudpolar-Exped.

1901–03. Berlin u. Leipzig, Deutschland, de Gruyter, v. 20 (Zoology, v. 12), p. 117, pl. 18, fig. 211.

Scarce in Shinzato assemblages only.
Length 0.35 mm; diameter 0.13 mm.

Oolina trigona-pulchella (Balkwill and Millett)

Plate 13, figures 30, 31

Lagena trigona-pulchella Balkwill and Millett, 1884, London, Micr. Nat. Sci. Jour., v. 3, p. 81, 87, pl. 3, fig. 11.

Recorded rarely in the Chinen deposits only.
Length 0.22 mm; diameter 0.15 mm.

Genus LAGENONODOSARIA Silvestri, 1900

Lagenonodosaria scalaris (Batsch)

Plate 15, figures 20, 29

Nodosaria scalaris (Batsch). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 199, pl. 35, fig. 6.

Rare in Chinen, Shinzato, and Yonabaru assemblages.
Length 0.77 mm; diameter 0.56 mm (fig. 20). Length 0.98 mm; diameter 0.43 mm (fig. 29).

Genus HEMICRISTELLARIA Stache, 1864

Hemicristellaria japonica (Asano)

Plate 5, figure 17

Lenticulina japonica Asano, 1936, Japanese Jour. Geology and Geography, v. 13, nos. 3, 4, p. 328, pl. 37, figs. 7a, b.

Very rare in Shinzato assemblages; common in the Pliocene of Japan according to Asano.
Length 1.18 mm; width 0.74 mm; thickness 0.20 mm.

Family POLYMORPHINIDAE

Genus GUTTULINA d'Orbigny, 1839

Guttulina orientalis Cushman and Ozawa

Plate 11, figures 23, 24

Guttulina orientalis Cushman and Ozawa, 1929, Cushman Lab. Foram. Research Contr., v. 4, p. 15, pl. 2, fig. 1.

The figured specimen appears to be within the range of this species that was recorded in limited numbers in Chinen assemblages only.
Length 0.54 mm.

Guttulina pusilla Stache

Plate 11, figures 30, 31

Guttulina pusilla Stache, 1865, *Novara*-Exped., Geol. Theil, v. 1, Abt. 2, p. 264, pl. 24, fig. 12.

Noted in limited numbers in the *Loxostomum pacificum* fauna of the Yonabaru only.
Length 0.75 mm.

Guttulina pacifica (Cushman and Ozawa)

Plate 11, figures 25, 26

Sigmoidella pacifica Cushman and Ozawa, 1929, Cushman Lab. Foram. Research Contr., v. 4, p. 19, pl. 2, fig. 13.

Several specimens closely allied to this species were recorded from the Yonabaru.
Length 0.74 mm.

Genus RAMULINA Rupert Jones, 1875

Ramulina globulifera H. B. Brady

Plate 14, figure 2

Ramulina globulifera H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 587, pl. 76, figs. 22–28.

Several specimens closely allied to this species were observed in the Chinen and Shinzato deposits.
Diameter 0.45 mm.

Genus PYRULINA d'Orbigny, 1839

Pyrulina fusiformis (Romer)

Plate 5, figure 26

Pyrulina fusiformis (Romer), Cushman and Ozawa, 1930, U.S. Natl. Mus. Proc., v. 77, p. 54, pl. 13, figs. 3–8.

Only one specimen showing an affinity to this species was noted in the Yonabaru.
Length 0.87 mm; width 0.40 mm; thickness 0.35 mm.

Family NONIONIDAE

Genus NONION Montfort, 1808

Nonion japonicum Asano

Plate 10, figures 12, 13

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

Several specimens closely related to this species were recorded from the Chinen Sand.
Diameter 0.45–0.58 mm; thickness 0.24 mm.

Nonion pompilioides (Fichtel and Moll)

Plate 10, figures 10, 11

Nautilus pompilioides Fichtel and Moll, 1798, Testacea microscopica, p. 31, pl. 2, figs. a–c.
Nonion pompilioides (Fichtel and Moll). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 19, pl. 5, figs. 9–12.

Rare in Shinzato and Yonabaru assemblages; common in the Pliocene of Japan.
Diameter 0.44–0.52 mm; thickness 0.31 mm.

Nonion pompilioides (Fichtel and Moll) var. okinawaense LeRoy, n. var.

Plate 10, figures 18, 19

Differs from the type by having a very irregular and deep umbilical depression and by being somewhat thicker; recorded in Shinzato assemblages only.
Diameter 0.49–0.56 mm; thickness 0.40–0.42 mm.

Nonion nicobarense Cushman

Plate 10, figures 14, 15

Nonion nicobarense Cushman, 1936, Lab. Foram. Research Contr., v. 12, p. 67, pl. 12, figs. 9a,b.

Common in Yonabaru assemblages; very rare in the Shinzato deposits.
Diameter 0.36–0.43 mm; thickness 0.17 mm.

Nonion akitaense Asano

Plate 10, figures 16, 17

Nonion akitaense Asano, 1950, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 1, p. 1, figs. 1, 2.

Recorded in Chinen assemblages only.
Diameter 0.18–0.21 mm; thickness 0.10 mm.

Nonion manpukujiense Otsuka

Plate 10, figures 22, 23

Nonion manpukujiense Otsuka, 1932 Geol. Soc. Japan Jour., v. 39, no. 467, p. 654, fig. 1.

Typical specimens of this species were observed in limited numbers in Yonabaru assemblages only.
Diameter 0.43–0.62 mm; thickness 0.36 mm.

Nonion novozealandicum Cushman

Plate 10, figures 20, 21

Nonion novozealandicum Cushman, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 66, pl. 12, figs. 6a, b.

Common in the Shinzato; rare in the Yonabaru and Chinen.
Diameter 0.55–0.64 mm; thickness 0.35 mm.

Genus ASTRONONION Cushman and Edwards, 1937

Astrononion sp. A LeRoy

Plate 6, figures 6, 7

Occurs in limited numbers in Naha assemblages only. Structurally shows an affinity to *A. italicum* Cushman and Edwards (Cushman, 1939 a, p. 37) but is much smaller.

Genus ELPHIDIUM Montfort, 1808

Elphidium poeyanum (d'Orbigny)

Plate 9, figures 37, 38

Polystomella poeyana d'Orbigny, 1839, in De la Sagra, Histoire physique, politique et naturelle de l'Ile du Cuba, Foraminifères, p. 55, pl. 6, figs. 25, 26.

Elphidium peoyanum (d'Orbigny). Cushman, 1930, U.S. Natl. Mus. Bull. 104, pt. 7, p. 25, pl. 10, figs. 4, 5.

Recorded rarely in Chinen assemblages only.
Diameter 0.26 mm; thickness 0.12 mm.

Elphidium simaense Makiyama and Nakagawa

Plate 9, figure 30, 31

Elphidium simaense Makiyama and Nakagawa, 1940, Geol. Soc. Japan Jour., v. 48, no. 572, p. 241, fig. 2.

Rare in Chinen assemblages only; characterized by its coarse surface texture.
Diameter 0.52 mm; thickness 0.32 mm.

Elphidium tikutoense Nakamura

Plate 10, figures 3, 4

Elphidium tikutoensis Nakamura, 1937, Japanese Jour. Geology and Geography Trans. [abs.], v. 14, p. 139, pl. 11, figs. 10a, b.

Very scarce in the Naha and Chinen deposits.
Diameter 0.26 mm; thickness 0.12 mm.

Elphidium advena (Cushman) var. depressula (Cushman)

Plate 10, figures 6, 7

Elphidium advenum (Cushman) var. *depressulum* Cushman, 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 51, pl. 12, fig. 4.

Occurs in limited numbers in the Chinen.
Diameter 0.27 mm; thickness 0.11 mm.

Elphidium fax barbarense Nicol

Plate 10, figures 1, 2

Elphidium fax barbarense Nicol, 1944, Jour. Paleontology, v. 18, no. 2, p. 178, pl. 29, figs. 10–12.

This subspecies was recorded occasionally in the Naha, Chinen, Shinzato, and Yonabaru.
Diameter 0.51 mm; thickness 0.23 mm.

Elphidium jenseni (Cushman)

Plate 10, figures 8, 9

Elphidium jenseni (Cushman), 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 48, pl. 11, figs. 6, 7.

Common in the Chinen Sand; rare in the upper part of the Yonabaru deposits.
Diameter 0.32–0.42 mm; thickness 0.14 mm.

Elphidium taiwanum Nakamura

Plate 10, figure 5

Elphidium taiwanum Nakamura, 1937, Japanese Jour. Geology and Geography Trans. [abs.], v. 14, nos. 3–4, p. 139, pl. 11, figs. 9a, b.

Recorded in limited numbers from the Naha and Chinen only.
Diameter 0.88 mm; thickness 0.40 mm.

Family CAMERINIDAE
Genus OPERCULINA d'Orbigny, 1826

Operculina gaimairdi d'Orbigny

Plate 5, figures 13, 14

Operculina gaimairdi d'Orbigny, 1826, Annales sci. nat., v. 7, no. 5, p. 281.
Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 375.

Rare in the basal part of the Chinen and in the *Loxostomum pacificum* fauna of the Yonabaru.
Diameter 0.85–1.10 mm; thickness 0.31 mm.

Family PENEROPLIDAE
Genus PENEROPLIS Montfort, 1808

Peneroplis pertusus (Forskal)

Plate 5, figure 20

Peneroplis pertusus (Forskal). Cushman, 1930, U.S. Natl. Mus. Bull. 104, pt. 7, p. 35, pl. 12, figs. 3–6.

Only several specimens were observed in the shallow-water facies of the Yonabaru.
Length 0.64 mm; width 0.43 mm; thickness 0.23 mm.

Family HETEROHELICIDAE
Genus BOLIVINOPSIS Yakovlev, 1891

Bolivinopsis hiratai Uchio

Plate 1, figure 10

Bolivinopsis hiratai Uchio, 1953, Japanese Jour. Geology and Geography, v. 23, p. 153, pl. 14, fig. 5.

Common in limited numbers in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru. A few specimens having a very fine textured calcareous wall were noted from the Shinzato.
Length 0.60 mm; width 0.14 mm; thickness 0.08 mm.

Genus BOLIVINITA Cushman, 1927

Bolivinita quadrilatera (Schwager)

Plate 2, figures 37, 38

Textularia quadrilatera Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 253, p. 7, fig. 10.
Bolivinita quadrilatera (Schwager). Cushman, 1942, U.S. Natl. Mus. Bull. 161, pt. 3, p. 2, pl. 1, figs. 1–4.

This species, originally described from the "Pliocene" of Kar Nicobar, is common in Shinzato assemblages and scarce in Yonabaru. Forms in the Yonabaru are generally smaller than those in the Shinzato. The species is widely recorded from the Indo-Pacific region.
Length 1.00 mm; width 0.41 mm; thickness 0.28 mm.

Genus PLECTOFRONDICULARIA Liebus, 1903

Plectofrondicularia interrupta (Karrer)

Plate 5, figure 25

Frondicularia interrupta Karrer. H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 523, pl. 66, figs. 6, 7.

Very scarce and observed in the Shinzato Member only.
Length 0.79 mm; width 0.16 mm.

Plectofrondicularia sp. A. LeRoy

Plate 5, figure 23

Test strongly compressed, periphery acute, initial end with short spine; chambers distinct, rather uniform in shape, gradually increasing in size as added; sutures distinct, slightly depressed, somewhat extended toward apertural end along medial axis; wall smooth, then finely perforate; aperture terminal.

One specimen of this form was noted from the Shinzato only.
Length 1.30 mm; width 0.72 mm.

Plectofrondicularia foliacea (Schwager)

Plate 11, figure 18

Frondicularia foliacea Schwager, 1866. *Novara*-Exped., Geol. Theil, v. 2, p. 236, pl. 6, fig. 76.

Very rare in Shinzato and Yonabaru assemblages.
Length 1.01 mm; width (max.) 0.68 mm.

Plectofrondicularia inaequalis (Costa)

Plate 11, figure 12

Frondicularia inaequalis Costa, 1855, Mem. Acad. Sci. Napoli, v. 2, p. 372, pl. 3, fig. 3.

Several specimens referable to this species were recorded from the Shinzato and Yonabaru only.
Length 1.25 mm; width (max.) 0.50 mm.

Plectofrondicularia totomiensis Makiyama

Plate 5, figures 18, 19

Plectofrondicularia totomiensis Makiyama, 1931, Kyoto Imp. Univ., Coll. Sci., Mem., ser. B, v. 7, no. 1, p. 51, pl. 2.

Several specimens were noted only in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru. This species appears to be closely related to *P. californica* Cushman and Stewart.
Length 1.30 mm; width 0.25 mm; thickness 0.12 mm.

Genus ORTHOMORPHINA Stainforth, 1952

Orthomorphina challengeriana (Thalmann)

Plate 15, figure 26

Nodosaria perversa H. B. Brady [not Schwager], 1884, *Challenger* Rept., Zoology, v. 9, pl. 64, figs. 25–27.
Nodogenerina challengeriana Thalmann, 1937, Eclogae geol. Helvetiae, v. 30, p. 341 (H. B. Brady, 1884, pl. 64, figs. 25–27).

Common in deepwater Yonabaru assemblages; rare in the Shinzato.
Length 0.82 mm.

Family BULIMINIDAE
Genus BULIMINOIDES Cushman, 1911

Buliminoides williamsonianus (H. B. Brady)

Plate 11, figure 11

Bulimina williamsoniana H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 408, pl. 51, figs. 16, 17.
Buliminoides williamsoniana (H. B. Brady). Cushman, 1911, U.S. Natl. Mus. Bull. 71, pt. 2, p. 90, fig. 144.

Occurs most frequently in the Chinen; absent in Shinzato and Yonabaru; widespread in the late Tertiary and Recent deposits of the Indo-Pacific region.
Length 0.53 mm; diameter 0.21 mm.

Genus ROBERTINA d'Orbigny, 1846

Robertina subteres (H. B. Brady)

Plate 3, figures 15, 16

Bulimina subteres H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 403, pl. 50, figs. 17, 18.

Scarce and recorded in Shinzato assemblages only.
Length 0.54 mm; diameter 0.35 mm.

Genus BULIMINA d'Orbigny, 1826

Bulimina marginata d'Orbigny

Plate 11, figure 2

Bulimina marginata d'Orbigny, 1826, Annales sci. nat., v. 7, p. 269, pl. 12, figs. 10–12.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 119, pl. 28, figs. 5, 6.

Occurs in limited numbers in the Naha, Chinen, and Shinzato.
Length 0.25 mm; diameter 0.14 mm.

Bulimina yonabaruensis LeRoy, n. sp.

Plate 11, figure 1

Test about twice as long as broad, last three or four chambers making up three-fourths of the test; sutures distinct, depressed; chambers slightly inflated, finely punctate, smooth, with minute spines on lower margins.

This species differs from *B. pyrula* d'Orbigny var. *spinescens* H. B. Brady by the chambers being more elongate. Occurs most commonly in the Yonabaru.
Length 0.70 mm; width 0.32 mm.

Bulimina subaffinis Cushman

Plate 11, figure 3

Bulimina subaffinis Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 166, figs. 7a, b.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 126, pl. 29, fig. 7.

Rare in the Yonabaru and Shinzato; widely recorded from late Tertiary and Recent deposits of the South Pacific region.
Length 0.50 mm; diameter 0.30 mm.

Bulimina inflata Seguenza

Plate 11, figure 6

Bulimina inflata Seguenza, 1861, Atti. Accad. Gioen., Sci. Nat. ser. 2, v. 17, p. 25, fig. 10.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 118, pl. 27, figs. 16, 17.

Common in both the Shinzato and Yonabaru; widely recorded in late Tertiary and Recent deposits of the Tropical Pacific.
Length 0.55 mm; diameter 0.39 mm.

Bulimina aculeata d'Orbigny

Plate 11, figure 7

Bulimina aculeata d'Orbigny, 1826, Annales sci. nat., v. 7, p. 269.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 120, pl. 28, figs. 8–11.

Recorded in limited numbers from the Shinzato deposits only; common in the Recent deposits of the Indo-Pacific region and in the Miocene and Pliocene formations of Japan.
Length 0.40 mm; diameter 0.25 mm.

Bulimina pupoides d'Orbigny

Plate 11, figures 4, 5

Bulimina pupoides d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 185, pl. 11, figs. 11, 12.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 105, pl. 25, figs. 3–7.

Rare and sporadic in the Yonabaru and Shinzato. The species exhibits considerable variation in the length-width ratio.
Length 0.73 mm; diameter 0.38 mm (fig. 4). Length 0.79 mm; diameter 0.35 mm (fig. 5).

Bulimina subcalva Cushman and K. E. Stewart

Plate 11, figure 8

Bulimina subcalva Cushman and K. E. Stewart. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 116, pl. 27, fig. 5.

The figured specimen is from the *Loxostomum pacificum* fauna of the Yonabaru and seems to be closely related to the type originally described from the Pliocene of California; occurs in the Pliocene of Japan.
Length 0.81 mm; diameter 0.54 mm.

Bulimina microlongistriata LeRoy

Plate 11, figure 9

Bulimina microlongistriata LeRoy, 1941, Colorado School of Mines Quart., v. 36, no. 1, p. 32, pl. 1, figs. 97, 98.

Extremely rare in the Yonabaru and Shinzato assemblages; described originally from the Miocene of central Sumatra.
Length 0.78 mm; diameter 0.42 mm.

Bulimina gutta Chapman and Parr

Plate 11, figure 10

Bulimina buchiana d'Orbigny var. *gutta* Chapman and Parr, 1937, Australasian Antarctic Exped., ser. c, v. 1, pt. 2, p. 86, pl. 8, fig. 4.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 127, pl. 29, fig. 16.

This costate species, more elongate than *B. rostrata* H. B. Brady, is common in the Yonabaru; few specimens were recorded from the Shinzato.
Length 0.30 mm; diameter 0.12 mm.

Genus GLOBOBULIMINA Cushman, 1927

Globobulimina pacifica Cushman

Plate 14, figure 3

Globobulimina pacifica Cushman, 1927, Cushman Lab. Foram. Research Contr., v. 3, p. 67, pl. 14, fig. 12.

A few specimens recorded in Shinzato assemblages only.
Length 0.92 mm; diameter 0.64 mm.

Globobulimina globosa LeRoy

Plate 14, figure 4

Globobulimina globosa LeRoy, 1944, Colorado School of Mines Quart., v. 39, no. 3, pt. 1, p. 27, pl. 1, fig. 3; pl. 5, fig. 13.

Several specimens referable to this species described originally from the Miocene of central Sumatra were recorded in the Chinen.

Length 0.57 mm; diameter 0.40 mm.

Genus BOLIVINA d'Orbigny, 1839

Bolivina albatrossi Cushman

Plate 2, figure 15

Bolivina albatrossi Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 153, pl. 18, figs. 22–24.

This small form is common in the Shinzato and rare in the Chinen; not observed in the Yonabaru.

Length 0.41 mm; width 0.19 mm; thickness 0.12 mm.

Bolivina alata (Seguenza)

Plate 2, figure 12

Vulvulina alata Seguenza, 1861, Atti. Accad. Gioen. Sci. Nat. ser. 2, v. 18, p. 115, pl. 2, figs. 5, 5a.

Bolivina alata (Seguenza). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 106, pl. 13, figs. 3–11.

Recorded in limited numbers from the Chinen and Shinzato only; common in late Tertiary and Recent deposits of the Tropical Pacific region.

Length 0.70 mm; width 0.38 mm; thickness 0.22 mm.

Bolivina hantkeniana H. B. Brady

Plate 2, figure 14

Bolivina hantkeniana H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 424, pl. 52, figs. 16–18.

Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 132, pl. 27, fig. 2.

Very rare and recorded in the Shinzato only; common in Recent deposits of the Philippine Sea and abundant in the Pliocene of Japan.

Length 1.10 mm; width 0.57 mm; thickness 0.26 mm.

Bolivina subreticulata Parr

Plate 2, figure 16

Bolivina subreticulata Parr, 1932, Royal Soc. Victoria Proc., v. 14, pl. 12, pl. 1, figs. 21a, b.

Noted only sporadically and in limited numbers from the Shinzato and from the upper part of the Yonabaru; recorded in Recent deposits of the Tropical Pacific.

Length 0.44 mm; width 0.24 mm; thickness 0.16 mm.

Bolivina robusta H. B. Brady

Plate 2, figure 13

Bolivina robusta H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 421, pl. 53, figs. 7–9.

Occurs rather frequently in the Yonabaru and Shinzato; widely recorded from late Tertiary and Recent deposits of the Indo-Pacific region; common in the Pliocene of Japan.

Length 1.00 mm; width 0.48 mm; thickness 0.32 mm.

Bolivina plano-convexa Cushman and Todd

Plate 2, figure 7

Bolivina plano-convexa Cushman and Todd, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 48, pl. 7, fig. 16.

Originally described from the Miocene of Jamaica; observed in limited numbers in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru only.

Length 0.97 mm; width 0.54 mm; thickness 0.30 mm.

Bolivina subangularis H. B. Brady var. agasaensis Asano

Plate 2, figures 24, 25

Bolivina subangularis H. B. Brady var. *agasaensis* Asano, 1936, Japanese Jour. Geology and Geography, v. 13, figs. 3, 4; p. 331, fig. 8.

Occasionally present in the Chinen; rare to common in the Pliocene of Japan.

Length 0.63 mm; width 0.31 mm; thickness 0.25 mm.

Bolivina striatula Cushman

Plate 2, figure 8

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

Several typical specimens were recorded from the Naha and Chinen deposits only.

Length 0.55 mm; width 0.16 mm; thickness 0.12 mm.

Bolivina spinescens Cushman

Plate 2, figure 21

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

Rarely found in Chinen assemblages only.

Length 0.33 mm; width 0.14 mm; thickness 0.10 mm.

Bolivina capitata Cushman

Plate 2, figure 9

Bolivina capitata Cushman, 1933, Cushman Lab. Foram. Research Spec. Pub. 9, p. 80, pl. 8, figs. 12a, b.

Few specimens recorded from the Chinen deposits only. The type was described from Recent deposits off Levuka, Fiji.

Length 0.66 mm; width 0.18 mm; thickness 0.12 mm.

Bolivina chinenensis LeRoy, n. sp.

Plate 2, figures 10, 11

Length about two times maximum width, broadens rather rapidly toward apertural end, moderately compressed; chambers distinct, noninflated; sutures distinct, curved, and angle about 45° in upper half; periphery sharply rounded with distinct blunt spines in lower half; wall minutely punctate, a few scattered minute

beads of clear shell material on surface; aperture elongate with faint rim.

This species is closely allied to *B. seranensis* Germeraad, described from the Neogene of Ceram, Indonesia, but differs by being thicker and exhibiting more surface beads on the upper half of the test and by more peripheral irregularity.

The peripheral spines and suture beads characterize the species which is named after the village of Chinen. It is rare and was found in the Chinen Sand only.

Length 0.42–0.45 mm; width 0.17–0.20 mm; thickness 0.10–0.12 mm.

Genus FISSURINA Reuss, 1850

Fissurina fasciata (Egger) var. spinosa (Sidebottom)

Plate 13, figures 11, 12

Lagena fasciata Egger var. *spinosa* Sidebottom, Quekett, 1912, Micr. Club Jour., ser. 2, v. 11, pl. 17, figs. 16a, b, 17.

Observed in limited numbers from the Yonabaru only.

Length 0.30 mm; width 0.24 mm; thickness 0.17 mm.

Fissurina echigoensis (Asano and Inomata), var.

Plate 13, figures 9, 10

Entosolenia echigoensis Asano and Inomata, 1952, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, supp. 1, p. 7, figs. 35, 36.

The Okinawan specimens, somewhat less elongate than the type, occurs rarely in Yonabaru assemblages only.

Length 0.24 mm; width 0.23 mm; thickness 0.19 mm.

Fissurina semiopaca (Wiesner)

Plate 13, figures 19, 20

Lagena (*Entosolenia*) *semiopaca* Wiesner, 1931, Deutsche *Südpolar*-Exped., Berlin u. Leipzig, v. 20 (Zoology), p. 120, pl. 19, fig. 223.

Very rare in Chinen deposits only.

Length 0.54 mm; width 0.49 mm; thickness 0.32 mm.

Fissurina ventricosa (Silvestri)

Plate 13, figures 13, 14

Lagena ventricosa Silvestri, 1904, R. Accad. Sci. Torino, Atti Italia, v. 39, p. 11, fig. 6.

Only a few specimens were recorded from the Yonabaru.

Length 0.45 mm; width 0.41 mm; thickness 0.33 mm.

Fissurina aff. F. crebra (Matthes)

Plate 13, figures 15, 16

Lagena crebra Matthes, 1939, Paleontography Stuttgart, v. 90, Abt. A, p. 72, pl. 5, figs. 66–70.

Very rare in Chinen assemblages only.

Length 0.21 mm; width 0.18 mm; thickness 0.11 mm.

Fissurina crebra (Matthes) var. scissa (Matthes)

Plate 13, figures 27, 28

Lagena crebra Matthes var. *scissa* Matthes, 1939, Paleontography Stuttgart, v. 90, Abt. A, p. 73, pl. 5, figs. 71–74.

Very rare in the Chinen deposits.

Length 0.25 mm; width 0.20 mm; thickness 0.14 mm.

Fissurina lacunata (Burrows and Holland)

Plate 13, figures 17, 18

Lagena lacunata Burrows and Holland, 1895, *in* Jones, Palaeont. Soc. Pub., p. 205, pl. 7, fig. 12.

Fissurina lacunata (Burrows and Holland) Cushman, Todd, and Post. 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 351, pl. 87, fig. 28.

A few specimens were noted from the Chinen only.

Length 0.29 mm; width 0.24 mm; thickness 0.12 mm.

Fissurina radiato-marginata (Parker and Jones)

Plate 13, figures 5, 6

Lagena radiato-marginata Parker and Jones, 1865, Philos. Trans., v. 155, p. 355, pl. 18, fig. 3.

Fissurina radiato-marginata (Parker and Jones). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 351, pl. 87, fig. 29.

A few specimens were found in the Chinen deposits only.

Length 0.37 mm; width 0.19 mm; thickness 0.10 mm.

Fissurina castrensis (Schwager) var. pacifica LeRoy, n. var.

Plate 13, figures 7, 8

Differs from the type described from the Pliocene of Kar Nicobar by having several low peripheral ridges between the two well-developed outer ones; noted rarely in the Shinzato.

Length 0.60–0.62 mm; width 0.46–0.49 mm; thickness 0.32–0.36 mm.

Fissurina lunata (Matthes)

Plate 13, figures 21, 22

Lagena lunata Matthes, 1939, Paleontography Stuttgart, v. 90, Abt. A, p. 90, pl. 8, figs. 153, 154.

The Okinawan specimens are very closely related to this species which occurs in limited numbers in Yonabaru assemblages only.

Length 0.32 mm; width 0.27 mm; thickness 0.15 mm.

Fissurina enderbiensis (Chapman)

Plate 13, figures 23, 24

Lagena enderbiensis Chapman, 1909, Philosophical Inst. Canterbury, v. 1, p. 339, pl. 16, figs. 1a, b.

Rarely found in the Shinzato only.

Length 0.28 mm; width 0.15 mm; thickness 0.08 mm.

Fissurina perforata LeRoy, n. sp.

Plate 13, figures 25, 26

Test compressed, about twice as long as broad, base rounded and with spine; periphery subacute with blunt

narrow rim; surface finely perforate; aperture elliptical, at end of short neck.

Similar to *F. milletti* Todd but differs by having a less extended neck, by possessing a blunt basal spine, and by showing finer perforations.

Rare in Shinzato assemblages only.

Length 0.40–0.42 mm; width 0.21–0.23 mm; thickness 0.10–0.13 mm.

Genus VIRGULINA d'Orbigny, 1826

Virgulina schreibersiana Czjzek

Plate 3, figure 14

Virgulina schreibersiana Czjzek. Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 13, pl. 2, figs. 11–20.

Observed rarely in only Naha and Chinen deposits.

Length 0.83 mm; width 0.15 mm.

Genus LOXOSTOMUM Ehrenberg, 1854

Loxostomum compressum LeRoy, n. sp.

Plate 2, figures 29, 30

Test small for the genus, very compressed, sides subparallel; periphery acute with narrow flange; chambers enlarge rapidly, noninflated; sutures distinct, angles at about 45°, flush with surface; wall smooth; aperture narrow with slight rim.

This species is very similar to *B. nitida* Brady (1884) originally described as *B. laevigata* (1881). It differs, however, by showing a more pronounced peripheral flange and less depression of the sutures.

Very rare in the Yonabaru.

Length 0.42–0.44 mm; width 0.18–0.21 mm; thickness 0.50–0.07 mm.

Loxostomum lobatum (H. B. Brady)

Plate 2, figure 19

Bolivina lobata H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 425, pl. 53, figs. 22, 23.

Loxostoma lobatum (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 188, pl. 22, figs. 2–4.

Few specimens observed in Chinen assemblages only.

Length 0.30 mm; width 0.11 mm; thickness 0.08 mm.

Loxostomum limbatum (H. B. Brady) var. costulatum (Cushman)

Plate 2, figure 20

Loxostoma limbatum (H. B. Brady) var. *costulatum* (Cushman), 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 187, pl. 21, figs. 20, 21.

Recorded in very limited numbers from Chinen deposits only.

Length 0.71 mm; width 0.25 mm; thickness 0.08 mm.

Loxostomum karrerianum (H. B. Brady)

Plate 2, figures 26, 27

Bolivina karrerianum H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 424, pl. 53, figs. 19–21.

Loxostoma karrerianum (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 184, pl. 21, fig. 17.

Recorded in Chinen assemblages and in limited numbers.

Length 0.60 mm; width 0.21 mm; thickness 0.14 mm.

Loxostomum amygdalaeforme (H. B. Brady) var. iokiense Asano

Plate 2, figures 22, 23

Loxostomum amygdalaeforme (H. B. Brady) var. *iokiense* Asano, 1938, Geol. Soc. Japan Jour., v. 45, no. 538, p. 605, pl. 16, figs. 3a, b.

Present in limited numbers in the Chinen and Shinzato, and in the upper part of the Yonabaru.

Length 0.54 mm; width 0.22 mm; thickness 0.15 mm.

Loxostomum pacificum LeRoy, n. sp.

Plate 2, figures 31, 32

Test two to three times as long as broad, thick, periphery broadly rounded, sides nearly parallel; chambers indistinct, only faintly inflated; sutures slightly depressed, somewhat crenulated, indistinct; wall with faint costae, which on some specimens are almost absent; aperture elongate with low marginal rim.

This species differs from *L. limbatum* (H. B. Brady) var. *costulatum* Cushman by being more robust, thicker, and by developing a more pronounced uniserial stage. In some respects it shows an affinity to *L. digitale* (d'Orbigny).

The species appears to be restricted to the upper part of the Yonabaru and typifies the *Loxostomum pacificum* fauna.

Length 0.97 mm; width 0.36 mm; thickness 0.25 mm.

Loxostomum okinawaense LeRoy, n. sp.

Plate 2, figures 17, 18

Test elongate, about five times as long as wide, twisted, gradually increasing in width toward apertural extremity; periphery broadly rounded; chambers distinct, last two or three inflated; sutures distinct, wide, nearly horizontal in early stage, up to 45° in later stage, flush to faintly raised; wall coarsely punctate; aperture elongate, comma shaped.

This species is similar to *L. capitata* (Cushman) described from Recent deposits off Levuka, Fiji, but differs by being more coarsely perforate and twisted.

Recorded in limited numbers in Naha assemblages only.

Length 0.47–0.49 mm; width 0.12–0.15 mm; thickness 0.10–0.12 mm.

Genus RECTOBOLIVINA Cushman, 1927

Rectobolivina? virgula (H. B. Brady)

Plate 3, figure 7

Sagrina virgula H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 583, pl. 66, figs. 4–10.

Observed rarely in Chinen assemblages only.
Length 0.47 mm; diameter 0.11 mm.

Rectobolivina dimorpha (Parker and Jones)

Plate 3, figures 3, 4

Siphogenerina dimorpha (Parker and Jones). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 279, pl. 56, fig. 8.

Very rarely found in Shinzato and Yonabaru assemblages.
Length 0.95 mm; diameter 0.31 mm.

Rectobolivina bifrons (H. B. Brady)

Plate 3, figures 1, 2

Sagrina bifrons Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 582, pl. 75, figs. 18–20.
Rectobolivina bifrons (H. B. Brady). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 204, pl. 23, figs. 13, 14.

This species commonly occurs in Recent sediments of the South Pacific and in the late Tertiary of the Indo-Pacific. It was observed in limited numbers within the Shinzato and the *Loxostomum pacificum* fauna of the Yonabaru. The species is common in the Pliocene of Japan. Cushman recorded the species as common from the following depths: 19, 272, and 554 fathoms, off the Philippines.
Length 0.97 mm.

Rectobolivina bifrons (H. B. Brady) var. striatula (Cushman)

Plate 3, figures 5, 6

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

Common in the shallow-water facies of the Yonabaru deposits; rare in the Shinzato.
Length 0.96 mm; width 0.28 mm.

Genus REUSSELLA Galloway, 1933

Reussella spinulosa (Reuss)

Plate 3, figure 19

Verneuilina spinulosa Reuss, 1850, Akad. Wiss. Wien, Math-naturwiss. Kl. Denkschr., v. 1, p. 374, pl. 47, fig. 12.

Recorded rarely in the Naha and Chinen assemblages and in the *Loxostomum pacificum* fauna of the Yonabaru.
Length 0.39 mm; width (max.) 0.25 mm.

Genus BITUBULOGENERINA Howe, 1934

Bitubulogenerina convallaria (Millett)

Plate 2, figure 28

Bolivina convallaria Millett, 1900, Royal Micr. Soc. Jour., p. 544, pl. 4, figs. 6a, b.
Loxostoma convallarium (Millett). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 191, pl. 22, figs. 11–13.

A few specimens referable to this species were recorded in Chinen assemblages only.
Length 0.39 mm; width 0.09 mm.

Genus UVIGERINA d'Orbigny, 1826

Uvigerina striatella Reuss

Plate 3, figure 42

Uvigerina striatella Reuss, 1851, Deutsche geol. Gesell. Zeitschr., v. 3, p. 159, pl. 8, fig. 7.

Rare in Shinzato and Yonabaru assemblages; most common in the shallow-water deposits of the Yonabaru.
Length 0.90 mm.

Uvigerina gemmaeformis Schwager

Plate 3, figure 39

Uvigerina gemmaeformis Schwager, 1866, *Novara*-Exped., Geo. Theil, v. 2, p. 247, pl. 7, fig. 92.

Recorded in limited numbers from the shallow-water deposits of the Yonabaru only.
Length 1.07 mm.

Uvigerina hispida Schwager

Plate 4, figures 2, 3

Uvigerina hispida Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 249, pl. 7, fig. 95.

Rare in Shinzato and Yonabaru assemblages.
Length 0.80–0.90 mm.

Uvigerina aculeata d'Orbigny

Plate 3, figures 40, 41

Uvigerina aculeata d'Orbigny, 1846, Foraminifères fossiles du bassin tertiare de Vienne, p. 191, pl. 11, figs. 27, 28.

Occurs in limited numbers and is seemingly restricted to the Shinzato.
Length 0.67 mm.

Uvigerina peregrina Cushman var. dirupta Todd

Plate 4, figure 4

Uvigerina peregrina Cushman var. *dirupta* Todd, 1948, Allan Hancock Pacific Exped., v. 6, no. 5, p. 267, pl. 34, fig. 3.

Occurs in limited numbers in Shinzato and Yonabaru assemblages, particularly in the Yonabaru.
Length 0.60 mm; width 0.34 mm.

Uvigerina hispido-costata Cushman and Todd

Plate 16, figure 7

Uvigerina hispido-costata Cushman and Todd, 1945, Cushman Lab. Foram. Research Spec. Pub. 15, p. 51, pl. 7, figs. 27, 31.

The Okinawan specimens, only occasionally found in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru, tend to show less spinosity of the costae than the typical. The figured specimen may well be a varietal form of *U. peregrina* Cushman.
Length 0.53 mm.

Uvigerina crassicostata Schwager

Plate 4, figure 1

Uvigerina crassicostata Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 248, pl. 7, fig. 94.

Rare in Shinzato and Yonabaru assemblages.
Length 1.16 mm.

Uvigerina proboscidea Schwager

Plate 16, figure 8

Uvigerina proboscidea Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 250, pl. 7, fig. 96.

Rare in Shinzato and Yonabaru assemblages.
Length 0.47 mm.

Uvigerina proboscidea Schwager var. vadescens Cushman

Plate 3, figure 38

Uvigerina proboscides Schwager var. *vadescens* Cushman, 1933, Cushman Lab. Foram. Research Contr., v. 9, p. 85, pl. 8, figs. 14, 15.

Recorded in limited numbers in Chinen, Shinzato, and Yonabaru.
Length 0.59 mm.

Uvigerina nitidula Schwager

Plate 3, figure 37

Uvigerina nitidula Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 248, pl. 7, fig. 93.

Recorded in limited numbers in Shinzato assemblages only.
Length 0.72 mm.

Genus RECTUVIGERINA Mathews, 1945

Rectuvigerina striata (Schwager)

Plate 3, figure 8

Dimorpha striata Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 251, pl. 7, fig. 99.
Siphogenerina striata (Schwager). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 280, pl. 56, fig. 5.

Recorded in limited numbers in Shinzato assemblages only; widely recorded in late Tertiary deposits of Indonesia.
Length 0.72 mm; diameter 0.23 mm.

Genus SIPHOGENERINA Schlumberger, 1883

Siphogenerina raphanus (Parker and Jones)

Plate 3, figure 35; plate 16, figure 9

Uvigerina (Sagrina) raphanus Parker and Jones, 1865, Philos. Trans., v. 155, p. 364, pl. 18, figs. 16, 17.
Siphogenerina raphanus (Parker and Jones). Cushman, 1942, U.S. Natl. Mus. Bull. 161, pt. 3, p. 55, pl. 15, figs. 6–9.

Common in the *Loxostomum pacificum* fauna of the Yonabaru; occasionally recorded in Naha, Chinen, and Shinzato.
Length 1.10 mm.

Genus STILOSTOMELLA, Guppy, 1894

Stilostomella lepidula (Schwager)

Not illustrated

Nodosaria lepidula Schwager, 1886, *Novara*-Exped., Geol. Theil, v. 2, p. 210, pl. 5, figs. 27, 28.
Siphonodosaria lepidula (Schwager). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 356, pl. 88, figs. 27, 28.

Abundant in Shinzato and Yonabaru assemblages.
Dimension: Length 0.73 mm.
USGS locality: f11536 (WF–274, Yonabaru Member).
USNM 625393.

Stilostomella ketenziensis (Ishizaki)

Plate 15, figure 33

Ellipsonodosaria ketenziensis (Ishizaki), 1943, Nat. Hist. Soc. Taiwan Trans., v. 33, p. 684, figs. 1, 6, 11.

Rare in Shinzato assemblages; sporadic in the Yonabaru.
Length 1.70 mm.

Genus TRIFARINA Cushman, 1923

Trifarina bradyi Cushman

Plate 3, figures 17, 18

Trifarina bradyi Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 99, pl. 22, figs. 3–9.

Constantly recurring in limited numbers in Chinen, Shinzato, and Yonabaru; abundant in Recent deposits of the South Pacific.
Length 0.36 mm; width 0.16 mm.

Genus ANGULOGERINA Cushman, 1927

Angulogerina japonica Asano

Plate 5, figure 24

Angulogerina japonica Asano, 1938, Geol. Soc. Japan Jour., v. 45, no. 538, p. 615, pl. 17, fig. 17.

Very rare in Shinzato and Yonabaru assemblages.
Length 0.29 mm; thickness 0.14 mm.

Genus PATELLINELLA Cushman, 1928

Patellinella jugosa (H. B. Brady)

Plate 2, figures 33, 34

Textularia jugosa H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 358, pl. 42, figs. 7a, b.

A few specimens were recorded in the Chinen and Shinzato.
Length 0.25 mm; width 0.21 mm; thickness 0.12 mm.

Patellinella inconspicua (H. B. Brady)

Plate 2, figures 35, 36

Textularia inconspicua H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 357, pl. 42, figs. 6a, b.
Discobolivina inconspicua (H. B. Brady). Hofker, 1951, *Siboga*-Exped., pt. 3, p. 431, fig. 296.

This distinctive species, more circular in plan view than Brady's form, was recorded in limited numbers in the Chinen.
Length 0.21 mm; width 0.26 mm; thickness 0.24 mm.

Family ELLIPSOIDINIDAE
Genus PLEUROSTOMELLA Reuss, 1860

Pleurostomella alternans Schwager

Plate 5, figure 5

Pleurostomella alternans Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 238, figs. 79, 80.

Noted in restricted numbers in the Shinzato and in the upper part of the Yonabaru.
Length 1.40 mm; width 0.27 mm; thickness 0.22 mm.

Pleurostomella brevis Schwager

Plate 5, figure 4

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

Rare in Shinzato and Yonabaru assemblages.
Length 0.60 mm; width 0.40 mm; thickness 0.37 mm.

Family ROTALIIDAE
Genus ROSALINA d'Orbigny, 1826

Rosalina isabelleana d'Orbigny

Plate 7, figures 51, 52

Rosalina isabelleana d'Orbigny, 1839, Voyage dans l'Amerique Méridonale, v. 5, p. 43, figs. 10–12.
Discorbis isabelleana (d'Orbigny). Cushman, 1915, U. S. Natl. Mus. Bull. 71, pt. 5, p. 15, pl. 6, fig. 1.

This species was noted in limited numbers in the Chinen deposits. It ranges through the Miocene and Pliocene section of Japan.
Diameter 0.24–0.29 mm; thickness 0.11 mm.

Rosalina stacyi LeRoy, n. sp.

Plate 7, figures 42–44

Test small for the genus, nearly equally biconvex; periphery slightly lobulate, subacute; chambers distinct, generally five in last whorl, moderately inflated, particularly the last one; chambers gradually increase in size as added; sutures distinct, depressed, slightly curved; some specimens have umbilical plug of clear shell material; wall distinctly perforate; test is light brown; aperture an elongate opening at base of last chamber.

This distinctive species cannot be compared with any published form. It appears to be confined to the Chinen deposits. The species is named for J. R. Stacy (scientific illustrator, U.S. Geol. Survey) who completed most of the illustrations in this paper.
Diameter 0.32–0.38 mm; thickness 0.14–0.16 mm.

Genus NEOCONOBRINA Hofker, 1951

Neoconobrina nakamurai (Asano)

Plate 7, figures 45–47

Discorbis nakamurai Asano, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 14, p. 2, figs. 8–10.

This distinctive species, originally described from the Pliocene of Japan, was recorded in restricted numbers from the Chinen deposits only. The species is easily identified by its peripheral spines, conical cross section, and granulosity near the center on the ventral side.
Diameter 0.25–0.29 mm; thickness 0.12 mm.

Neoconobrina opercularis (d'Orbigny)

Plate 9, figures 9, 10

Rosalina opercularis d'Orbigny, 1839, *in* De la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 101, pl. 3, figs. 24, 25.
Discorbis opercularis (d'Orbigny). Cushman, 1915, U.S. Natl. Mus. Bull. 71, pt. 5, p. 18, pl. 11, fig. 3.

This species was observed in the Chinen only and in the *Loxostomum pacificum* fauna of the Yonabaru. Its tubercled ventral side, strongly curved sutures, and conical cross section distinguish the species. It is found frequently in the Pliocene of Japan.
Diameter 0.28–0.36 mm; thickness 0.10 mm.

Neoconobrina pacifica LeRoy, n. sp.

Plate 4, figures 26–28

Test nearly circular in plan view, more convex dorsally than ventrally; generally five chambers in last whorl, noninflated; ventral sutures slightly depressed, slightly curved; dorsal sutures flush with surface, broad, strongly curved and oblique; wall coarsely punctate dorsally, finely punctate ventrally; periphery subacute with narrow rim containing minute radiating pores; aperture small at base of last chamber.

Similar to but differs from *Neoconobrina* (*Discorbis*) *australis* (Parr) by being somewhat convex ventrally instead of being slightly concave.
Diameter 0.43–0.47 mm; thickness 0.28–0.30 mm.

Genus ROTORBINELLA Bandy, 1944

Rotorbinella chinenensis LeRoy, n. sp.

Plate 7, figures 48–50

Test small for the genus, more convex dorsally than ventrally, nearly circular in plan view, periphery sub-

acute, with narrow border of clear shell material; chambers distinct, six to seven in last whorl, noninflated, enlarge very gradually as added; sutures distinct, flush with surface and strongly oblique dorsally, slightly depressed radial and faintly curved ventrally; distinct ventral umbilical plug; wall finely perforate; aperture elongate at base of last chamber extending toward ventral umbilical plug.

This species appears to be related to *D. turbo* (d'Orbigny) as figured by Brady (1884, p. 642, pl. 87, figs. 8a–c) but which shows broader ventral sutures and more convexity of dorsal side. The species commonly occurs in the Chinen assemblages.

Diameter 0.24–0.28 mm; thickness 0.12 mm.

Genus LAMARCKINA Berthelin, 1881

Lamarckina ventricosa (H. B. Brady)

Not illustrated

Discorbina ventricosa H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 654, pl. 91, figs. 7a, c.

Several specimens closely related to this species were recorded in the Chinen deposits.

Diameter 0.48–0.53 mm; thickness 0.38 mm.

USGS locality: f11541 (ME–21, Chinen formation).

USNM 625391.

Genus VALVULINERIA Cushman, 1926

Valvulineria laevigata Phleger and Parker

Plate 16, figures 27, 28

Valvulineria laevigata Phleger and Parker, 1951, Geol. Soc. America Mem. 46, pt. 2, p. 25, pl. 13, figs. 11, 12.

Observed in limited numbers in Yonabaru assemblages only.

Diameter 0.23–0.25 mm; thickness 0.16 mm.

Genus GYROIDINA d'Orbigny, 1826

Gyroidina trincherasensis Bermúdez

Plate 7, figures 1–3

Gyroidina trincherasensis Bermúdez, 1949, Cushman Lab. Foram. Research Spec. Pub. 25, p. 254, pl. 17, figs. 55–57.

This form, having a concave dorsal side, is common in the Shinzato and Yonabaru. The dorsal sutures of the Okinawan specimens appear to be somewhat less curved than shown by the figure of the type.

Diameter 0.51 mm; thickness 0.43 mm.

Gyroidina cibaoensis Bermúdez

Plate 7, figures 16–18

Gyroidina cibaoensis Bermúdez, 1949, Cushman Lab. Foram. Research Spec. Pub. 25, p. 252, pl. 17, figs. 61–63.

Most common in the Shinzato and rare in the Yonabaru.

Diameter 0.40 mm; thickness 0.27 mm.

Gyroidina neosoldanii Brotzen

Plate 7, figures 4–6

Rotalia soldanii d Orbigny. H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 706, pl. 107, figs. 6, 7.

Gyroidina neosoldanii Brotzen, 1936, Sweden, Sveriges geol. undersökning Avh., ser. C, no. 396, p. 158, pl. 107, figs. 6, 7 (of Brady).

Recorded rarely in Yonabaru assemblages only. Most of the specimens exhibit a more rounded peripheral margin than the one illustrated.

Diameter 0.80 mm; thickness 0.58 mm.

Gyroidina altispira Cushman and Stainforth

Plate 7, figures 10–12

Gyroidina altispira Cushman and Stainforth, 1945, Cushman Lab. Foram. Research Spec. Pub. 14, p. 61, pl. 11, fig. 1.

Several small specimens showing an affinity to this species were recorded from the Shinzato.

Diameter 0.51 mm; thickness 0.38 mm.

Gyroidina altiformis R. E. and K. E. Stewart

Plate 7, figures 7–9

Gyroidina soldanii d'Orbigny var. *altiformis* R. E. and K. E. Stewart, 1938, Jour. Paleontology, v. 4, p. 67, pl. 9, fig. 2.

Rare in the Shinzato and Yonabaru. The specimens are somewhat smaller than the type but are morphologically similar.

Diameter 0.50 mm; thickness 0.40 mm.

Gyroidina nipponica Ishizaki

Plate 7, figures 13–15

Gyroidina nipponica Ishizaki, 1944, Nat. Hist. Soc. Taiwan Trans., v. 34, no. 244, p. 102, pl. 3, fig. 3a–c.

Seldom found in the Yonabaru only.

Diameter 0.28 mm; thickness 0.21 mm.

Genus EPONIDES Montfort, 1808

Eponides margaritiferus (H. B. Brady)

Plate 7, figures 19–21

Truncatulina margaritifera H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 667, pl. 96, figs. 2a-c.

This species was only noted from late Tertiary deposits on Heanna Island off the east coast of Okinawa. It is a form widely recorded in late Tertiary and Recent sediments of the Indo-Pacific region.

Diameter 0.89 mm; thickness 0.50 mm.

Eponides hyalinus (Hofker)

Plate 7, figures 24–26

Cibicides hyalina Hofker, 1951, *Siboga*-Exped., pt. 3, p. 359, figs. 244, 245.

Rather common in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru.

Diameter 0.37 mm; thickness 0.21 mm.

Eponides praecintus (Karrer)

Plate 7, figures 30–32

Rotalia praecinta Karrer, 1868, Akad, Wiss. Wien, Sitzungsber., v. 58, p. 189, pl. 5, fig. 7.
Truncatulina praecinta (Karrer). Cushman, 1915, U.S. Natl. Mus. Bull. 71, pt. 5, p. 39, pl. 26, fig. 2.

Commonly occurs in the shallow-water deposits of the Naha, Chinen, and Yonabaru; rare in Shinzato assemblages.

Diameter 0.81 mm; thickness 0.48 mm.

Eponides procerus (H. B. Brady)

Plate 7, figures 22, 23

Pulvinulina procera H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 698, pl. 105, figs. 7a–c.

Occurs frequently in the *Loxostomum pacificum* fauna of the Yonabaru; common in the late Tertiary and Recent deposits of the Indo-Pacific region.

Diameter 0.60 m; thickness 0.53 mm.

Eponides subornatus (Cushman)

Plate 7, figures 27–29

Pulvinulina berthelotiana d'Orbigny var. *subornata* Cushman, 1931, U.S. Natl. Mus. Bull. 100, v. 4, p. 333, pl. 70, figs. 1a–c.

Appears most frequently in the *Loxostomum pacificum* fauna of the Yonabaru; only a few specimens were noted in the Shinzato and Chinen.

Diameter 0.62 mm; thickness 0.43 mm.

Genus OSANGULARIA Brotzen, 1940

Osangularia bengalensis (Schwager)

Plate 9, figures 32, 33

Anomalina bengalensis Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 259, pl. 7, fig. 111.
Osangularia bengalensis (Schwager). Cushman, Todd, and Post, 1954. U.S. Geol. Survey Prof. Paper 260–H, p. 360. pl. 89. fig. 21.

Schwager originally defined this species from the Pliocene of Kar Nicobar. It occurs in limited numbers in the Yonabaru and Shinzato; attains greater dimensions in the Shinzato.

Diameter 0.67–0.75 mm; thickness 0.46 mm.

Genus STREBLUS Fischer, 1917

Streblus beccarii tepida (Cushman)

Plate 4, figures 16, 17

Rotalia beccarii (Linné) var. *tepida* Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 61, pl. 13, figs. 3a–c.

Present in limited numbers in the Naha and Chinen only.

Diameter 0.60 mm; thickness 0.30 mm.

Genus PARAROTALIA LeCalvez, 1949

Pararotalia yonabaruensis LeRoy, n. sp.

Plate 4, figures 23–25

Test strongly convex ventrally, slightly convex dorsally, irregularly umbilicate ventrally, frequently shows distinct, irregular ventral plug, periphery subacute, lobulate, with narrow flange and with blunt spines or slight protuberances; chambers distinct, 6 to 7 in last whorl, slightly inflated, enlarge only gradually as added; ventral sutures deeply depressed, nearly straight but somewhat oblique, sometimes bordered with minute beads of clear shell material; dorsal sutures flush with surface, slightly oblique; aperture small at base of last chamber just below peripheral margin and opening into ventral umbilical region.

Diameter 0.39–0.44 mm; thickness 0.25 mm.

Genus ROTALIDIUM Asano, 1936

Rotalidium okinawaensis LeRoy, n. sp.

Plate 4, figures 29–31

Test nearly equally biconvex, almost circular in plan view; chambers distinct, 7 to 10 in last whorl, enlarging very gradually as added; dorsal sutures flush, straight to slightly curved; ventral sutures slightly depressed, straight; periphery sharply rounded, faintly lobulate; ventral umbilical area raised and with irregular mass of clear shell material; wall smooth and minutely punctate; aperture small and at base of last chamber near peripheral margin.

Differs from *R. pacificum* Asano by showing more convexity of the dorsal side, thus more equally biconvex.

Diameter 0.52 mm; thickness 0.30 mm.

Genus ROTALIA Lamarck, 1804

Rotalia stachi Asano

Plate 16, figures 34–36

Rotalia stachi Asano, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 13, p. 14, figs. 10–12.

Common in the basal part of the Chinen and rare in the *Loxostomum pacificum* fauna of the Yonabaru.

Diameter 0.96 mm; thickness 0.63 mm.

Genus HOEGLUNDINA Brotzen, 1948

Hoeglundina elegans (d'Orbigny)

Plate 6, figures 27, 28

Rotalia (*Turbinulina*) *elegans* d'Orbigny. 1826, Annales sci. nat., v. 7, p. 276.
Hoeglundina elegans (d'Orbigny). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 360, pl. 89, fig. 23.

Common in the Shinzato and in the upper part of the Yonabaru.

Diameter 1.22 mm; thickness 0.60 mm.

Genus POROEPONIDES Cushman, 1944

Poroeponides cribrorepandus Asano and Uchio

Plate 9, figures 26, 27

Poeroeponides cribrorepandus Asano and Uchio, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 14, p. 18, figs. 134, 135.

Recorded in limited numbers in the Naha and Chinen only.

Diameter 0.62–0.77 mm; thickness 0.32 mm.

Genus PSEUDOEPONIDES Uchio, 1950

Pseudoeponides japonicus Uchio

Plate 9, figures 20–22

Pseudoeponides japonicus Uchio, 1950, Assoc. Petroleum Technology Jour., v. 15(4), p. 190, fig. 16.

Scarce and sporadic in Shinzato assemblages.

Diameter 0.23–0.30 mm; thickness 0.15 mm.

Pseudoeponides umbonatus (Reuss)

Plate 7, figures 33–38

Rotalina umbonata Reuss, 1851, Deutsche geol. Gesell. Zeitschr., v. 3, p. 75, pl. 5, figs. 35a–c.

Eponides umbonata (Reuss). Cushman, 1929, Cushman Lab. Foram. Research Contr., v. 5, p. 98, pl. 14, fig. 8.

Occurs most frequently in the upper part of the Yonabaru; few specimens were recorded from the Shinzato.

Diameter 0.60 mm; thickness 0.38 mm (figs. 33–35).

Diameter 0.63 mm; thickness 0.34 m (figs. 36–38).

Genus SIPHONINA Reuss, 1850

Siphonina australis Cushman

Plate 4, figures 20–22

Siphonina australis Cushman, 1927, U.S. Natl. Mus. Proc., v. 27, p. 8, pl. 2, figs. 6a–c; pl. 3, figs. 7a–c.

A few specimens were recorded in Shinzato and Yonabaru.

Diameter 0.45 mm; thickness 0.18 mm.

Siphonina tubulosa Cushman

Plate 16, figures 10, 11

Siphonina tubulosa Cushman, 1924, Carnegie Inst. Washington Pub. 342, p. 40, pl. 13, figs. 1, 2.

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

Several typical specimens were recorded from the Chinen deposits only.

Diameter 0.40 mm; thickness 0.24 mm.

Genus CANCRIS Montfort, 1808

Cancris auriculus (Fichtel and Moll)

Plate 6, figures 23, 24

Cancris auricula (Fichtel and Moll). Cushman and Todd, 1942, Cushman Lab. Foram. Research Contr., v. 18, p. 74, pl. 18, figs. 1–11; pl. 23, fig. 6.

Occurs most frequently in the Chinen; rare in the Shinzato.

Length 0.40 mm; width 0.27 mm; thickness 0.19 mm.

Cancris communis Cushman and Todd

Plate 6, figures 25, 26

Cancris sagra (d'Orbigny) var. *communis* Cushman and Todd, 1942, Cushman Lab. Foram Research Contr., v. 18, p. 79, pl. 19, figs. 8–11; pl. 20, fig. 1.

A few specimens referable to this species were noted in Naha and Chinen assemblages.

Length 0.64 mm; width 0.43 mm; thickness 0.23 mm.

Genus BAGGINA Cushman, 1926

Baggina totomiensis Makiyama

Plate 6, figures 20–22

Baggina totomiensis Makiyama, 1931, Kyoto Imp. Univ., Coll. Sci. Mem., ser. B, v. 7, p. 42, fig. 4.

Asano, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Smaller Foraminifera, pt. 14, p. 21, figs. 154, 155.

Occurs rarely in the *Loxostomum pacificum* fauna of the Yonabaru. Several specimens were recorded from the Chinen but not in the Shinzato.

Length 0.57 mm; thickness 0.37 mm; width 0.35 mm.

Genus ASTEROROTALIA Hofker, 1951

Asterorotalia trispinosa (Thalmann)

Plate 6, figures 18, 19

Rotalia pulchella H. B. Brady (not d'Orbigny), 1884, *Challenger* Rept., Zoology, v. 9, p. 710, pl. 115, figs. 8a, b.

Rotalia trispinosa Thalmann, 1933, Eclogae geol. Helvetiae, v. 26, p. 248.

Observed in limited numbers in the *Loxostomum pacificum* fauna of the Yonabaru only.

Diameter 0.48 mm; thickness 0.17 mm.

Family AMPHISTEGINIDAE

Genus AMPHISTEGINA d'Orbigny, 1826

Amphistegina wanneriana Fischer

Plate 6, figures 3–5

Amphistegina wanneriana Fischer, 1927, Paleontologie von Timor, Stuttgart, Deutschland, E. Schweizerbart, v. 15, p. 170, pl. 217, figs. 131a–c.

This relatively compressed form described from Pliocene of Seran occurs frequently in the *Loxostomum pacificum* fauna of the Yonabaru; rare in the basal part of the Chinen.

Diameter 0.97 mm; thickness 0.43 mm.

Amphistegina madagascariensis d'Orbigny

Plate 6, figures 1, 2

Amphistegina madagascariensis d'Orbigny, 1826, Annales sci. nat., v. 7, no. 5, p. 304.

Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 362, pl. 90, figs. 1, 2.

Commonly occurs in the Naha Limestone and in the upper part of the Yonabaru deposits; scattered occurrences noted in the Chinen. It is widely distributed in the recent shallow-water sediments of the Indo-Pacific region. Many workers have recorded this species as *A. lessoni* d'Orbigny.
Diameter 0.78 mm; thickness 0.50 mm.

Family CALCARINIDAE
Genus CALCARINA d'Orbigny, 1826

Calcarina rustica Todd and Post

Plate 5, figures 1, 2

Calcarina rustica Todd and Post, 1954, U.S. Geol. Survey Prof. Paper 260–N, p. 563, pl. 201, fig. 7.

Occurs sporadically only in the basal part of the Chinen and in the Naha.
Diameter 0.76 mm; thickness 0.36 mm.

Calcarina spengleri (Gmelin)

Plate 5, figure 3

Calcarina spengleri (Gmelin). H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 712, pl. 108, figs. 5, 7.

Associated with *C. rustica* Todd and Post, and is seemingly restricted to the basal part of the Chinen and Naha.
Diameter 1.45 mm; thickness 0.55 mm.

Family CYMBALOPORIDAE
Genus CYMBALOPORETTA Cushman, 1928

Cymbaloporetta bradyi (Cushman)

Plate 5, figures 6, 7

Cymbaloporetta bradyi Cushman, 1924, Carnegie Inst. Washington Pub. 342, p. 34, pl. 10, figs. 2–4.

Noted from only the Chinen in limited numbers.
Diameter 0.48 mm; thickness 0.21 mm.

Family CASSIDULINIDAE
Genus CERATOBULIMINA Toula, 1915

Ceratobulimina pacifica Cushman and Harris

Plate 9, figures 23, 24

Ceratobulimina pacifica Cushman and Harris, 1927, Cushman Lab. Foram. Research Contr., v. 3, p. 176, pl. 29, fig. 9.

Rather common in restricted numbers in the Shinzato and rare in Yonabaru assemblages.
Length 0.67 mm; width 0.54 mm; thickness 0.32 mm.

Genus CASSIDULINA d'Orbigny, 1826

Cassidulina inflata LeRoy

Plate 11, figures 13, 14

Cassidulina inflata LeRoy, 1944, Colorado School of Mines Quart., v. 39, no. 3, p. 37, pl. 4, figs. 30, 31.

This small form occurs frequently in the *Nonion nicobarense-Cibicides macneili* fauna of the Yonabaru and also in Shinzato assemblages.
Diameter 0.17–0.21 mm; thickness 0.15 mm.

Cassidulina orientale Cushman

Plate 11, figures 15, 16

Cassidulina orientale Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 37, pl. 7, figs. 6a, c.

Common in the Shinzato deposits and rare in those of the Yonabaru. Specimens appear to be slightly thicker than the type.
Diameter 0.17–0.23 mm; thickness 0.10 mm.

Cassidulina okinawaensis LeRoy, n. sp.

Plate 11, figures 21, 22

Test small for the genus, moderately compressed, periphery sharply rounded, slightly lobulate; chambers distinct, seven to eight pairs in last whorl, noninflated, enlarge gradually and uniformly as added; sutures distinct, slightly curved, flush with surface; wall smooth; aperture elongate.

This species occurs rarely in the Chinen, Shinzato, and Yonabaru, and is smiliar to *C. tortuosa* Cushman but much smaller.
Diameter 0.33 mm; thickness 0.20 mm.

Cassidulina margareta Karrer

Plate 11, figures 27, 28

Cassidulina margareta Karrer, 1877, K. K. Geol Reischsanst., Abh., Wien, Osterreich, v. 9, p. 386, pl. 16b, fig. 52.

Several specimens closely resembling this species were recorded from the Chinen.
Diameter 0.38 mm; thickness 0.24 mm.

Cassidulina subglobosa H. B. Brady

Plate 11, figure 17

Cassidulina subglobosa H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 430, pl. 54, figs. 17a–c.
Cushman, 1921, U. S. Natl. Mus. Bull. 100, v. 4, p. 171, pl. 32, fig. 2.

Rare in Shinzato and Yonabaru assemblages.
Diameter 0.51 mm; thickness 0.38 mm.

Cassidulina asanoi Uchio

Plate 11, figure 29

Cassidulina asanoi Uchio, 1950, Assoc. Petroleum Technology, v. 15, no. 4, p. 190, fig. 13.

Very rare in the Shinzato and Yonabaru.
Diameter 0.20 mm; thickness 0.06 mm.

Cassidulina pacifica Cushman

Plate 11, figures 19, 20

Cassidulina pacifica Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 53, figs. 14–16.

Common in the Shinzato assemblages and rare in the Yonabaru; abundant in the Miocene and Pliocene deposits of Japan and in the late Tertiary and Recent

sediments of the Indo-Pacific region.
Diameter 0.33 mm; thickness 0.37 mm.

Genus CASSIDULINOIDES Cushman, 1921

Cassidulinoides tenuis Phleger and Parker

Plate 12, figures 1, 2

Cassidulinoides tenuis Phleger and Parker, 1951, Geol. Soc. America Mem. 46, p. 27, pl. 14, figs. 14–17.

Several specimens were recorded from the Shinzato deposits only.
Length 0.73 mm; width 0.27 mm; thickness 0.24 mm.

Cassidulinoides bradyi (Norman)

Plate 12, figures 5, 6

Cassidulina bradyi (Norman). H. B. Brady, 1884, *Challenger* Rept., v. 9, p. 431, pl. 54, figs. 6–10.

Occasionally were noted from the Chinen only.
Length 0.37 mm; width 0.19 mm; thickness 0.19 mm.

Cassidulinoides braziliensis (Cushman)

Plate 12, figures 3, 4

Cassidulina braziliensis Cushman, 1922, U. S. Natl. Mus. Bull. 104, p. 130, pl. 25, figs. 4, 5.

Very rare in and restricted to the Shinzato.
Length 0.34 mm; width 0.22 mm; thickness 0.16 mm.

Genus EHRENBERGINA Reuss, 1850

Ehrenbergina bradyi Cushman

Plate 5, figures 21, 22

Ehrenbergina serrata H. B. Brady (part) (not Reuss), 1884, *Challenger* Rept., Zoology, v. 9, p. 434, pl. 55, figs. 6, 7.
Ehrenbergina bradyi Cushman, 1922, U.S. Natl. Mus. Bull. 104, pt. 3, p. 134, pl. 26, fig. 5.

Occurs in limited numbers within the Shinzato and in the upper part of the Yonabaru.
Length 0.56 mm; width 0.55 mm (max).

Ehrenbergina bosoensis var. decorata Takayanagi

Plate 5, figures 27, 28

Ehrenbergina bosoensis var. *decorata* Takayanagi, 1951, Paleont. Soc. Japan Trans. and Proc., v. 3, p. 89, fig. 9.

This spinose species was found in limited numbers in the Chinen.
Length 0.55 mm; width 0.47 mm (max.).

Family CHILOSTOMELLIDAE
Genus CHILOSTOMELLA Cushman, 1926

Chilostomella oolina Schwager

Plate 2, figure 39

Chilostomella oolina Schwager, 1878, Bol. Com. Geol., Italy, v. 9, p. 527, pl. 1, fig. 16.
Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 74, pl. 11, figs. 3–10.

A few specimens were recorded from the *Loxostomum pacificum* fauna of the Yonabaru.
Length 0.85 mm; diameter 0.39 mm.

Genus SPHAEROIDINA d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny

Plate 16, figures 21, 22

Sphaeroidina bulloides d'Orbigny, 1826, Annales sci. nat., v. 7, p. 267, Modéles no. 65.

Common in the Shinzato and Yonabaru.
Diameter 0.40 mm.

Sphaeroidina haueri (Czjzek)

Not illustrated

Sphaeroidina haueri (Czjzek). Cushman and Todd, 1949, Cushman Lab. Foram. Research Contr., v. 25, pt. 1, p. 16, pl. 4, figs. 1, 2.

Rare and sporadic in the Shinzato and Yonabaru.
Diameter 0.35 mm.
USGS locality: f11536 (WF–274, Yonabaru Member).
USNM 625387.

Genus PULLENIA Parker and Jones, 1862

Pullenia quadriloba Reuss

Plate 10, figures 28, 29

Pullenia compressiuscula Reuss var. *quadriloba* Reuss, 1867, Akad. Wiss. Wien, Sitzungsber. v. 55, p. 87, pl. 3, fig. 8.
Pullenia quadriloba Reuss. Cushman and Todd, 1943, Cushman Lab. Foram. Research Contr., v. 19, pt. 1, p. 15, pl. 2, figs. 20, 21.

Several specimens closely related to this species were recorded from the Yonabaru only.
Diameter 0.45–0.55 mm; thickness 0.38 mm.

Pullenia miocenica Kleinpell

Plate 10, figures 26, 27

Pullenia miocenica Kleinpell, 1943, Cushman Lab. Foram. Research Contr., v. 19, pt. 1, p. 17, pl. 3, figs. 3, 4.

Very rare in Shinzato and Yonabaru assemblages.
Diameter 0.44 mm; thickness 0.40 mm.

Pullenia bulloides (d'Orbigny)

Plate 10, figures 30, 31

Nonionina bulloides d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 107, pl. 5, figs. 9, 10.

Rare in both the Shinzato and Yonabaru.
Diameter 0.32 mm; thickness 0.30 mm.

Pullenia salisburyi R. E. and K. E. Stewart

Plate 10, figures 24, 25

Pullenia salisburyi R. E. and K. E. Stewart, 1930, Jour. Paleontology, v. 4, p. 72, pl. 8, figs. 2a, b.
Cushman and Todd, 1943, Cushman Lab. Foram. Research Contr., v. 19, pt. 1, p. 20, pl. 3, figs. 10, 11.

Several specimens typical of this species were recorded from the Shinzato only.
Diameter 0.39 mm; thickness 0.25 mm.

Family GLOBIGERINIDAE
Genus GLOBIGERINA d'Orbigny, 1826

Globigerina baroemoenensis LeRoy

Plate 14, figures 9, 10

Globigerina baroemoenensis LeRoy, 1939, Natuurk. tijdschr. Ned. Indië, pt. 99, afl. 6, p. 263, pl. 6, figs. 1–2.

Common in the Yonabaru and rare in the Shinzato.
Diameter 0.42 mm.

Globigerina bulloides d'Orbigny

Plate 14, figure 11

Globigerina bulloides d'Orbigny, 1826, Annales sci. nat., v. 7, p. 277, Modèles 76.
Cushman, Todd, and Post, 1954, U. S. Geol. Survey Prof. Paper 260–H, p. 368, pl. 91, fig. 2.

Occurs in most of the Okinawa section, particularly in the Shinzato and Yonabaru.
Diameter 0.29–0.39 mm.

Globigerina dubia Egger

Plate 14, figures 6–8

Globigerina dubia Egger, 1857, Neues Jahrb. Min. Geog. Petrif. Kunde Stuttgart, Deutschland, p. 281, pl. 9, figs. 7–9.

Common in Shinzato and Yonabaru assemblages, particularly in the Shinzato.
Diameter 0.47–0.55 mm.

Genus GLOBIGERINOIDES Cushman, 1927

Globigerinoides triloba immatura LeRoy

Plate 14, figure 16

Globigerinoides sacculifera (H. B. Brady) var. *immatura* LeRoy, 1939, Natuurk, tijdschr. Ned.-Indië, pt. 99, afl. 6, p. 263, pl. 3, figs. 19–21.
Globigerinoides triloba immatura LeRoy. Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 113, pl. 25, figs. 3a–4c.

Common in Chinen, Shinzato, and Yonabaru assemblages.
Diameter 0.60 mm (max).

Globigerinoides triloba sacculifera (H. B. Brady)

Plate 14, figure 18

Globigerina sacculifera H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 604, pl. 80, figs. 11–17; pl. 82, fig. 4.
Globigerinoides triloba sacculifera (H. B. Brady). Bolli, 1957, U.S. Natl. Mus. Bull. 215, p. 113, pl. 25, figs. 5a, b.

Common in Shinzato assemblages and rare in the Chinen and upper part of the Yonabaru.
Diameter 0.67 mm (max).

Globigerinoides triloba fistulosa (Schubert)

Plate 14, figure 17

Globigerina fistulosa Schubert, 1910, Geol. Reichsanst. Verh., Wien., no. 14, p. 324, fig. 2.
Globigerinoides sacculifera (H.B. Brady) var. *fistulosa* (Schubert). Cushman, 1933, Cushman Lab. Foram. Research Spec. Pub. 5, p. 132, pl. 34, figs. 6a–c.

Recorded in limited numbers from the Shinzato only. The figured specimen is in an early stage of development.
Diameter 0.62 mm (max).

Globigerinoides ruber (d'Orbigny)

Plate 14, figure 14

Globigerina rubra d'Orbigny, 1839, *in* De la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 82, pl. 4, figs. 12–14.

Very common in the Shinzato; rare in the Chinen and in upper part of the Yonabaru.
Length 0.58 mm.

Globigerinoides mitra Todd

Plate 14, figure 15

Globigerinoides mitra Todd, 1957, U.S. Geol. Survey Prof. Paper 280–H, p. 302, pl. 78, figs. 3, 6.

This species, originally described from the Miocene of Saipan, was observed sparingly in the deepwater Yonabaru assemblages.
Length 1.10 mm.

Genus GLOBIGERINELLA Cushman, 1927

Globigerinella aequilateralis (H. B. Brady)

Plate 14, figures 19, 20

Globigerina aequilateralis H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 605, pl. 80, figs. 18–21.

Appears most commonly in Shinzato assemblages; rare in the Chinen and Yonabaru.
Diameter 0.40–0.52 mm; thickness 0.31 mm.

Genus ORBULINA d'Orbigny, 1839

Orbulina universa d'Orbigny

Plate 14, figure 5

Orbulina universa d'Orbigny, 1839, *in* De la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, Foraminifères, p. 3, pl. 1, fig. 1.

This planktonic species is scarce in the Chinen, common to abundant in the Shinzato, and frequent throughout the Yonabaru. The Yonabaru forms are generally smaller than those in the Shinzato and probably reflect cooler surface waters. In the Yonabaru 1 the species appeared to extend to a total depth (4,036 ft).
Diameter 0.46 mm.

Genus PULLENIATINA Cushman, 1927

Pulleniatina obliquiloculata (Parker and Jones)

Plate 14, figures 25–28

Pullenia obliguiloculata Parker and Jones, 1865, Philos, Trans., v. 155, p. 368, pl. 19, figs. 4a, b.

This widely recorded species commonly occurs in the Shinzato and is rare in the Yonabaru.
Diameter 0.47 mm; height 0.40 mm (figs. 25, 26). Diameter 0.53 mm; height 0.53 mm (figs. 27, 28).

Genus SPHAEROIDINELLA Cushman, 1927

Sphaeroidinella seminulina (Schwager)

Plate 14, figures 23, 24

Globigerina seminulina Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 256, fig. 112.

Occurs in the Shinzato and Yonabaru faunas in varying numbers.
Diameter 0.50–0.67 mm.

Sphaeroidinella dehiscens (Parker and Jones)

Plate 14, figures 21, 22

Sphaeroidina dehiscens Parker and Jones, 1865, Philos. Trans., v. 155, p. 369, pl. 19, figs. 5a, b.
Sphaeroidinella dehiscens (Parker and Jones). Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 297.

Common in the Shinzato and rare in the Yonabaru.
Diameter 0.61–0.80 mm.

Genus GLOBOQUADRINA Finlay, 1947

Globoquadrina altispira (Cushman and Jarvis)

Plate 14, figures 12, 13

Globigerina altispira Cushman and Jarvis, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 5, pl. 1, figs. 13, 14.

This species, originally described from the Miocene of Jamaica, occurs in appreciable numbers in the upper part of the Yonabaru and is rare in the Shinzato.
Diameter 0.55 mm; height 0.47 mm.

Genus CANDEINA d'Orbigny, 1839

Candeina nitida d'Orbigny

Plate 6, figure 11

Candeina nitida d'Orbigny, 1839, *in* De la Sagra, Histoire physique, politique et naturelle de l'Ile de Cuba, Foraminiféres, p. 108, pl. 2, figs. 27, 28.
H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 622, pl. 82, figs. 13–20.

This pelagic species was observed in limited numbers in Shinzato assemblages only. According to Cushman it is extremely rare in Recent deposits of the South Pacific and Philippine region.
Diameter 0.40 mm.

Family GLOBOROTALIIDAE
Genus GLOBOROTALIA Cushman, 1927

Globorotalia punctulata (d'Orbigny)

Plate 9, figures 11–13

Globigerina punctulata d'Orbigny, 1826, Annales sci. nat., v. 7, p. 277, Fornasini, 1898, Paleontolographia Italico, v. 4, p. 210, text fig. 5.
Globorotalia punctulata (d'Orbigny), Phleger, Parker, and Pierson, 1947–48, Rept. Swedish Deep-sea Exped., v. 7, sediment cores, no. 1, p. 20–21, pl. 4, figs. 8–12.

Common in the Shinzato and seemingly absent in Yonabaru.
Diameter 0.36–0.43 mm; thickness 0.31 mm.

Globorotalia praemenardii Cushman and Stainforth

Plate 9, figures 14, 15

Globorotalia praemenardii Cushman and Stainforth, 1945, Cushman Lab. Foram. Research Spec. Pub. 14, p. 70, pl. 13, fig. 14a–c.

Rare in Shinzato and Yonabaru assemblages.
Diameter 0.48–0.59 mm; thickness 0.16 mm.

Globorotalia tumida (H. B. Brady)

Plate 9, figures 18, 19

Pulvinulina tumida H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 692, pl. 103, figs. 4–6.
Globorotalia tumida (H. B. Brady). Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 95, pl. 12, figs. 3a–c.

Abundant in the Shinzato; rare to common in the Chinen and Yonabaru.
Diameter 0.56–0.77 mm; thickness 0.20 mm.

Globorotalia menardii multicamerata Cushman and Jarvis

Plate 9, figures 16, 17

Globorotalia menardii (d'Orbigny) var. *multicamerata* Cushman and Jarvis, 1930, Jour. Paleontology, v. 4, p. 367, pl. 34, fig. 8.

Common in Shinzato assemblages and rare in the Chinen and Yonabaru. Typical *G. menardii* (d'Orbigny) also occur in considerable numbers in the assemblages.
Diameter 0.57–0.61 mm; thickness 0.21 mm.

Family ANOMALINIDAE
Genus ANOMALINA d'Orbigny, 1826

Anomalina glabrata Cushman

Plate 6, figures 8–10

Anomalina glabrata Cushman, 1942, Carnegie Inst. Washington Pub. 342, p. 39, pl. 12, figs. 5–7.
Asano, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 13, p. 14, figs. 10–12.

Common in late Tertiary and Recent deposits in the Indo-Pacific region and occurs rarely in the Chinen, Shinzato, and in the upper part of the Yonabaru; common in late Tertiary deposits of Japan.
Diameter 0.52–0.70 mm; thickness 0.29 mm.

Anomalina bradyi Said

Plate 6, figures 12–14

Anomalina ammonoides H. B. Brady (not Reuss), 1884, *Challenger* Rept., Zoology, v. 9, p. 672, pl. 94, figs. 2, 3.
Anomalina bradyi Said, 1949, Cushman Lab. Foram. Research Spec. Pub. 26, p. 41, pl. 4, fig. 2.

Common in the Shinzato; rare in the Chinen and Yonabaru deposits; common in late Tertiary and Recent sediments of the Indo-Pacific region.
Diameter 0.54–0.70 mm; thickness 0.23 mm.

Genus LATICARININA Galloway and Wissler, 1927

Laticarinina pauperata (Parker and Jones)

Plate 9, figure 25

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

Rare in Shinzato and Yonabaru assemblages.
Diameter 0.58–0.73 mm; thickness 0.21 mm.

Genus HYALINEA Hofker, 1951

Hyalina balthica (Schroeter)

Plate 9, figures 34–36

Hyalinea balthica (Schroeter). Hofker, 1951, *Siboga*-Exped., pt. 3, p. 508, figs. 345–348.

Widely recorded in late Tertiary and Recent deposits of the South Pacific and is seldom found in the Shinzato and Yonabaru.
Diameter 0.33–0.39 mm; thickness 0.11 mm.

Genus ANOMALINELLA Cushman, 1927

Anomalinella rostrata (H. B. Brady)

Plate 6, figures 15–17

Truncatulina rostrata H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 668, pl. 94, figs. 6a–c.
Anomalinella rostrata (H. B. Brady). Cushman, 1928, Cushman Lab. Foram. Research Spec. Pub. 1, p. 322, pl. 50, fig. 1.

Rare in the Naha and Shinzato; widely recorded from late Tertiary and Recent shallow-water deposits of the Indo-Pacific region.
Diameter 0.77–0.85 mm; thickness 0.46 mm.

Genus CIBICIDES Montfort, 1808

Cibicides tenuimargo (H. B. Brady)

Plate 8, figures 30–32

Truncatulina tenuimargo H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 662, pl. 93, fig. 3.

Recorded in limited numbers in the Shinzato and in the *Loxostomum pacificum* fauna of the Yonabaru.
Diameter 0.59–0.63 mm; thickness 0.20 mm.

Cibicides Macneili LeRoy, n. sp.

Plate 9, figures 4–6

Test small for the genus, generally light amber, nearly circular in plan view, slightly more convex ventrally than dorsally; periphery sharp, faintly lobulate; chambers distinct, seven to eight in last whorl, increase gradually in size as added; sutures distinct, slightly depressed dorsally, ventrally wide, somewhat curved and widened toward umbilical area; wall more coarsely punctate on dorsal side; aperture peripheral, small.

This species, except for reworked specimens, appears to be confined to the Yonabaru Member. No published species appears to be closely related to this form. It is named in honor of F. S. MacNeil of the U.S. Geological Survey.
Diameter 0.28–0.37 mm; thickness 0.15 mm.

Cibicides okinawaensis LeRoy, n. sp.

Plate 9, figures 1–3

Test of medium size for the genus, slightly more convex ventrally than dorsally; periphery subacute, slightly lobulate, with very narrow marginal chord; chambers distinct, 9 to 10 in last whorl, increasing gradually in size as added; ventral sutures distinct, strongly curved, depressed between last two or three chambers; dorsal sutures obliquely curved, distinct, faintly depressed; ventral and dorsal surfaces perforate, more so dorsally; aperture a small arch on the periphery extending slightly over peripheral margin and then along base of last two chambers on dorsal side.

Appears to be confined to Shinzato assemblages.
Diameter 0.60–0.75 mm; thickness 0.25 mm.

Cibicides refulgens (Montfort)

Plate 8, figures 22–24

Truncatulina refulgens (Montfort). H. B. Brady, 1884, *Challenger* Rept., Zoology v. 9, p. 659, pl. 92, figs. 7–9.

Occurs sporadically in the *Loxostomum pacificum* fauna of the Yonabaru only.
Diameter 0.32–0.38 mm; thickness 0.19 mm.

Cibicides shinzatoensis LeRoy, n. sp.

Plate 8, figures 7–9

Test of medium size for the genus, slightly longer than broad, moderately compressed, dorsal side more convex than ventral side; periphery slightly lobulate, sharply rounded; chambers distinct, seven to eight in last whorl, enlarge gradually as added, last two or three rather strongly inflated on ventral side; dorsal sutures distinct, raised and reinforced with clear shell material, last one or two depressed, strongly curved; dorsal sutures distinct, broad, strongly curved, flush with surface; ventral surface rough, coarsely perforate, dorsal surface smooth, glassy; aperture peripheral, at base of last chamber and extends into dorsal umbilical area along base of last two chambers.

This species occurs rarely in the Shinzato and Yonabaru. The ornamentation is similar to that of *Planu-*

lina foveolata (H. B. Brady) which is more evolute and which fails to exhibit the inflation of the last two or three chambers.
Diameter 0.38–0.49 mm; thickness 0.20 mm.

Cibicides lobatulus (d'Orbigny)

Plate 8, figures 10–12

Truncatulina lobatula d'Orbigny, 1846, Foraminifères fossiles du bassin tertiaire de Vienne, p. 168, pl. 9, figs. 18–23.
Cibicides lobatulus (d'Orbigny). Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 118, pl. 21, figs. 3a–c.

Rare in the Naha, Chinen, Shinzato, and Yonabaru.
Diameter 0.46–0.57 mm; thickness 0.23 mm.

Cibicides haidingerii (d'Orbigny) var. pacificus (Cushman)

Plate 8, figures 4–6

Truncatulina haidingerii d'Orbigny var. *pacifica* Cushman, 1924, Carnegie Inst. Washington Pub. 342, p. 39, pl. 12, fig. 1.

Noted occasionally in Chinen assemblages only.
Diameter 0.71–0.87 mm; thickness 0.34 mm.

Cibicides convexa (Takayanagi)

Plate 9, figures 7, 8

Planulina convexa Takayanagi, 1953, Tōhoku Univ., Inst. Geology and Paleontology (Short Papers), no. 5, p. 34, pl. 4, figs. 14a–c.

This species was noted in limited numbers in the Shinzato only. The specimens appear to have more suture limbosity than *C. convexa* as originally illustrated.
Diameter 0.30–0.40 mm; thickness 0.18 mm.

Cibicides pseudoungerianus (Cushman)

Plate 8, figures 13–15

Truncatulina pseudoungeriana Cushman, 1922, U.S. Geol. Survey Prof. Paper 129, p. 97, pl. 20, fig. 9.
Cibicides pseudoungeriana (Cushman), 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 123, pl. 22, figs. 3–7.

Common in the Shinzato and Yonabaru.
Diameter 0.50–0.60 mm; thickness 0.24 mm.

Cibicides cicatricosa (Schwager)

Plate 8, figures 27–29

Anomalina cicatricosa Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 260, pl. 7, fig. 4.

Rare in the Shinzato and Yonabaru.
Diameter 0.59–0.72 mm; thickness 0.33 mm.

Cibicides wuellerstorfi (Schwager)

Plate 8, figures 25, 26

Anomalina wuellerstorfi Schwager, 1866, *Novara*-Exped., Geol. Theil, v. 2, p. 258, pl. 7, figs. 105, 107.
Planulina wuellerstorfi (Schwager). Cushman, 1929, Cushman Lab. Foram. Research Contr., v. 5, p. 104, pl. 15, figs. 1, 2.

Occurs in limited numbers in the Shinzato and Yonabaru. Frequently recorded in late Tertiary and Recent deposits of the Tropical Pacific.
Diameter 0.58–0.78 mm; thickness 0.25 mm.

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Cibicides fijiensis (Cushman)

Plate 8, figures 16–18

Planulina fijiensis Cushman, 1934, B. P. Bishop Mus. Bull. 119, p. 136, pl. 18, figs. 4a–c.

Appears to be confined to the Shinzato but has been recorded by several workers from late Tertiary and Recent deposits of the Indo-Pacific region.
Diameter 0.90–1.35 mm; thickness 0.43 mm.

Cibicides circularis LeRoy, n. sp.

Plate 7, figures 39–41

Test small for the genus, slightly more convex ventrally than dorsally, nearly circular in plan view; periphery subacute, lobulate, with narrow marginal flange; ventral umbilical area filled with clear glassy plug; chambers distinct, 7 or 8 in last whorl, enlarge gradually as added, last 2 or 3 slightly inflated; ventral sutures distinct, faintly curved, radial; dorsal sutures strongly oblique, slightly curved, flush with surface; wall minutely perforate on the ventral side, coarsely perforate on the dorsal side; aperture small, at base of last chamber, with slight lip.

This species is similar to *C. punctatus* (LeRoy) described from the Miocene and Pliocene of Sangkoelirang Bay, East Borneo, but differs by being less convex dorsally. Commonly occurs in Yonabaru assemblages and very rare in the younger part of the section.
Diameter 0.48–0.50 mm; thickness 0.18–0.21 mm.

Cibicides ornatus (Cushman)

Plate 8, figures 19–21

Truncatulina ungeriana (d'Orbigny) var. *ornata* Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 317, fig. 12a, b.
Cibicides dorsopustulosus LeRoy, 1939, Natuurk. tidjschr. Ned.-Indië, no. 6, pt. 99, p. 268, pl. 1, figs. 1–3.

Observed most frequently in the *Loxostomum pacificum* fauna of the Yonabaru; widely recorded in the late Tertiary and Recent deposits of the Indo-Pacific region.
Diameter 0.54–0.68 mm; thickness 0.25 mm.

Genus VAGOCIBICIDES Finlay, 1939

Vagocibicides nipponicus Uchio

Plate 4, figures 18, 19

Vagocibicides nipponicus Uchio, 1951, Paleont. Soc. Japan Trans. and Proc. (new ser.), v. 2, p. 41, pl. 3, figs. 8a–c.

Observed rarely in Shinzato assemblages only.
Length 0.81 mm; width 0.41 mm; thickness 0.15 mm.

Genus DISCANOMALINA Asano, 1951

Discanomalina japonica Asano

Plate 8, figures 1–3

Discanomalina japonica Asano, 1951, Inst. Geology and Paleontology, Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera, pt. 13, p. 13, figs. 3–5.

This conspicuous species was defined originally from the Pliocene of Japan. In the Okinawan section it was observed in the Shinzato only. The thick, blunt peripheral spines and coarse punctations characterize the species.

Diameter 0.71–0.92 mm; thickness 0.53 mm.

Genus HANZAWAIA Asano, 1944

Hanzawaia nipponica Asano

Plate 9, figures 28, 29

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

This distinctive species occurs rather frequently in the *Loxostomum pacificum* fauna of the Yonabaru. It was originally described from the late Tertiary deposits of Japan.

Diameter 0.64–0.77 mm; thickness 0.30 mm.

Family PLANORBULINIDAE
Genus PLANORBULINELLA Cushman, 1927

Planorbulinella larvata (Parker and Jones)

Plate 5, figures 8, 9

Planorbulinella larvata (Parker and Jones). Cushman, 1933, Cushman Lab. Foram. Research Spec. Pub. 4, p. 278, pl. 29, figs. 5a, b.

This shallow-water tropical species is best developed in the *Loxostomum pacificum* fauna of the Yonabaru. Several specimens were observed in the Chinen and Naha deposits.

Diameter 0.87 mm; thickness 0.17 mm.

Genus GYPSINA Carter, 1877

Gypsina globula (Reuss)

Plate 3, figure 20

Ceriopora globulus Reuss, 1847, Haidinger's Nat. Abh., v. 2, p. 33, pl. 5, fig. 7.

Gypsina globulus (Reuss). H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 717, pl. 101, fig. 8.

Only a few specimens were observed in the Shinzato.

Diameter 0.64 mm.

DESCRIPTION OF SAMPLE LOCALITIES

[Map sheets are part of AMS series L791 (1 : 50,000)]

USGS f11507 (MD–149). Chinen Sand. *Rotorbinella chinenensis* fauna. In lower part of large roadcut at top of hill on Highway 31 about 0.3 mile northeast of the junction of Highways 8 and 31, Okinawa.

USGS f11508 (FSM–27). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray sandy foraminiferal marl. In high roadcut along Highway 64 about 0.1 mile west of sharp bend in road about 0.3 mile east of Yashitomi (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11509 (FSM–31). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray sandy foraminiferal mudstone. In ditch 100 yd north of gap in limestone escarpment along Highway 17 and about 0.4 mile north of Maegawa (map sheet 3625II, Itoman NE), Okinawa.

USGS f11510 (RS–314). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray slightly silty claystone. In roadcut on south side of Highway 137 and 0.5 mile southeast of Shinzato (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11511 (RS–321). Shinzato Member. *Globorotalia punctulata* fauna. Grayish-white soft foraminiferal marl. In quarry at the north end of the Chinen Plateau and 0.7 mile southeast of Shinzato. Due east of loc. f11510 (RS–314) (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11512 (RS–322). Shinzato Member. *Globorotalia punctulata* fauna. Light-gray soft silty foraminiferal marl. Prominent outcrop of tuffaceous bed on edge of Chinen Plateau and 0.5 mile N. 80° E. of Yabiku (map sheet 3625I, Yonabaru SW), Okinawa.

USGS f11513 (RS–323). Shinzato Member. *Globorotalia punctulata* fauna. Light-yellow soft silty marl. In small hill on the northeast end of the Chinen Plateau and 0.6 mile N. 80° E. of Yabiku (map sheet 3625I, Yonabaru SW), Okinawa.

USGS f11514 (RS–324). Shinzato Member. *Globorotalia punctulata* fauna. Light-gray sandy to silty claystone. Outcrop at edge of Chinen Plateau and 0.33 mile east of Ibara (map sheet 3625I, Yonabaru SW), Okinawa.

USGS f11515 (RS–331). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray soft silty claystone. In roadcut on Highway 64 on east edge of the Chinen Plateau and 0.1 mile northeast of junction of Highways 64 and 137 at Hiyakuna (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11516 (RS-339). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray soft silty claystone and clayey foraminiferal marl. Outcrop on slope 600 yd N. 45° E. of Yabiku (map sheet 3625I, Yonabaru SW), Okinawa.

USGS f11517 (RS–360). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray soft silty claystone. Outcrop in roadcut at bend on Highway 64 and 0.33 mile northeast of Horikawa (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11518 (RS–366). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray soft silty foraminiferal mudstone. In low cut on secondary road and about 0.6 mile north of the junction of road with Highway 64 at Asato (map sheet 3625II, Itoman NE), Okinawa.

USGS f11519 (RS–372). Shinzato Member. *Globorotalia punctulata* fauna. Light- to medium-gray silty soft foraminiferal marl. Thin tuffaceous layer in low roadcut on east side of Highway 64 and about 0.6 mile west of the junction of Highways 137 and 64 at Hiyakuna (map sheet 3625II, Tamagusuku NW), Okinawa.

USGS f11520 (RS–376). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray soft claystone. Outcrop along Highway 54 and 0.33 mile southeast of junction with Highway 7 and near Arakaki (map sheet 3525III, Itoman NE), Okinawa.

USGS f11521 (RS–377). Shinzato Member. *Globorotalia punctulata* fauna. Light-gray claystone. In low roadcut on west side of secondary road leading to Makabe to Highway 7 and 200 yds northeast of Makabe (map sheet 3625III, Itoman NE), Okinawa.

USGS f11522 (RS–54). Yonabaru Member. *Loxostomum pacificum* fauna. Light-tan medium-grained sand. Molluscan fragments common. Exposure in roadbed passing through limits of Kohatsu and about 0.25 mile southwest of Highway 38 (map sheet 3625I, Yonabaru SW), Okinawa.

USGS f11523 (RS–149). Yonabaru Member. *Loxostomum pacificum* fauna. Medium-gray sandy clay. Outcrop on the north side of poor road between Bingusuku and Tohashima and 150 yds west of Bingusuku (map sheet 3625III, Itoman NE), Okinawa.

USGS f11524 (RS–150). Yonabaru Member. *Loxostomum pacificum* fauna. Light-gray coarse-grained conglomeratic sand containing many molluscan fragments. Outcrop along path leading upstream 0.2 mile southeast of Nesabu (map sheet 3625 IV, Naha SE), Okinawa.

USGS f11525 (RS–152). Yonabaru Member. *Loxostomum pacificum* fauna. Grayish-brown sandy claystone. In cut on very poor road 0.25 mile S. 35° E. of Gishi (map sheet 3625III, Itoman NE), Okinawa.

USGS f11526 (RS–196). Yonabaru Member. *Loxostomum pacificum* fauna. Medium-gray sandy to silty claystone. In low cut on side of promontory on top of a narrow erosional spur, about 0.5 mile north-northwest of the junction of Highways 13 and 46 at Iwa, Okinawa.

USGS f11527 (RS–197). Yonabaru Member. *Loxostomum pacificum* fauna. Light-tan sandy claystone. Outcrop on ridge just north of Hirakawa (map sheet 3625IV, Naha SE), Okinawa.

USGS f11528 (RS–198). Yonabaru Member. *Loxostomum pacificum* fauna. Medium-gray soft claystone. Outcrop on east end of ridge and 1.8 miles southeast of intersection of Highways 5 and 44 (map sheet 3625IV, Naha SE), Okinawa.

USGS f11529 (FSM–41). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. On Highway 31 and about 0.6 mile north of Heanna (map sheet 3625I, Yonabaru 3625I, Yonabaru NE), Okinawa.

USGS f11530 (FSM–44). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. In Highway 16 and just west of junction with Highway 24, about 1 mile east of Chibana (map sheet 3626II, Kin), Okinawa.

USGS f11531 (FSM–45). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. On Highway 24 and about 0.8 mile northeast of junction with Highway 13. Northwest of Awashi Airfield (map sheet 3626II, Kin), Okinawa.

USGS f11532 (FSM–47). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. On road to Yajibanta and about 0.5 mile from intersection with Highway 5 (map sheet 3625I, Yonabaru NE), Okinawa.

USGS f11533 (RS–129). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. Cut on north side of secondary road in Naha Air Base housing area and 0.6 mile west of Highways 3 and 60 junction (map sheet 3625IV, Naha SE), Okinawa.

USGS f11534 (WF–272). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. On secondary road and 0.5 mile north of junction of Highways 30 and 132 (map sheet 3625I, Yonabaru NE), Okinawa.

USGS f11535 (WF–273). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray soft silty claystone. On Highway 5 at Nagata (map sheet 3625I, Yonabaru NE), Okinawa.

USGS f11536 (WF–274). Yonabaru Member. *Nonion nicobarense-Cibicides macneili* fauna. Medium-gray claystone. On Highway 5 and about 0.3 mile northwest of junction with Highway 30. West of Yonabaru Airfield, Okinawa.

USGS f11537 (MD–25). Chinen Sand (marl facies). Fine-grained marly sand. Along east side of narrow ridge just north of Highway 8, about 0.25 mile east of intersection of the junction of Highways 8 and 16, Okinawa.

USGS f11538 (RS–350). Chinen Sand. *Rotorbinella chinenensis* fauna. Light-yellow foraminiferal and molluscan marl. At base of

high limestone, sea cliff forming a headland about 0.8 mile southeast of Nakaza on Highway 64 (map sheet 3625III, Itoman NE), Okinawa.

USGS f11539 (FSM–12). Shinzato Member. *Globorotalia punctulata* fauna. Medium-gray foraminiferal claystone. In roadcut just below top of long hill on Highway 137 and about 0.3 mile south of Shinzato, Okinawa.

USGS f11540 (TKRS–7). Chinen Sand. Bluish-gray tuffaceous clay. In low cliff 0.3 mile northeast of northwest tip of Heanza-Shisna, Okinawa Gunto.

USGS f11541 (Me–21). Chinen Sand. *Rotorbinella chinenensis* fauna. Near mouth of small stream emptying into Katena-ko directly across road from Nakoshi Primary School (map sheet 3726IV, Okinawa).

USGS f11542 (ME–36). Naha Limestone (marl facies) (Nakoshi Sand). In cut on the north side of road 0.2 mile from Untenko LCT landing on the Unten Peninsula (map sheet 2727III, Unten), Okinawa.

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INDEX

[Italic numbers indicate descriptions]

PLATES 1–16

PLATE 1

FIGURES 1, 2. *Ammobaculites* sp. A LeRoy (p. F17).
USNM 625137, × 23; USGS loc. f11538 (RS–351, Chinen); 1, side view; 2, edge view.

3, 4. *Ammobaculites subagglutinans* Bandy (p. F17).
USNM 625136, × 25; USGS loc. f11513 (RS–323, Shinzato); 3, apertural view; 4, side view.

5, 6. *Ammobaculites* aff. *A. cyclindricus* Cushman (p. F17).
USNM 625135, × 30; USGS loc. f11508 (FSM–27, Shinzato); 5, apertural view; 6, side view.

7. *Bathysiphon arenacea* Çushman (p. F15).
USNM 625322, × 30; Yonabaru 1–3,480 ft (Yonabaru); side view.

8, 9. *Cornuspira involvens* (Reuss), var. (p. F21).
USNM 625319, × 32; USGS loc. f11509 (FSM–31, Shinzato); 8, edge view; 9, side view.

10. *Bolivinopsis hiratai* Uchio (p. F29).
USNM 625307, × 72; USGS loc. f11528 (RS–198, Yonabaru); side view.

11. *Clavulina yabei akiensis* Asano (p. F18).
USNM 625321, × 23; USGS loc. f11537 (MD–25, Naha); side view.

12. *Ammodiscus dominicensis* var. *deformis* Bermudez (p. F15).
USNM 625258, × 22; Yonabaru 1–3,670 ft (Yonabaru); side view.

13, 14. *Eggerella bradyi* Cushman (p. F18).
USNM 625139, × 38; USGS loc. f11533 (RS–129, Yonabaru); 13, apertural view; 14, side view.

15. *Goesella schencki* Asano (p. F18).
USNM 625279, × 14; Yonabaru 1–3,320 ft (Yonabaru); side view.

16. *Schenckiella okinawaensis* LeRoy, n. sp. (p. F19).
Holotype, USNM 625211, × 80; Yonabaru 1–3,440 ft (Yonabaru); side view.

17. *Schenckiella communis* (d'Orbigny) (p. F19).
USNM 625214, × 27; Yonabaru 1–1,190 ft (Yonabaru); side view.

18. *Schenckiella communis* (d'Orbigny) *hosoyaensis* (Asano) (p. F19).
USNM 625215, × 38; USGS loc. f11531 (FSM–45, Yonabaru); side view.

19. *Schenckiella victoriensis* (Cushman) (p. F19).
USNM 625213, × 23; USGS loc. f11529 (FSM–41, Yonabaru); side view.

20. *Schenckiella howchini* (Cushman) (p. F19).
USNM 625212, × 40; USGS loc. f11526 (RS–196, Yonabaru); side view.

21. *Gaudryina siphonifera* (H. B. Brady) (p. F18).
USNM 625256, × 40; USGS loc. f11526 (RS–196, Yonabaru); side view.

22, 23. *Karreriella bradyi* (Cushman) (p. F18).
USNM 625273, × 65; USGS loc. f11539 (FSM–27, Shinzato); 22, apertural view; 23, side view.

24. *Glomospira glomerata* Höglund (p. F15).
USNM 625275, × 38; Yonabaru 1–3,420 ft (Yonabaru); side view.

25. *Glomospira gordialis* (Parker and Jones) var. *diffundens* Cushman and Renz (p. F17).
USNM 625274, × 58; Yonabaru 1–3,480 ft (Yonabaru); side view.

26, 27. *Gaudryina karreriana* Cushman (p. F18).
USNM 625255, × 38; USGS loc. f11526 (RS–196, Yonabaru); 26, apertural view; 27, side view.

28, 29. *Gaudryina solida* Schwager (p. F18).
USNM 625257, × 26; Yonabaru 1–270 ft (Yonabaru); 28, apertural view; 29, side view.

30, 31. *Textularia sagittula* Defrance var. *fistulosa* H. B. Brady (p. F17).
USNM 625361, × 30; USGS loc. f11538 (RS–351, Chinen); 30, apertural view; 31, side view.

32. *Adercotryma glomerata* (H. B. Brady) (p. F17).
USNM 625282, × 23; Yonabaru 1–3,000 ft (Yonabaru); side view of distorted specimen.

33, 34. *Testularia acuta* Reuss (p. F17).
USNM 625363, × 39; USGS loc. f11518 (RS–366, Shinzato); 33, apertural view; 34, side view.

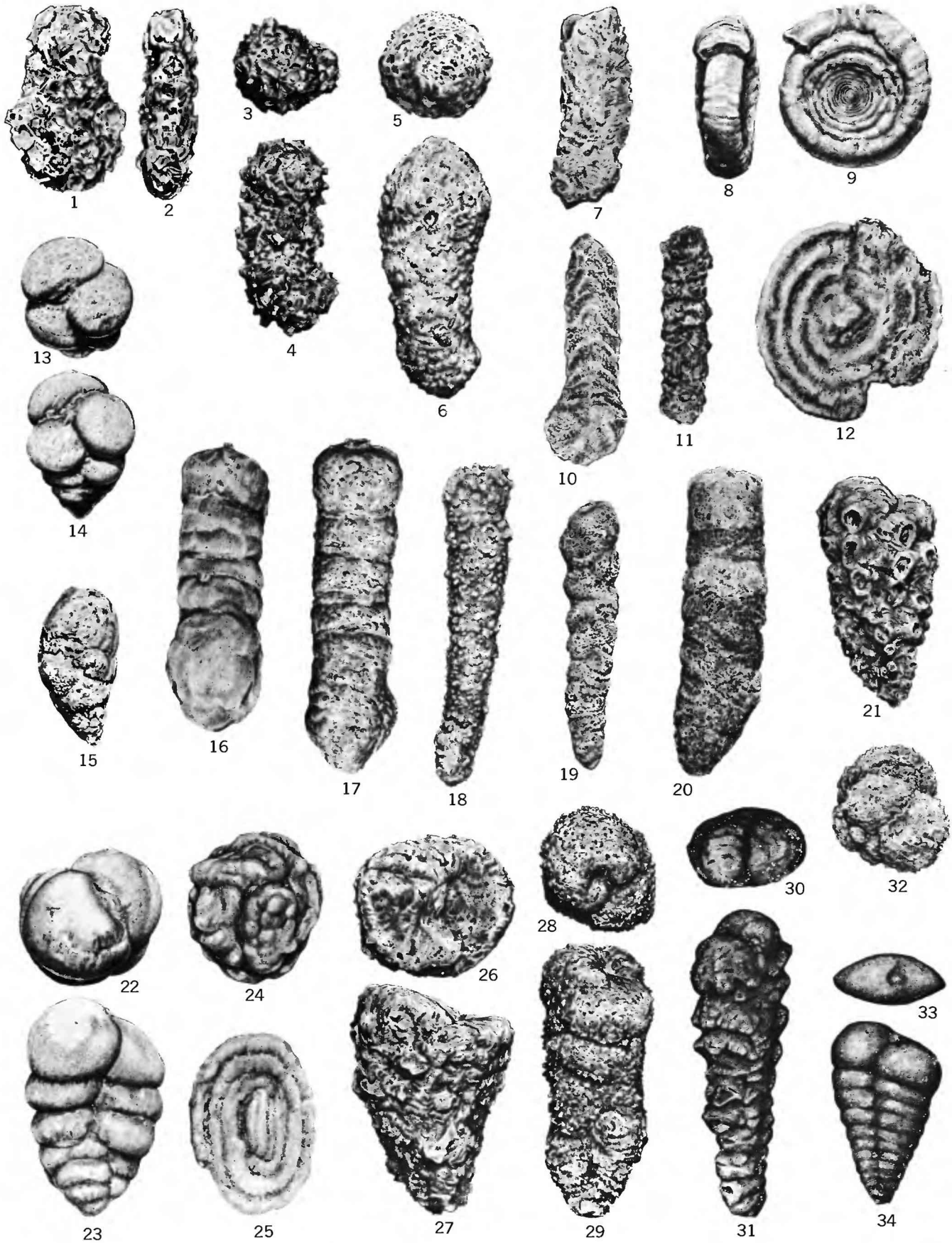

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PLATE 2

FIGURES 1, 2. *Textularia bocki* Höglund (p. F17).
USNM 625359, × 40; USGS loc. f11509 (FSM–31, Shinzato); 1, apertural view; 2, side view.

3, 4. *Siphotextularia flintii* (Cushman) var. *pacifica* LeRoy, n. var. (p. F18).
Holotype, USNM 625360, × 40; Yonabaru 1–3,250 ft (Yonabaru); 3, apertural view; 4, side view.

5, 6. *Textularia candeiana* d'Orbigny (p. F17).
USNM 625362, × 38; USGS loc. f11529 (FSM–41, Yonabaru); 5, apertural view; 6, side view.

7. *Bolivina plano-convexa* Cushman and Todd (p. F31).
USNM 625153, × 36; USGS loc. f11536 (WF–274, Yonabaru); side view.

8. *Bolivina striatula* Cushman (p. F31).
USNM 625147, × 76; USGS loc. f11542 (ME–36, Naha); side view.

9. *Bolivina capitata* Cushman (p. F31).
USNM 625144, × 66; USGS loc. f11541 (ME–21, Chinen); side view.

10, 11. *Bolivina chinenensis* LeRoy, n. sp. (p. F31).
Holotype, USNM 625143, × 108; Katchin Hanto 1–245 ft (Chinen); 10, apertural view; 11, side view.

12. *Bolivina alata* (Seguenza) (p. F31).
USNM 625151, × 72; USGS loc. f11541 (ME–21, Chinen); side view.

13. *Bolivina robusta* (H. B. Brady) (p. F31).
USNM 625145, × 37; USGS loc. f11529 (FSM–41, Yonabaru); side view.

14. *Bolivina hantkeniana* H. B. Brady (p. F31).
USNM 625152, × 35; USGS loc. f11512 (RS–322, Shinzato); side view.

15. *Bolivina albatrossi* Cushman (p. F31).
USNM 625149, × 122; USGS loc. f11512 (RS–322, Shinzato); side view.

16. *Bolivina subreticulata* Parr (p. F31).
USNM 625148, × 100; Yonabaru 1–90 ft (Yonabaru); side view.

17, 18. *Loxostomum okinawaense* LeRoy, n. sp. (p. F33).
Holotype, USNM 625290, × 78; USGS loc. f11542 (ME–36, Naha); 17, side view; 18, peripheral view.

19. *Loxostomum lobatum* (H. B. Brady) (p. F33).
USNM 625133, × 163; USGS loc. f11541 (ME–21, Chinen); side view.

20. *Loxostomum limbatum* (H. B. Brady) var. *costulatum* (Cushman) (p. F33).
USNM 625277, × 30; Katchin Hanto 1–295 ft (Chinen); side view.

21. *Bolivina spinescens* Cushman (p. F31).
USNM 625150, × 115; USGS loc. f11541 (ME–21, Chinen); side view.

22, 23. *Loxostomum amygdalaeforme* (H. B. Brady) var. *iokiense* Asano (p. F33).
USNM 625134, × 80; USGS loc. f11541 (ME–21, Chinen); 22, side view; 23, peripheral view.

24, 25. *Bolivina subangularis* H. B. Brady var. *agasaensis* Asano (p. F31).
USNM 625146, × 71; USGS loc. f11541 (ME–21, Chinen); 24, apertural view; 25, side view.

26, 27. *Loxostomum karrerianum* (H. B. Brady) (p. F33).
USNM 625289, × 78; Katchin Hanto 1–265 ft (Chinen); 26, side view; 27, peripheral view.

28. *Bitubulogenerina convallaria* (Millett) (p. F34).
USNM 625166, × 118; USGS loc. f11541 (ME–21, Chinen); side view.

29, 30. *Loxostomum compressum* LeRoy, n. sp. (p. F33).
Holotype, USNM 625333, × 81; USGS loc. f11522 (RS–54, Yonabaru); 29, side view; 30, peripheral view.

31, 32. *Loxostomum pacificum* LeRoy, n. sp. (p. F33).
Holotype, USNM 625132, × 39; USGS loc. f11525 (RS–152, Yonabaru); 31, peripheral view; 32, side view.

33, 34. *Patellinella jugosa* (H. B. Brady) (p. F35).
USNM 625141, × 80; USGS loc. f11541 (ME–21, Chinen); 33, apertural view; 34, side view.

35, 36. *Patellinella inconspicua* (H. B. Brady) (p. F36).
USNM 625142, × 101; USGS loc. f11541 (ME–21, Chinen); 35, apertural view; 36, side view.

37, 38. *Bolivinita quadrilatera* (Schwager) (p.F29).
USNM 625164, × 39; USGS loc. f11510 (RS–314, Shinzato); 37, side view; 38, peripheral view.

39. *Chilostomella oolina* Schwager (p. F41).
USNM 625320, × 37; Yonabaru 1–330 ft (Yonabaru); side view.

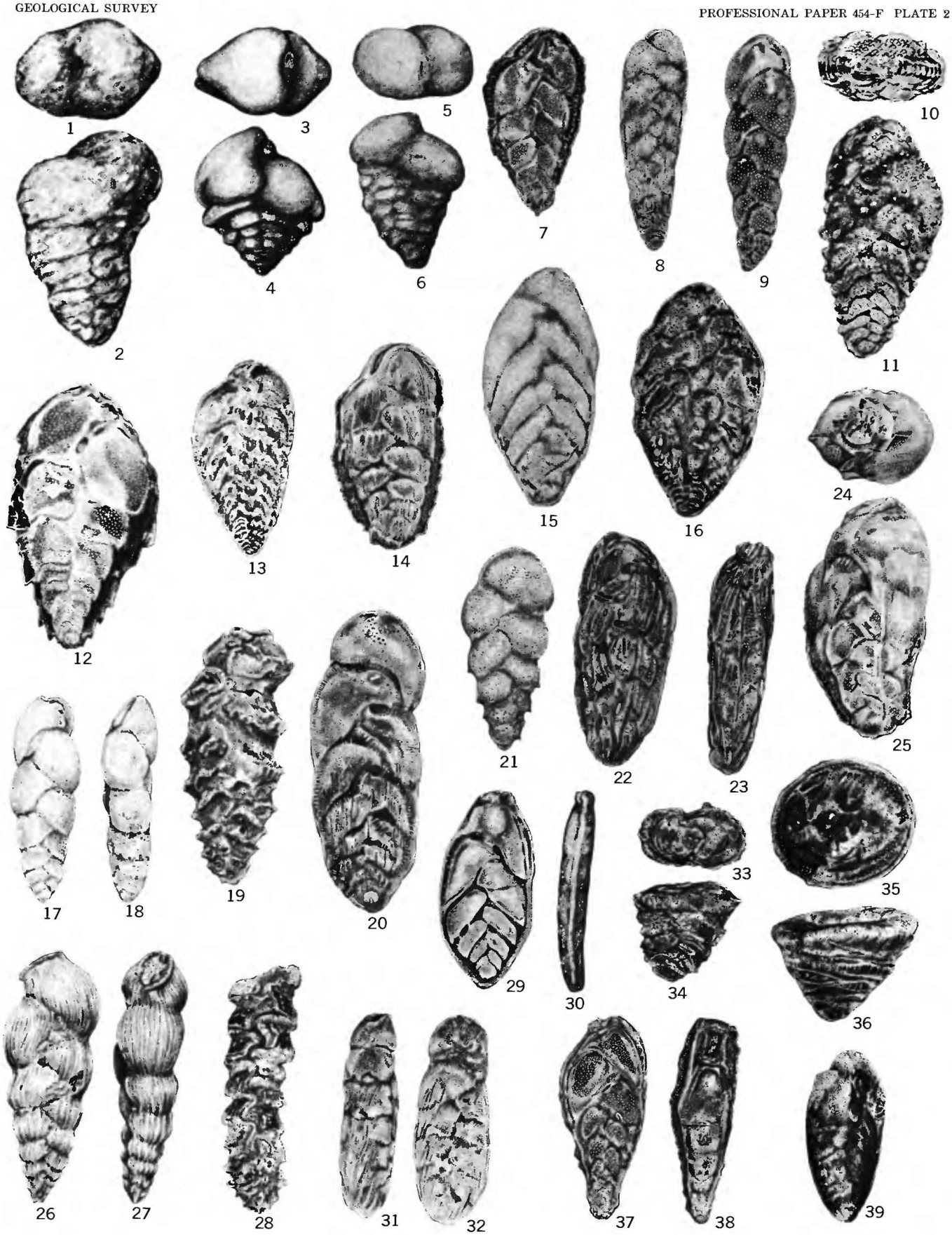

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PLATE 3

FIGURES 1, 2. *Rectobolivina bifrons* (H. B. Brady) (p. F34).
USNM 625347, × 38; USGS loc. f11527 (RS–197, Yonabaru); 1, apertural view; 2, side view.

3, 4. *Rectobolivina dimorpha* (Parker and Jones) (p. F34).
USNM 625349, × 38; USGS loc. f11521 (RS–377, Shinzato); 3, apertural view; 4, side view.

5, 6. *Rectobolivina bifrons* (H. B. Brady) var. *striatula* (Cushman) (p. F34).
USNM 625348, × 43; USGS loc. f11523 (RS–149, Yonabaru); 5, apertural view; 6 side view.

7. *Rectobolivina*? *virgula* (H. B. Brady) (p. F34).
USNM 625350, × 84; USGS loc. f11541 (ME–21, Chinen); side view.

8. *Rectuvigerina striata* (Schwager) (p. F35).
USNM 625355, × 64; USGS loc. f11539 (FSM–12, Shinzato); side view.

9, 10. *Vulvulina pacifica* Cushman (p. F18).
USNM 625354, × 40; USGS loc. f11521 (RS–377, Shinzato); 9, apertural view; 10, side view.

11, 12. *Vaginulina yoshihamaensis* Inoue and Nakaseko (p. F25).
USNM 625340, × 28; USGS loc. f11524 (RS–150, Yonabaru); 11, apertural view; 12, side view.

13. *Vaginulina tenuis* (Bornemann) (p. F25).
USNM 625341, × 27; USGS loc. f11526 (RS–196, Yonabaru); side view.

14. *Virgulina schreibersiana* Czjzek (p. F33).
USNM 625335, × 62; USGS loc. f11542 (ME–36, Naha); side view.

15, 16. *Robertina subteres* (H. B. Brady) (p. F29).
USNM 625338, × 63; USGS loc. f11511 (RS–321, Shinzato); 15, apertural view; 16, side view.

17, 18. *Trifarina bradyi* Cushman (p. F35).
USNM 625334, × 113; USGS loc. f11541 (ME–21, Chinen); 17, apertural view; 18, side view.

19. *Reussella spinulosa* (Reuss) (p. F34).
USNM 625336, × 80; USGS loc. f11542 (ME–36, Naha); side view.

20. *Gypsina globula* (Reuss) (p. F46).
USNM 625352, × 40; USGS loc. f11513 (RS–323, Shinzato); side view.

21, 22. *Sigmolina celata* (Costa) (p. F20).
USNM 625383, × 40; USGS loc. f11513 (RS–323, Shinzato); 21, apertural view; 22, side view.

23, 24. *Spiroloculina circularis* Cushman and Todd (p. F20).
USNM 625346, × 42; USGS loc. f11529 (FSM–41, Yonabaru); 23, side view; 24, peripheral view.

25, 26. *Spiroloculina penglaiensis* Jacot (p. F20).
USNM 625345, × 26; USGS loc. f11534 (WF–272, Yonabaru); 25, peripheral view; 26, side view.

27, 28. *Spiroloculina communis* Cushman and Todd (p. F20).
USNM 625344, × 42; USGS loc. f11537 (MD–25, Chinen); 27, side view; 28, peripheral view.

29, 30. *Saracenaria italica* Defrance (p. F25).
USNM 625380, × 28; USGS loc. f11529 (FSM–41, Yonabaru); 29, side view; 30, front view.

31. *Reophax agglutinatus* Cushman (p. F15).
USNM 625351, × 28; USGS loc. f11526 (RS–196, Yonabaru); side view.

32, 33. *Triloculina tricarinata* d'Orbigny (p. F20).
USNM 625343, × 60; USGS loc. f11541 (ME–21, Chinen); 32, apertural view; 33, side view.

34. *Sigmoilina miocenica* Cushman (p. F20).
USNM 625382, × 63; USGS loc. f11509 (FSM–31, Shinzato); side view.

35. *Siphogenerina raphanus* (Parker and Jones) (p. F35).
USNM 625386, × 39; USGS loc. f11537 (MD–25, Chinen); side view.

36. *Saracenaria latifrons* (H. B. Brady) (p. F25).
USNM 625381, × 37; USGS loc. f11517 (RS–360, Shinzato); side view.

37. *Uvigerina nitidula* Schwager (p. F35).
USNM 625365, × 36; USGS loc. f11511 (RS–321, Shinzato); side view.

38. *Uvigerina proboscidea* Schwager var. *vadescens* Cushman (p. F35).
USNM 625364, × 64; USGS loc. f11521 (RS–377, Shinzato); side view.

39. *Uvigerina gemmaeformis* Schwager (p. F34).
USNM 625372, × 28; Yonabaru 1–1,170 ft (Yonabaru); side view.

40, 41. *Uvigerina aculeata* d'Orbigny (p. F34).
40, USNM 625366; 41, USNM 625369, × 46; USGS loc. f11508 (FSM–27, Shinzato); side views.

42. *Uvigerina striatella* Reuss (p. F34).
USNM 625373, × 37; Yonabaru 1–850 ft (Yonabaru); side view.

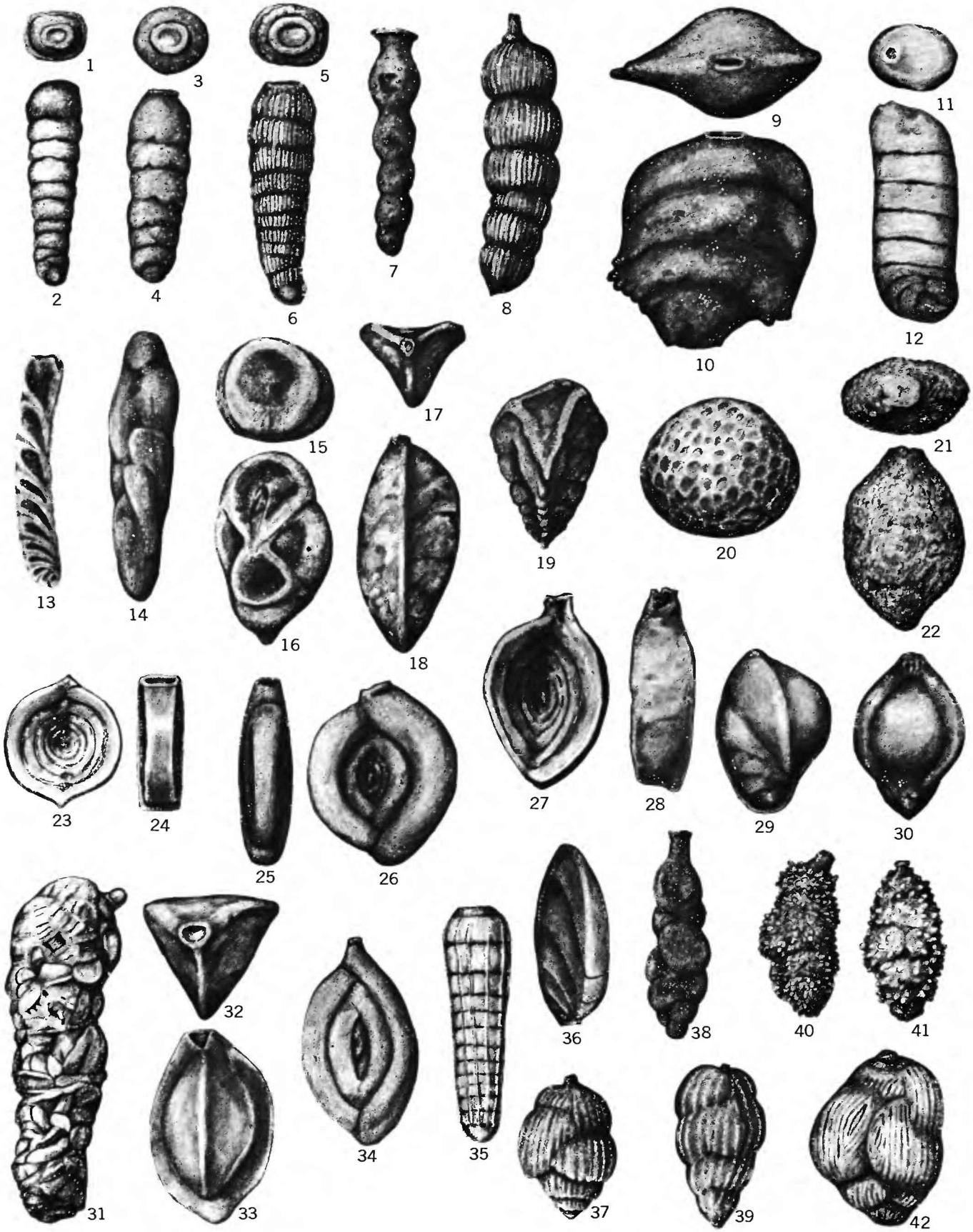

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PLATE 4

FIGURES 1. *Uvigerina crassicostata* Schwager (p. F35).
USNM 625368, × 36; USGS loc. f11527 (RS–197, Yonabaru); side view.

2, 3. *Uvigerina hispida* Schwager (p. F34).
2, USNM 625370; 3, USNM 625371, × 45; USGS loc. f11521 (RS–377, Shinzato); side views.

4. *Uvigerina peregrina* Cushman var. *dirupta* Todd (p. F34).
USNM 625385, × 67; USGS loc. f11536 (WF–274, Yonabaru); side view.

5, 6. *Lenticulina peregrina* (Schwager) (p. F22).
USNM 625379, × 30; USGS loc. f11526 (RS–196, Yonabaru); 5, side view; 6, peripheral view.

7, 8. *Robulus vortex* (Fichtel and Moll) (p. F21).
USNM 625376, × 30; USGS loc. f11526 (RS–196, Yonabaru); 7, side view; 8, peripheral view.

9, 10. *Robulus costatus* (Fichtel and Moll) (p. F22).
USNM 625377, × 30; USGS loc. f11515 (RS–331, Shinzato); 9, peripheral view; 10, side view.

11, 12. *Robulus costatus* (Fichtel and Moll) var. *multicostatus* (Cushman) (p. F22).
USNM 625375, × 29; USGS loc. f11513 (RS–323, Shinzato); 11, peripheral view; 12, side view.

13. *Robulus yabei* (Asano) (p. F21).
USNM 625378, × 28; USGS loc. f11507 (MD–149, Chinen); side view.

14, 15. *Robulus calcar* (Linné) (p. F22).
USNM 625374, × 48; USGS loc. f11539 (FSM–27, Shinzato); 14, peripheral view; 15, side view.

16, 17. *Streblus beccarii tepida* (Cushman) (p. F38).
USNM 625337, × 42; USGS loc. f11542 (ME–36, Naha); 16, ventral view; 17, dorsal view.

18, 19. *Vagocibicides nipponicus* Uchio (p. F45).
USNM 625339, × 41; USGS loc. f11520 (RS–376, Shinzato); 18, ventral view; 19, dorsal view.

20–22. *Siphonina australis* Cushman (p. F39).
USNM 625342, × 68; USGS loc. f11509 (FSM–31, Yonabaru); 20, dorsal view; 21, peripheral view; 22, ventral view.

23–25. *Pararotalia yonabaruensis* LeRoy, n. sp. (p. F38).
Holotype, USNM 625367, × 59; Yonabaru 1–650 ft (Yonabaru); 23, ventral view; 24, peripheral view; 25, dorsal view.

26–28. *Neoconobrina pacifica* LeRoy, n. sp. (p. F36).
Holotype, USNM 625356, × 64; Yonabaru 1–830 ft (Yonabaru); 26, ventral view; 27, peripheral view; 28, dorsal view.

29–31. *Rotalidium okinawaensis* LeRoy, n. sp. (p. F38).
Holotype, USNM 625384, × 66; Yonabaru 1–290 ft (Yonabaru); 29, ventral view; 30, peripheral view; 31, dorsal view.

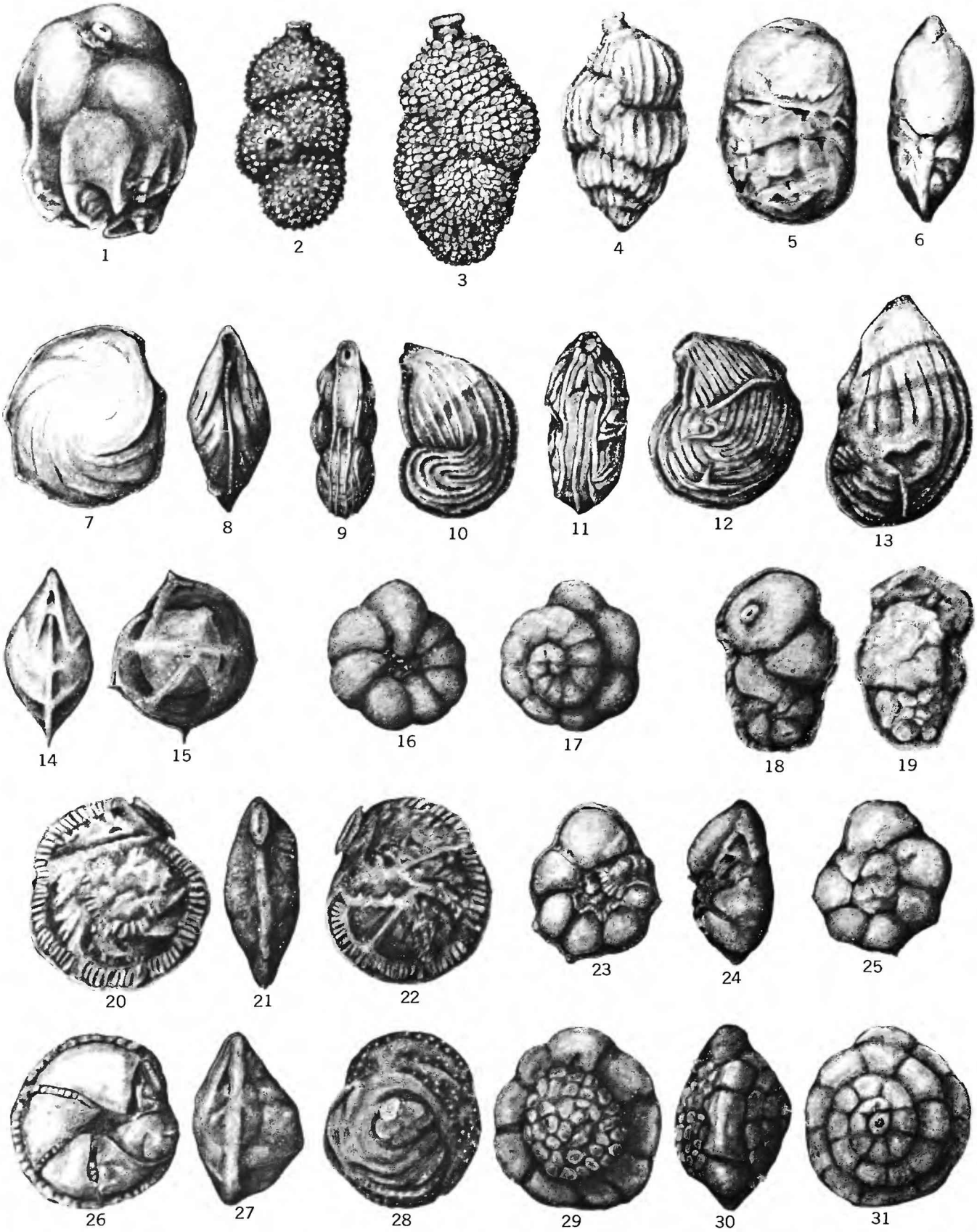

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PLATE 5

FIGURES 1, 2. *Calcarina rustica* Todd and Post (p. F40).
USNM 625308, × 42; USGS loc. f11537 (MD–25, Chinen); 1, ventral view; 2, dorsal view.

3. *Calcarina spengleri* (Gmelin) (p. F40).
USNM 625309, × 23; USGS loc. f11537 (MD–25, Chinen); ventral view.

4. *Pleurostomella brevis* Schwager (p. F36).
USNM 625300, × 67; Yonabaru 1–30 ft (Yonabaru); oblique side view.

5. *Pleurostomella alternans* Schwager (p. F36).
USNM 625301, × 40; USGS loc. f11529 (FSM–41, Yonabaru); side view.

6, 7. *Cymbaloporetta bradyi* (Cushman) (p. F40).
USNM 625165, × 64; USGS loc. f11541 (ME–21, Chinen); opposite sides.

8, 9. *Planorbulinella larvata* (Parker and Jones) (p. F46).
USNM 625299, × 40; Yonabaru 1–230 ft (Yonabaru); opposite sides.

10. *Marginulinopsis perprocera* (Schwager) (p. F22).
USNM 625285, × 40; USGS loc. f11539 (FSM–27, Shinzato); side view.

11. *Marginulina striatula* Cushman (p. F22).
USNM 625286, × 77; USGS loc. f11521 (RS–377, Shinzato); side view.

12. *Marginulinopsis nozimaensis* Asano (p. F22).
USNM 625284, × 14; USGS loc. f11524 (RS–150, Yonabaru); side view.

13, 14. *Operculina gaimairdi* d'Orbigny (p. F28).
USNM 625304, × 26; USGS loc. f11524 (RS–150, Yonabaru); 13, side view; 14, peripheral view.

15, 16. *Miliammina echigoensis* Asano and Inomata (p. F19).
USNM 625292, × 82; Yonabaru 1–3,830 ft; (Yonabaru); 15, peripheral view; 16, side view.

17. *Hemicristellaria japonica* (Asano) (p. F27).
USNM 625283, × 39; USGS loc. f11517 (RS–360, Shinzato); side view.

18, 19. *Plectofrondicularia totomiensis* Makiyama (p. F29).
USNM 625314, × 40; USGS loc. f11536 (WF–274), Yonabaru); 18, side view; 19, peripheral view.

20. *Peneroplis pertusus* (Forskal) (p. F28).
USNM 625298, × 70; Yonabaru 1–350 ft (Yonabaru); side view.

21, 22. *Ehrenbergina bradyi* Cushman (p. F41).
USNM 625162, × 64; USGS loc. f11517 (RS–360, Shinzato); 21, 22, opposite views.

23. *Plectofrondicularia* sp. A LeRoy (p. F29).
USNM 625353, × 35; USGS loc. f11519 (WF–372, Shinzato); side view.

24. *Angulogerina japonica* Asano (p. F35).
USNM 625317, × 113; USGS loc. f11521 (RS–377, Shinzato); side view.

25. *Plectofrondicularia interrupta* (Karrer) (p. F29).
USNM 625318, × 65; USGS loc. f11509 (FSM–31, Shinzato); side view.

26. *Pyrulina fusiformis* (Romer) (p. F27).
USNM 625332, ×37; USGS loc. f11524 (RS–150, Yonabaru); side view.

27, 28. *Ehrenbergina bosoensis* var. *decorata* Takayanagi (p. F41).
USNM 625163, × 66; USGS loc. f11538 (RS–350, Chinen); opposite sides.

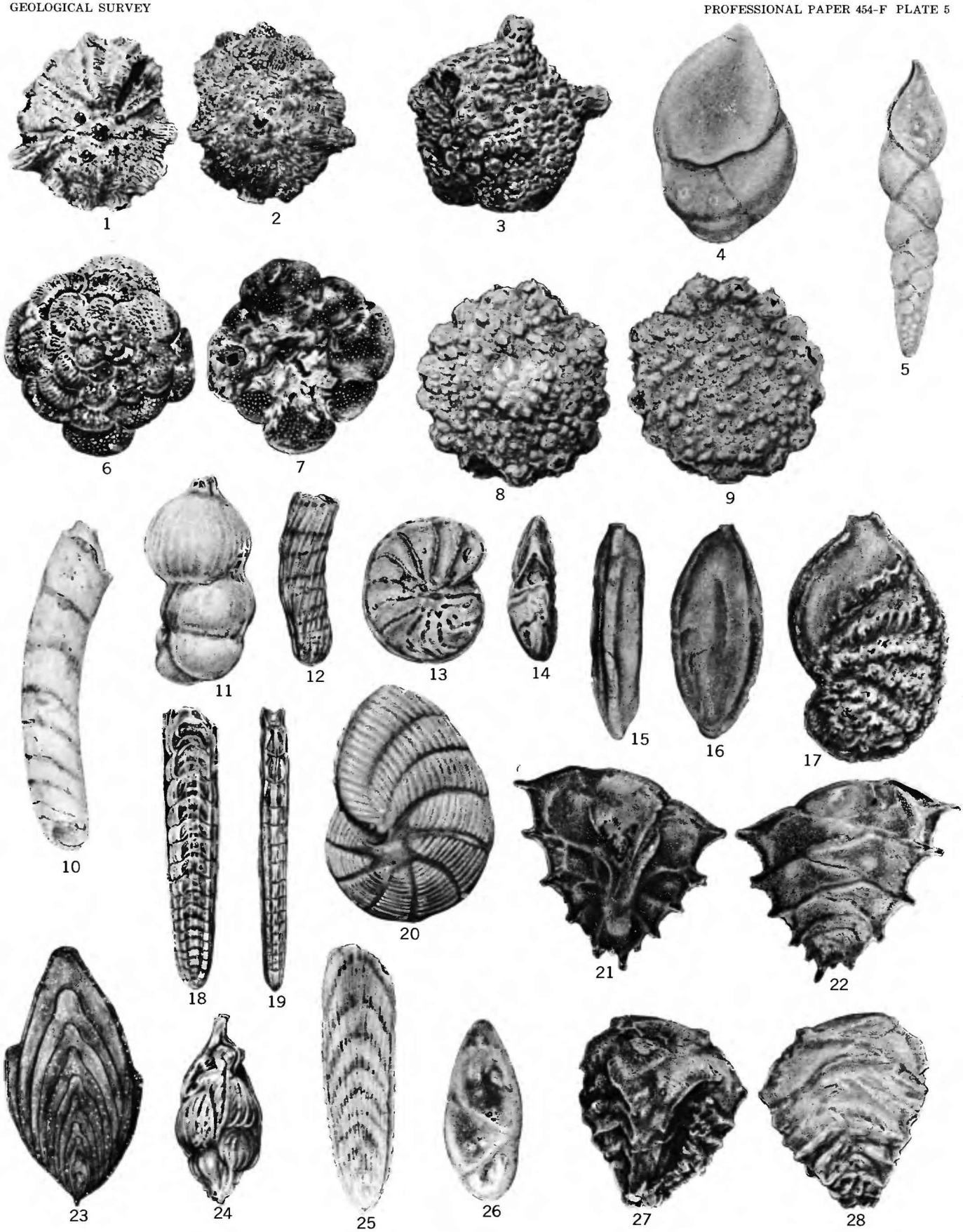

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PLATE 6

FIGURES 1, 2. *Amphistegina madagascariensis* d'Orbigny (p. F39).
USNM 625311, × 46; USGS loc. f11537 (MD–25, Chinen), 1, side view; 2, peripheral view.

3–5. *Amphistegina wanneriana* Fischer, (p. F39).
USNM 625310, × 36; USGS loc. f11537 (MD–25, Chinen); 3, dorsal view; 4, peripheral view; 5, ventral view.

6, 7. *Astrononion* sp. A LeRoy (p. F28).
USNM 625168, × 128; USGS loc. f11542 (ME–36, Naha); 6, side view; 7, peripheral view.

8–10. *Anomalina glabrata* Cushman (p. F43).
USNM 625170, × 52; USGS loc. f11537 (MD–25, Chinen); 8, ventral view; 9, peripheral view; 10, dorsal view.

11. *Candeina nitida* d'Orbigny (p. F43).
USNM 625306, × 72; USGS loc. f11521 (RS–377, Shinzato); side view.

12–14. *Anomalina bradyi* Said (p. F43).
USNM 625171, × 52; USGS loc. f11512 (RS–322, Shinzato); 12, ventral view; 13, peripheral view; 14, dorsal view.

15–17. *Anomalinella rostrata* (H. B. Brady) (p. F44).
USNM 625313, × 39; USGS loc. f11537 (MD–25, Chinen); 15, ventral view; 16, peripheral view; 17, dorsal view.

18, 19. *Asterorotalia trispinosa* (Thalmann) (p. F39).
USNM 625169, ×72; USGS loc. f11525 (RS–152, Yonabaru); 18, ventral view; 19, dorsal view.

20–22. *Baggina totomiensis* Makiyama (p. F39).
USNM 625312, × 62; USGS loc. f11541 (ME–21, Chinen); 20, 22, opposite sides; 21, peripheral view.

23, 24. *Cancris auriculus* (Fichtel and Moll) (p. F39).
USNM 625302, × 110; USGS loc. f11541 (ME–21, Chinen); 23, ventral view; 24, dorsal view.

25, 26. *Cancris communis* Cushman and Todd (p. F39).
USNM 625303, × 72; USGS loc. f11542 (ME–36, Naha); 25, dorsal view; 26, ventral view.

27, 28. *Hoeglundina elegans* (d'Orbigny) (p. F38).
USNM 625276, × 22; USGS loc. f11535 (WF–273, Yonabaru); 27, dorsal view; 28, ventral view.

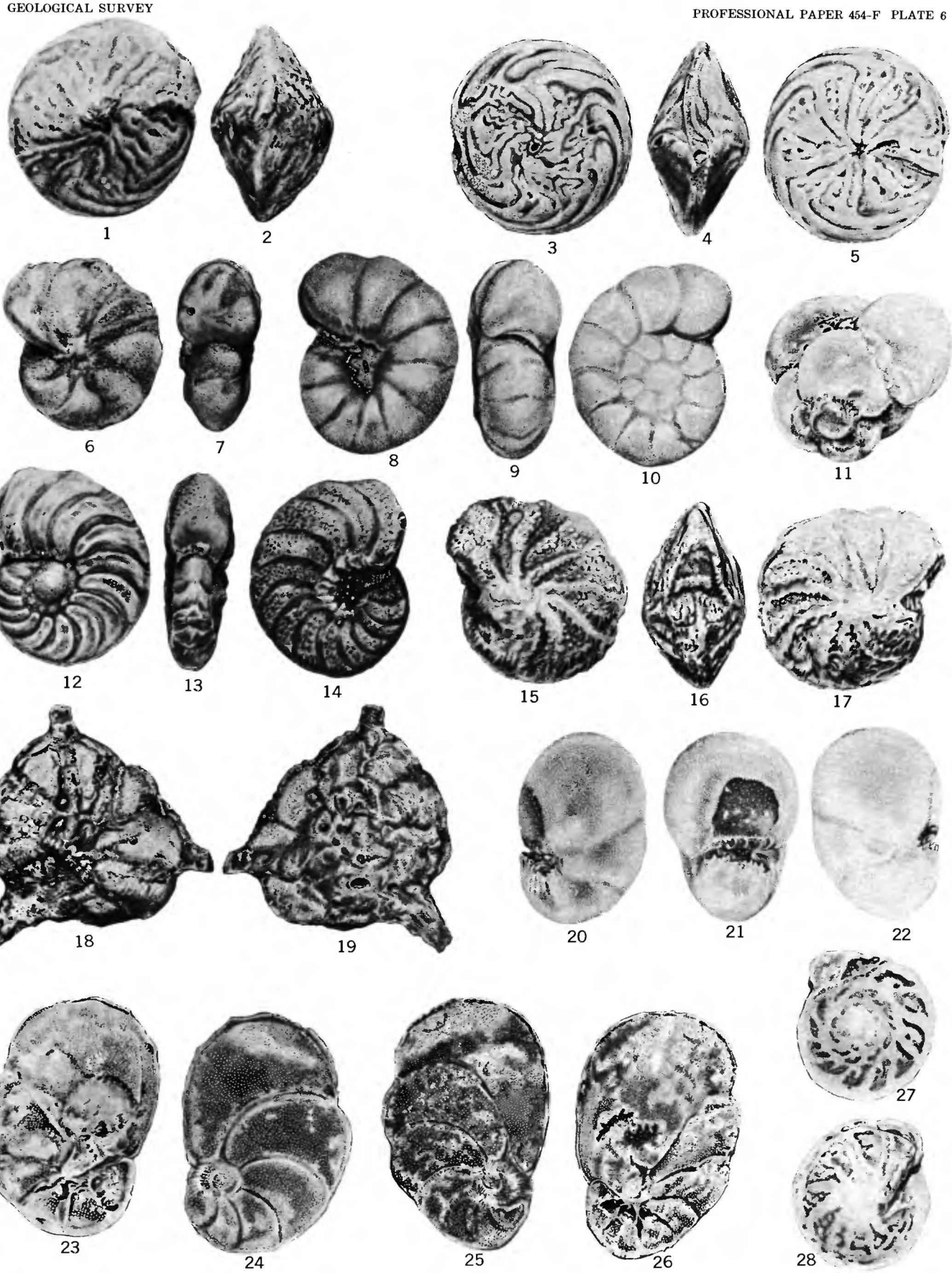

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PLATE 7

FIGURES 1–3. *Gyroidina trincherasensis* Bermudez (p. F37).
USNM 625266, × 39; USGS loc. f11521 (RS–377, Shinzato); 1, ventral view; 2, peripheral view; 3, dorsal view.

4–6. *Gyroidina neosoldanii* Brotzen (p. F37).
USNM 625270, × 26; Yonabaru 1–1,170 ft (Yonabaru); 4, ventral view; 5, peripheral view; 6, dorsal view.

7–9. *Gyroidina altiformis* R. E. and K. E. Stewart (p. F37).
USNM 625269, × 40; USGS loc. f11525 (RS–152, Yonabaru); 7, ventral view; 8, peripheral view; 9, dorsal view.

10–12. *Gyroidina altispira* Cushman and Stainforth (p. F37).
USNM 625267, × 37; USGS loc. f11516 (RS–339, Shinzato); 10, ventral view; 11, peripheral view; 12, dorsal view.

13–15. *Gyroidina nipponica* Ishizaki (p. F37).
× 76; USGS loc. f11530 (FSM–44, Yonabaru); 13, ventral view; 14, peripheral view; 15, dorsal view.

16–18. *Gyroidina cibaoensis* Bermudez (p. F37).
USNM 625268, × 64; USGS loc. f11529 (FSM–41, Yonabaru); 16, ventral view; 17, peripheral view; 18, dorsal view.

19–21. *Eponides margaritiferus* (H. B. Brady) (p. F37).
USNM 625105, × 26; USGS loc. f11540 (TKRS–7, Chinen); 19, dorsal view; 20, peripheral view; 21, ventral view.

22, 23. *Eponides procerus* (H. B. Brady) (p. F38).
USNM 625074, × 38; USGS loc. f11524 (RS–150, Yonabaru); 22, ventral view; 23, peripheral view.

24–26. *Eponides hyalinus* (Hofker) (p. F37).
USNM 625103, × 62; USGS loc. f11529 (FSM–41, Yonabaru); 24, ventral view; 25, peripheral view; 26, dorsal view.

27–29. *Eponides subornatus* (Cushman) (p. F38).
USNM 625073, × 37; USGS loc. f11541 (ME–21, Chinen); 27, dorsal view; 28, peripheral view; 28, ventral view.

30–32. *Eponides praecintus* (Karrer) (p. F38).
USNM 625100, × 27; USGS loc. f11538 (RS–351, Chinen); 30, ventral view; 31, peripheral view; 32, dorsal view.

33–35. *Pseudoeponides umbonatus* (Reuss) (p. F39).
USNM 625104, × 38; USGS loc. f11531 (FSM–45, Yonabaru); 33, ventral view; 34, peripheral view; 35, dorsal view.

36–38. *Pseudoeponides umbonatus* (Reuss) (p. F39).
USNM 625101, × 38; USGS loc. f11528 (RS–198, Yonabaru); 36, ventral view; 37, peripheral view; 38, dorsal view.

39–41. *Cibicides circularis* LeRoy, n. sp. (p. F45).
Holotype, USNM 625102, × 62; USGS loc. f11539 (FSM–12, Yonabaru); 39, ventral view; 40, peripheral view; 41, dorsal view.

42–44. *Discorbis stacyi* LeRoy, n. sp. (p. F36).
Holotype, USNM 625111, × 73; USGS loc. f11541 (ME–21, Chinen); 42, ventral view; 43, dorsal view; 44, peripheral view.

45–47. *Neoconobrina nakamurai* (Asano) (p. F36).
USNM 625108, × 76; Katchin Hanto 1–85 ft (Chinen); 45, ventral view; 46, peripheral view; 47, dorsal view.

48–50. *Rotorbinella chinenensis* LeRoy, n. sp. (p. F36).
USNM 625110, × 74; Katchin Hanto 1–245 ft (Chinen); 48, ventral view; 49, peripheral view; 50, dorsal view.

51, 52. *Rosalina isabelleana* d'Orbigny (p. F36).
USNM 625107, × 79; USGS loc. f11541 (ME–21, Chinen); 51, dorsal view; 52, ventral view.

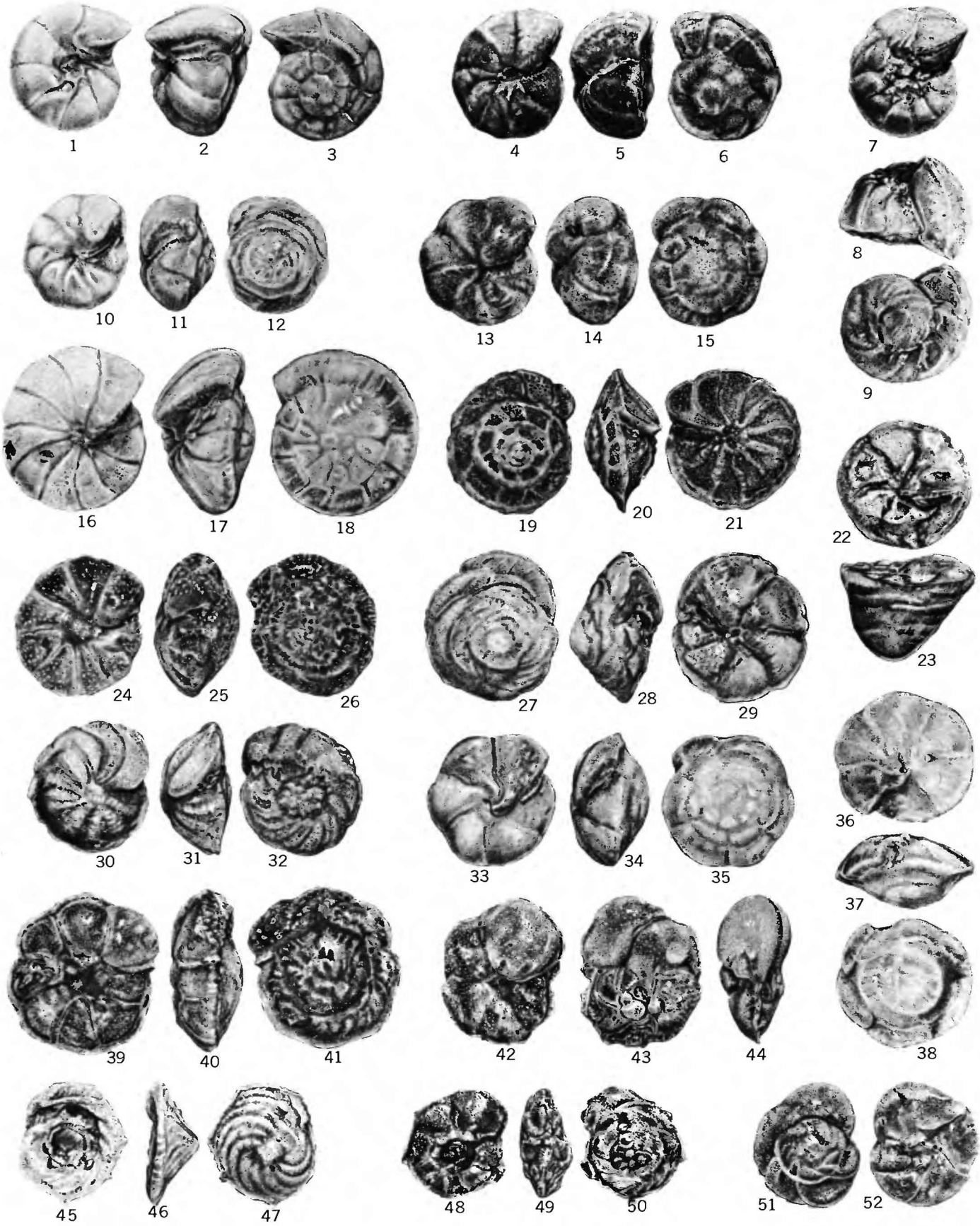

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PLATE 8

FIGURES 1–3. *Discanomalina japonica* Asano (p. F45).
USNM 625140, × 38; USGS loc. f11520 (RS–376, Shinzato); 1, ventral view; 2, peripheral view; 3, dorsal view.

4–6. *Cibicides haidingerii* (d'Orbigny) var. *pacificus* (Cushman) (p. F45).
USNM 625155, × 38; USGS loc. f11541 (ME–21, Chinen); 4, ventral view; 5, peripheral view, 6; dorsal view.

7–9. *Cibicides shinzatoensis* LeRoy, n. sp. (p. F44).
Holotype, USNM 625097, × 78; USGS loc. f11524 (RS–150, Yonabaru); 7, ventral view; 8, peripheral view; 9, dorsal view.

10–12. *Cibicides lobatulus* (d'Orbigny) (p. F45).
USNM 625156, × 70; USGS loc. f11541 (ME–21, Chinen); 10, dorsal view; 11, peripheral view; 12, ventral view.

13–15. *Cibicides pseudoungerianus* (Cushman) (p. F45).
USNM 625099, × 63; USGS loc. f11529 (FSM–41, Yonabaru); 13, ventral view; 14, peripheral view; 15, dorsal view.

16–18. *Cibicides fijiensis* (Cushman) (p. F45).
USNM 625154, × 28; USGS loc. f11515 (RS–331, Shinzato); 16, dorsal view; 17, peripheral view; 18, ventral view.

19–21. *Cibicides ornatus* (Cushman) (p. F45).
USNM 625160, × 63; USGS loc. f11526 (RS–196, Yonabaru); 19, ventral view; 20, peripheral view; 21, dorsal view.

22, 24. *Cibicides refulgens* (Montfort) (p. F44).
USNM 625158, ×78; USGS loc. f11523 (RS–149, Yonabaru); 22, ventral view; 23, peripheral view; 24, dorsal view.

25, 26. *Cibicides wuellerstorfi* (Schwager) (p. F45).
USNM 625098, × 65; USGS loc. f11509 (FSM–31, Shinzato); 25, dorsal view; 26, ventral view.

27–29. *Cibicides cicatricosa* (Schwager), (p. F45).
USNM 625161, × 39; USGS loc. f11529 (FSM–41, Yonabaru); 27, ventral view; 28, peripheral view; 29, dorsal view.

30–32. *Cibicides tenuimargo* (H. B. Brady) (p. F44).
USNM 625159, × 41; USGS loc. f11525 (RS–152, Yonabaru); 30, dorsal view; 31, peripheral view; 32, ventral view.

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PLATE 9

FIGURES 1–3. *Cibicides okinawaensis* LeRoy, n. sp. (p. F44).
Holotype, USNM 625106, × 39; USGS loc. f11519 (RS–372, Shinzato); 1, ventral view; 2, peripheral view; 3, dorsal view.

4–6. *Cibicides macneili* LeRoy, n. sp. (p. F44).
Holotype, USNM 625157, × 82; USGS loc. f11530 (FSM–44, Yonabaru); 4, dorsal view; 5, peripheral view, 6, ventral view.

7, 8. *Cibicides convexa* (Takayanagi) (p. F45).
USNM 625096, × 79; USGS loc. f11509 (FSM–31, Shinzato); 7, ventral view; 8, dorsal view.

9, 10. *Neoconobrina opercularis* (d'Orbigny) (p. F36).
USNM 625109, × 74; Katchin Hanto 1–205 ft (Chinen); 9, ventral view; 10, dorsal view.

11–13. *Globorotalia punctulata* (d'Orbigny) (p. F43).
USNM 625325, × 64; USGS loc. f11509 (FSM–31, Shinzato); 11, ventral view; 12, peripheral view; 13, dorsal view.

14, 15. *Globorotalia praemenardii* Cushman and Stainforth (p. F43).
USNM 625326, × 63; USGS loc. f11529 (FSM–41, Yonabaru); 14, ventral view; 15, dorsal view.

16, 17. *Globorotalia menardii multicamerata* Cushman and Jarvis (p. F43).
USNM 625328, × 39; USGS loc. f11512 (RS–322, Shinzato); 16, dorsal view; 17, ventral view.

18, 19. *Globorotalia tumida* (H. B. Brady) (p. F43).
USNM 625327, × 39; USGS loc. f11509 (FSM–31, Shinzato); 18, ventral view; 19, dorsal view.

20–22. *Pseudoeponides japonicus* Uchio (p. F39).
USNM 625330, × 122; USGS loc. f11539 (FSM–12, Shinzato); 20, dorsal view; 21, peripheral view; 22, ventral view.

23, 24. *Ceratobulimina pacifica* Cushman and Harris (p. F40).
USNM 625316, × 39; USGS loc. f11509 (FSM–31, Shinzato); 23, 24, opposite sides.

25. *Laticarinina pauperata* (Parker and Jones) (p. F44).
USNM 625216, × 64; USGS loc. f11529 (FSM–41, Yonabaru); side view.

26, 27. *Poroeponides cribrorepandus* Asano and Uchio (p. F39).
USNM 625329, × 39; USGS loc. f11541 (ME–21, Chinen); 26, ventral view; 27, dorsal view.

28, 29. *Hanzawaia nipponica* Asano (p. F46).
USNM 625278, × 39; USGS loc. f11522 (RS–54, Yonabaru); 28, ventral view; 29, dorsal view.

30, 31. *Elphidium simaense* Makiyama and Nakagawa (p. F28).
USNM 625086, × 37; USGS loc. f11541 (ME–21, Chinen); 30, side view; 31, peripheral view.

32, 33. *Osangularia bengalensis* (Schwager) (p. F38).
USNM 625305, × 39; USGS loc. f11529 (FSM–41, Yonabaru); 32, dorsal view; 33, ventral view.

34–36. *Hyalinea balthica* (Schroeter) (p. F44).
USNM 625172, × 77; USGS loc. f11509 (FSM–31, Shinzato); 34, 35, opposite sides; 36, peripheral view.

37, 38. *Elphidium poeyanum* (d'Orbigny) (p. F28).
USNM 625085, × 81; USGS loc. f11541 (ME–21, Chinen); 37, side view; 38, peripheral view.

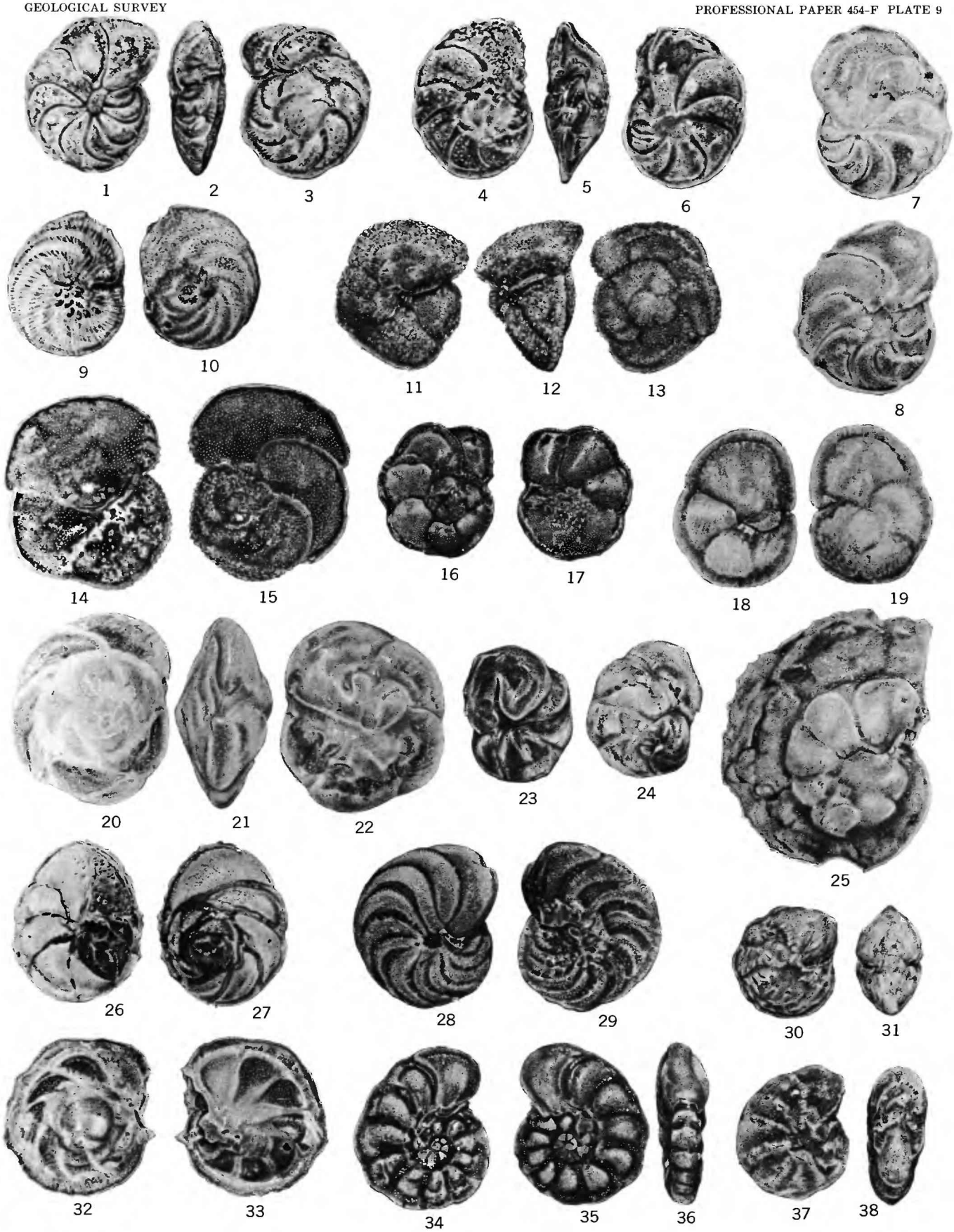

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PLATE 10

FIGURES 1, 2. *Elphidium fax barbarense* Nicol (p. F28).
USNM 625083, × 65; USGS loc. f11541 (ME–21, Chinen); 1, side view; 2, peripheral view.

3, 4. *Elphidium tikutoense* (Nakamura) (p. F28).
USNM 625088, × 97; USGS loc. f11542 (ME–36, Naha); 3, peripheral view; 4, side view.

5. *Elphidium taiwanum* Nakamura (p. F28).
USNM 625087, × 25; USGS loc. f11507 (MD–149, Chinen); side view.

6, 7. *Elphidium advena* (Cushman) var. *depressula* (Cushman) (p. F28).
USNM 625082, × 73; USGS loc. f11541 (ME–21, Chinen); 6, side view; 7, peripheral view.

8, 9. *Elphidium jenseni* (Cushman) (p. F28).
USNM 625084, × 65; USGS loc. f11541 (ME–21, Chinen); 8, side view; 9, peripheral view.

10, 11. *Nonion pompilioides* (Fichtel and Moll) (p. F27).
USNM 625075, × 64; USGS loc. f11522 (RS–54, Yonabaru); 10, side view; 11, peripheral view.

12, 13. *Nonion japonicum* Asano (p. F27).
USNM 625080, × 55; USGS loc. f11541 (ME–21, Chinen); 12, side view; 13, peripheral view.

14, 15. *Nonion nicobarense* Cushman (p. F27).
USNM 625077, × 77; USGS loc. f11530 (FSM–44, Yonabaru); 14, side view; 15, peripheral view.

16, 17. *Nonion akitaensis* Asano (p. F28).
USNM 625076, × 157; USGS loc. f11541 (ME–21, Chinen); 16, peripheral view; 17, side view.

18, 19. *Nonion pompilioides* (Fichtel and Moll) var. *okinawaense* LeRoy, n. var. (p. F27).
Holotype, USNM 625079, × 64; USGS loc. f11511 (RS–321, Shinzato); 18, side view; 19, peripheral view.

20, 21. *Nonion novozealandicum* Cushman (p. F28).
USNM 625315, × 58; USGS loc. f11511 (RS–321, Shinzato); 20, peripheral view; 21, side view.

22, 23. *Nonion manpukujiensis* Otsuka (p. F28).
USNM 625078, × 65; Yonabaru 1–750 ft (Yonabaru); 22, side view; 23, peripheral view.

24, 25. *Pullenia salisburyi* R. E. and K. E. Stewart (p. F41).
USNM 625262, × 77; USGS loc. f11539 (FSM–12, Shinzato); 24, side view; 25, peripheral view.

26, 27. *Pullenia miocenica* Kleinpell (p. F41).
USNM 625259, × 80; USGS loc. f11509 (FSM–31, Shinzato); 26, peripheral view; 27, side view.

28, 29. *Pullenia quadriloba* Reuss (p. F41).
USNM 625260, × 73; USGS loc. f11529 (FSM–41, Yonabaru); 28, side view; 29, peripheral view.

30, 31. *Pullenia bulloides* (d'Orbigny) (p. F41).
USNM 625261, × 78; USGS loc. f11532 (FSM–47, Yonabaru); 30, side view; 31, peripheral view.

SMALLER FORAMINIFERA

PLATE 11

FIGURES 1. *Bulimina yonabaruensis* LeRoy, n. sp. (p. F30).
Holotype, USNM 625227, × 72; Yonabaru 1–840 ft (Yonabaru); side view.

2. *Bulimina marginata* d'Orbigny (p. F30).
USNM 625223, × 160; USGS loc. f11542 (ME–36, Naha); side view.

3. *Bulimina subaffinis* Cushman (p. F30).
USNM 625220, × 79; USGS loc. f11509 (FSM–31, Shinzato); side view.

4, 5. *Bulimina pupoides* d'Orbigny (p. F30).
4, USNM 625228; 5, USNM 625402, × 66; USGS loc. f11535 (WF–273, Yonabaru); side views.

6. *Bulimina inflata* Seguenza (p. F30).
USNM 625221, × 72; USGS loc. f11517 (RS–360, Shinzato); side view.

7. *Bulimina aculeata* d'Orbigny (p. F30).
USNM 625224, × 119; USGS loc. f11509 (FSM–31, Shinzato); side view.

8. *Bulimina subcalva* Cushman and K. E. Stewart (p. F30).
USNM 625222, × 65; USGS loc. f11535 (WF–273, Yonabaru); side view.

9. *Bulimina microlongistriata* LeRoy (p. F30).
USNM 625225, × 60; USGS loc. f11521 (RS–377, Shinzato); side view.

10. *Bulimina gutta* Chapman and Parr (p. F30).
USNM 625226, × 126; USGS loc. f11530 (FSM–44, Yonabaru); side view.

11. *Buliminoides williamsonianus* (H. B. Brady) (p. F29).
USNM 625229, × 72; USGS loc. f11537 (MD–25, Chinen); side view.

12. *Plectofrondicularia inaequalis* (Costa) (p. F29).
USNM 625271, × 40; USGS loc. f11536 (WF–274, Yonabaru); side view.

13, 14. *Cassidulina inflata* LeRoy (p. F40).
USNM 625230, × 172; Yonabaru 1–700 ft (Yonabaru); 13, peripheral view; 14, side view.

15, 16. *Cassidulina orientale* Cushman (p. F40).
USNM 625094, × 136; USGS loc. f11519 (RS–372, Shinzato); 15, side view; 16, peripheral view.

17. *Cassidulina subglobosa* H. B. Brady (p. F40).
USNM 625092, × 69; USGS loc. f11516 (RS–339, Shinzato); peripheral view.

18. *Plectofrondicularia foliacea* (Schwager) (p. F29).
USNM 625272, × 39; USGS loc. f11509 (FSM–31, Shinzato); side view.

19, 20. *Cassidulina pacifica* Cushman (p. F40).
USNM 625231, × 81; USGS loc. f11511 (RS–321, Shinzato); 19, side view; 20, peripheral view.

21, 22. *Cassidulina okinawaensis* LeRoy, n. sp. (p. F40).
Holotype, USNM 625093, × 80; USGS loc. f11520 (RS–376, Shinzato); 21, side view; 22, peripheral view.

23, 24. *Guttulina orientalis* Cushman and Ozawa (p. F27).
USNM 625263, × 39; USGS loc. f11541 (ME–21, Chinen); 23, 24, side views.

25, 26. *Guttulina pacifica* (Cushman and Ozawa) (p. F27).
USNM 625265, × 38; USGS loc. f11524 (RS–150, Yonabaru); 25, 26, side views.

27, 28. *Cassidulina margareta* Karrer (p. F40).
USNM 625091, × 76; USGS loc. f11538 (RS–350, Chinen); 27, peripheral view; 28, side view.

29. *Cassidulina asanoi* Uchio (p. F40).
USNM 625232, × 170; USGS loc. f11508 (FSM–27, Shinzato); side view.

30, 31. *Guttulina pusilla* Stache (p. F27).
USNM 625264, × 40; USGS loc. f11524 (RS–150, Yonabaru); 30, 31, side views.

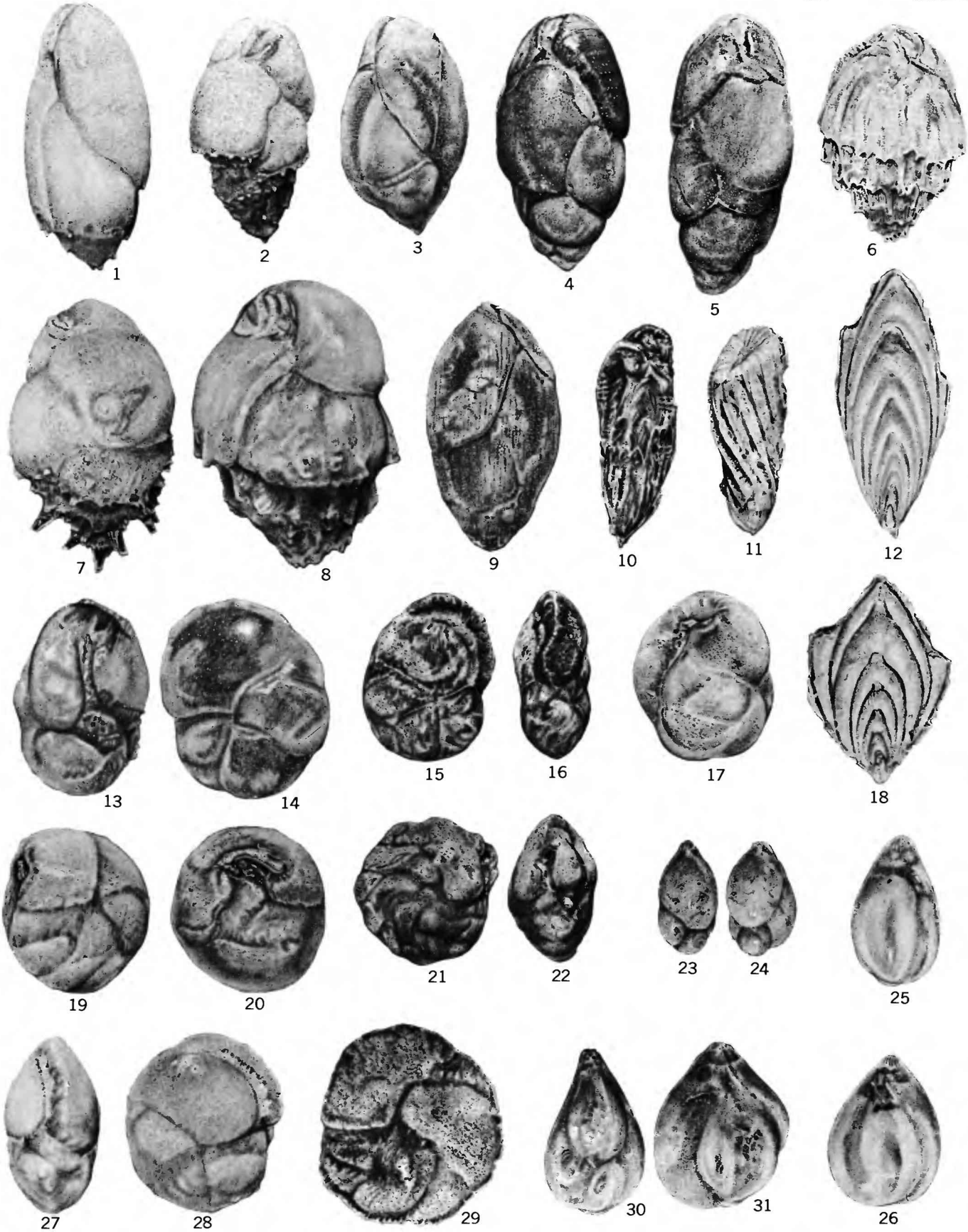

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PLATE 12

FIGURES 1, 2. *Cassidulinoides tenuis* Phleger and Parker (p. F41).
USNM 625095, × 66; USGS loc. f11517 (RS–360, Shinzato); 1, side view; 2, peripheral view.

3, 4. *Cassidulinoides braziliensis* (Cushman) (p. F41).
USNM 625089, × 82; USGS loc. f11511 (RS–321, Shinzato); 3, peripheral view; 4, side view.

5, 6. *Cassidulinoides bradyi* (Norman) (p. F41).
USNM 625090, × 82; Hatchin Hanto 1–135 ft (Chinen); 5, peripheral view; 6, side view.

7, 8. *Quinqueloculina contorta* d'Orbigny (p. F20).
USNM 625188, × 40; USGS loc. f11512 (RS–322, Shinzato); 7, apertural view; 8, side view.

9, 10. *Quinqueloculina pygmea* Reuss (p. F20).
USNM 625185, × 132; USGS loc. f11542 (ME–36, Naha); 9, apertural view; 10, side view.

11, 12. *Quinqueloculina elongata* Natland (p. F20).
USNM 625191, × 84; USGS loc. f11541 (ME–21, Chinen); 11, apertural view; 12, side view.

13, 14. *Quinqueloculina akneriana* d'Orbigny (p. F19).
USNM 625192, × 40; USGS loc. f11537 (MD–25, Chinen); 13, apertural view; 14, side view.

15, 16. *Quinqueloculina tricarinata* d'Orbigny (p. F19).
USNM 625187, × 38; USGS loc. f11537 (MD–25, Chinen); 15, apertural view; 16, side view.

17, 18. *Quinqueloculina sagamiensis* Asano (p. F19).
USNM 625189, × 24; USGS loc. f11537 (MD–25, Chinen); 17, apertural view; 18, side view.

19, 20. *Quinqueloculina carinata* d'Orbigny (p. F19).
USNM 625186, × 40; USGS loc. f11537 (MD–25, Chinen); 19, apertural view; 20, side view.

21, 22. *Quinqueloculina reticulata* (d'Orbigny) (p. F19).
USNM 625190, × 43; USGS loc. f11526 (RS–196, Yonabaru); 21, apertural view; 22, side view.

23, 24. *Cruciloculina striata* Loeblich and Tappan (p. F21).
USNM 625167, × 40; Yonabaru 1–1,110 ft (Yonabaru); 23, side view; 24, apertural view.

25, 26. *Pyrgo affinis* (d'Orbigny) (p. F21).
USNM 625176, × 69; USGS loc. f11541 (ME–21, Chinen); 25, ventral view; 26, dorsal view.

27, 28. *Miliolinella australis* (Parr) (p. F21).
USNM 625293, × 26; Yonabaru 1–1,170 ft (Yonabaru); 27, side view; 28, apertural view.

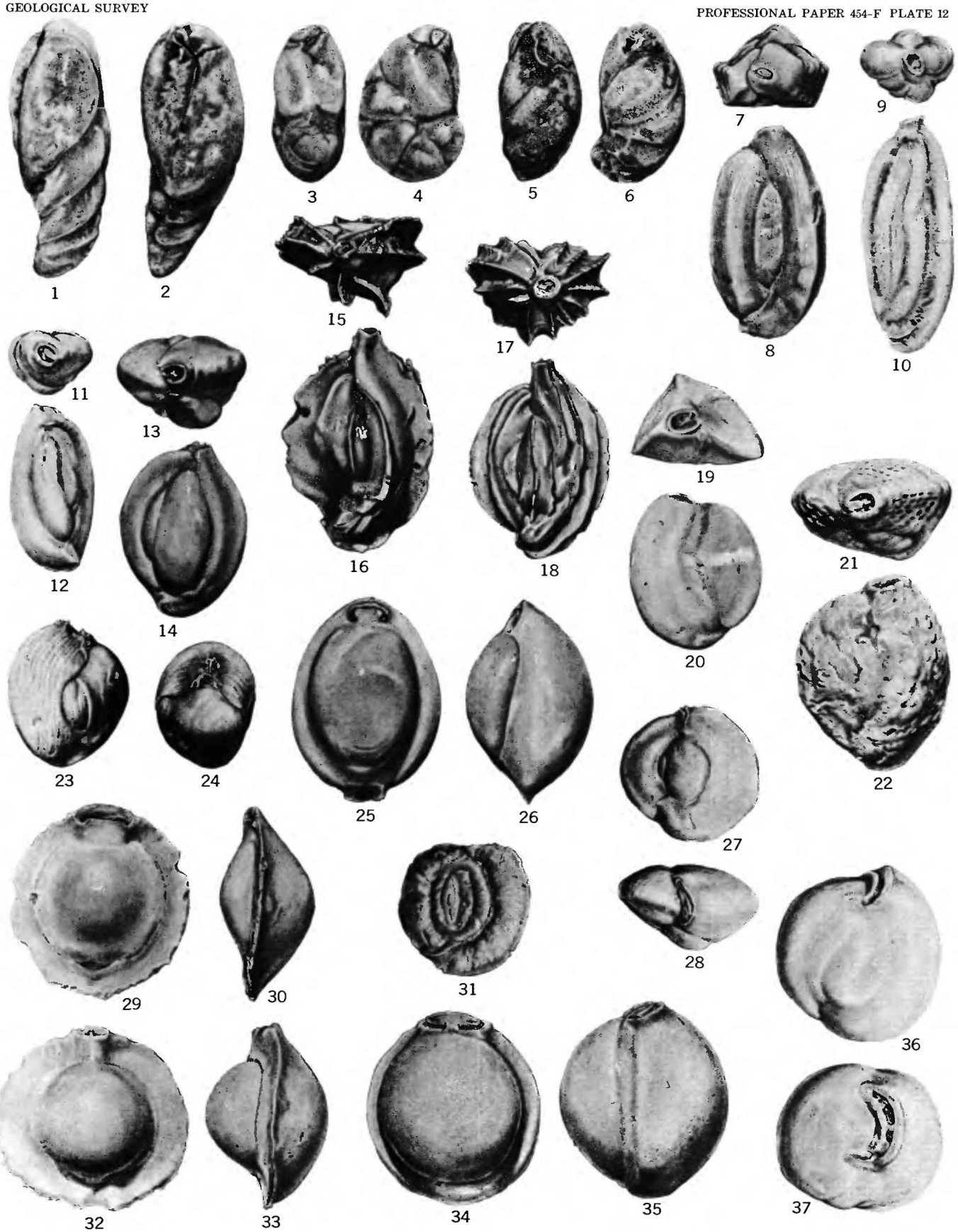
29, 30. *Pyrgo depress* (d'Orbigny) (p. F21).
USNM 625173, × 41; USGS loc. f11521 (RS–377, Shinzato); 29, ventral view; 30, peripheral view.

31. *Massilina fragilissima* (H. B. Brady) (p. F20).
USNM 625291, × 38; USGS loc. f11541 (ME–21, Chinen); side view.

32, 33. *Pyrgo murrhina* (Schwager) (p. F21).
USNM 625174, × 75; Yonabaru 1–1,740 ft (Yonabaru); 32, ventral view; 33, peripheral view.

34, 35. *Pyrgo subsphaerica* (d'Orbigny) (p. F21).
USNM 625175, × 38; Yonabaru 1–750 ft (Yonabaru); 34, ventral view; 35, peripheral view.

36, 37. *Miliolinellna inflata* LeRoy, n. sp. (p. F21).
Holotype, USNM 625294, × 66; USGS loc. f11526 (RS–196, Yonabaru); 36, side view; 37, apertural view.



SMALLER FORAMINIFERA

PLATE 13

FIGURES 1, 2. *Cyclammina ezoensis* Asano (p. F17).
USNM 625323, × 13; Yonabaru 1–4,020 ft (Yonabaru); 1, side view; 2, peripheral view.

3, 4. *Cyclammina* sp. A LeRoy (p. F17).
USNM 625324, × 38; Yonabaru 1–2,930 ft (Yonabaru); 3, side view; 4, peripheral view.

5, 6. *Fissurina radiato-marginata* (Parker and Jones) (p. F32).
USNM 625249, × 82; USGS loc. f11541 (ME–21, Chinen); 5, top view; 6, peripheral view.

7, 8. *Fissurina castrensis* (Schwager) var. *pacifica* LeRoy, n. var. (p. F32).
Holotype, USNM 625245, × 39; USGS loc. f11539 (FSM–12, Shinzato); 7, top view; 8, peripheral view.

9, 10. *Fissurina echigoensis* (Asano and Inomata) var. (p. F32).
USNM 625246, × 74; Yonabaru 1–830 ft (Yonabaru); 9, top view; 10, peripheral view.

11, 12. *Fissurina fasciata* (Egger) var. *spinosa* (Sidebottom) (p. F32).
USNM 625254, × 75; Yonabaru 1–650 ft (Yonabaru); 11, top view; 12, peripheral view.

13, 14. *Fissurina ventricosa* (Silvestri) (p. F32).
USNM 625253, × 66; USGS loc. f11535 (WF–273, Yonabaru); 13, top view; 14, side view.

15, 16. *Fissurina* aff. *F. crebra* (Matthes) (p. F32).
USNM 625243, × 107; USGS loc. f11541 (ME–21, Chinen); 15, top view; 16, peripheral view.

17, 18. *Fissurina lacunata* (Burrows and Holland) (p. F32).
USNM 625251, × 80; USGS loc. f11541 (ME–21, Chinen); 17, top view; 18, peripheral view.

19, 20. *Fissurina semiopaca* (Wiesner) (p. F32).
USNM 625250, × 37; Yonabaru 1–1,660 ft (Yonabaru); 19, top view; 20, peripheral view.

21, 22. *Fissurina lunata* (Matthes) (p. F32).
USNM 625252, × 79; USGS loc. f11535 (WF–273, Yonabaru); 21, peripheral view; 22, top view.

23, 24. *Fissurina enderbiensis* (Chapman) (p. F32).
USNM 625247, × 74; USGS loc. f11539 (FSM–12, Shinzato); 23, peripheral view; 24, top view.

25, 26. *Fissurina perforata* LeRoy, n. sp. (p. F32).
Holotype, USNM 625248, × 77; USGS loc. f11521 (RS–377, Shinzato); 25, peripheral view; 26, top view.

27, 28. *Fissurina crebra* (Matthes) var. *scissa* (Matthes) (p. F32).
USNM 625244, × 80; USGS loc. f11541 (ME–21, Chinen); 27, peripheral view; 28, top view.

29. *Lagena aspera* Reuss (p. F25).
USNM 625197, × 41; Yonabaru 1–1,180 ft (Yonabaru); side view.

30, 31. *Oolina trigona-pulchella* (Balkwill and Millett) (p. F27).
USNM 625199, × 169; USGS loc. f11541 (ME–21, Chinen); 30, apertural view; 31, side view.

32. *Lagena sulcata* (Walker and Jacob) var. *spirata* Bandy (p. F25).
USNM 625207, × 160; USGS loc. f11541 (ME–21, Chinen); side view.

33. *Lagena laevis* (Montagu) var. *baggi* Cushman and Gray (p. F26).
USNM 625205, × 140; USGS loc. f11521 (RS–377, Shinzato); side view.

34. *Lagena striato-punctata* Parker and Jones, var. *bulbosa* LeRoy, n. var. (p. F26).
Holotype, USNM 625202, × 79, USGS loc. f11539 (FSM–27, Shinzato); side view.

35. *Lagena distoma* Parker and Jones (p. F26).
USNM 625198, × 66; USGS loc. f11535 (WF–273, Yonabaru); side view.

36. *Lagena elongata* (Ehrenberg) (p. F26).
USNM 625194, × 66; USGS loc. f11541 (ME–21, Chinen); side view.

37. *Oolina gracilis* Williamson var. *meridionalis* (Wiesner) (p. F26).
USNM 625204, × 128; USGS loc. f11508 (FSM–27, Shinzato); side view.

38. *Lagena sulcata* (Walker and Jacob) var. *spirata* Bandy (p. F25).
USNM 625207, × 79; USGS loc. f11541 (ME–21, Chinen); side view.

39. *Lagena striata* (d'Orbigny) var. *toddi* LeRoy, n. var. (p. F25).
Holotype, USNM 625209, × 66; USGS loc. f11539 (FSM–27, Shinzato); side view.

40. *Lagena williamsoni* (Alcock) (p. F26).
USNM 625200, × 81; Yonabaru 1–1,500 ft (Yonabaru); side view.

41. *Lagena intermedia* Hada (p. F26).
USNM 625196, × 66; loc. f11531 (FSM–45, Yonabaru); side view.

42. *Oolina squamosa* (Montague) var. *apiciglabra* (Ten Dam and Reinhold) (p. F26).
USNM 625208, × 127; USGS loc. f11541 (ME–21, Chinen); side view.

43. *Oolina squamosa* (Montagu) var. *scalariformis* (Williamson) (p. F26).
USNM 625193, × 129; USGS loc. f11530 (FSM–44, Yonabaru); side view.

44. *Oolina globosa* (Montagu) var. *setesa* (Earland) (p. F26).
USNM 625203, × 67; USGS loc. f11528 (RS–198, Yonabaru); side view.

45. *Lagena sulcata* (Walker and Jacob) var. *spicata* Cushman and McCullock (p. F26).
USNM 625206, × 132; USGS loc. f11541 (ME–21, Chinen); side view.

46. *Lagena striata* (d'Orbigny) var. *semistriata* Williamson (p. F26).
USNM 625210, × 80; USGS loc. f11539 (FSM–27, Shinzato); side view.

47. *Lagena hystrix* Reuss (p. F25).
USNM 625201, × 68; USGS loc. f11508 (FSM–27, Shinzato); side view.

SMALLER FORAMINIFERA

PLATE 14

FIGURES 1. *Lagena advena* Cushman (p. F26).
USNM 625195, × 64; USGS loc. f11531 (FSM–45, Yonabaru); side view.

2. *Ramulina globulifera* H. B. Brady (p. F27).
USNM 625295, × 60; USGS loc. f11538 (RS–351, Chinen); side view.

3. *Globobulimina pacifica* Cushman (p. F30).
USNM 625280, × 40; USGS loc. f11539 (FSM–12, Shinzato); side view.

4. *Globobulimina globosa* LeRoy (p. F31).
USNM 625281, × 60; Katchin Hanto 1–150 ft (Chinen); side view.

5. *Orbulina universa* d'Orbigny (p. F42).
USNM 625138, × 67; USGS loc. f11509 (FSM–31, Shinzato); side view.

6–8. *Globigerina dubia* Egger (p. F42).
USNM 625235, × 36; USGS loc. f11509 (FSM–31, Shinzato); 6, dorsal view; 7, peripheral view; 8, ventral view.

9, 10. *Globigerina baroemoenensis* LeRoy, (p. F42).
USNM 625237, × 60; USGS loc. f11529 (FSM–41, Yonabaru); 9, peripheral view; 10, ventral view.

11. *Globigerina bulloides* d'Orbigny (p. F42).
USNM 625236, × 80; USGS loc. f11509 (FSM–31, Shinzato); dorsal view.

12, 13. *Globoquadrina altispira* (Cushman and Jarvis) (p. F43).
USNM 625234, × 36; USGS loc. f11539 (FSM–31, Shinzato); 12, side view; 13, ventral view.

14. *Globigerinoides ruber* (d'Orbigny) (p. F42).
USNM 625241, × 65; USGS loc. f11509 (FSM–31, Shinzato); side view.

15. *Globigerinoides mitra* Todd (p. F42).
USNM 625242, × 36; Yonabaru 1–960 ft (Yonabaru); side view.

16. *Globigerinoides triloba immatura* LeRoy (p. F42).
USNM 625239, × 64; USGS loc. f11509 (FSM–31, Shinzato); oblique view.

17. *Globigerinoides triloba fistulosa* (Schubert) (p. F42).
USNM 625238, × 65; USGS loc. f11509 (FSM–31, Shinzato); side view.

18. *Globigerinoides triloba sacculifera* (H. B. Brady) (p. F42).
USNM 625240, × 63; USGS loc. f11521 (RS–377, Shinzato); side view.

19, 20. *Globigerinella aequilateralis* (H. B. Brady) (p. F42).
USNM 625233, × 64; USGS loc. f11509 (FSM–31, Shinzato); 19, peripheral view; 20, side view.

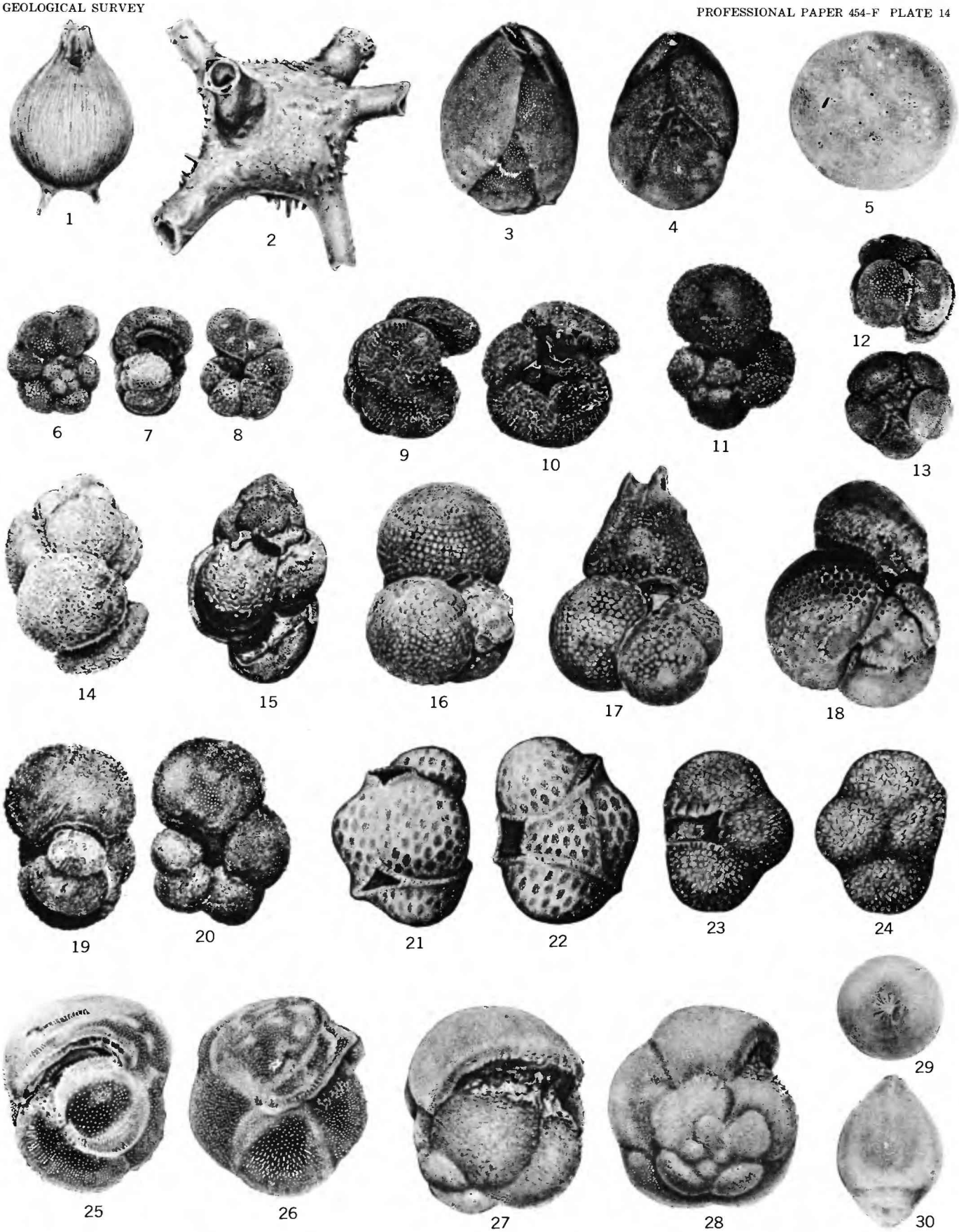
21, 22. *Sphaeroidinella dehiscens* (Parker and Jones) (p. F43).
USNM 625357, × 41; USGS loc. f11509 (FSM–31, Shinzato); 21, 22, opposite sides.

23, 24. *Sphaeroidinella seminulina* (Schwager) (p. F43).
USNM 625358, × 45; Yonabaru 1–120 ft (Yonabaru); 23, 24, opposite sides.

25, 26. *Pulleniatina obliquiloculata* (Parker and Jones) (p. F42).
USNM 625287, × 75; USGS loc. f11529 (FSM–41, Yonabaru); 25, peripheral view; 26, ventral view.

27, 28. *Pulleniatina obliquiloculata* (Parker and Jones) (p. F42).
USNM 625288, × 75; USGS loc. f11521 (RS–377, Shinzato); 27, oblique peripheral view; 28, dorsal view.

29, 30. *Rectoglandulina laevigata* (d'Orbigny) (p. F23).
USNM 625296, × 41; USGS loc. f11535 (WF–273, Yonabaru); 29, apertural view; 30, side view.



SMALLER FORAMINIFERA

PLATE 15

FIGURES 1. *Nodosaria tosta* Schwager (p. F23).
USNM 625124, × 22; Yonabaru 1–100 ft (Yonabaru); side view.

2. *Nodosaria* ? aff. *N.* ? *exilis* Schwager (p. F23)
USNM 625114, × 40; USGS loc. f11515 (RS–331, Shinzato); side view.

3. *Nodosaria hirsuta* (d'Orbigny) (p. F24).
USNM 625131, × 26; USGS loc. f11521 (RS–377, Shinzato); side view.

4. *Nodosaria hispidula* Cushman (p. F24).
USNM 625128, × 39; USGS loc. f11532 (FSM–47, Yonabaru); side view.

5. *Nodosaria subtertenuata* Schwager (p. F24).
USNM 65129, × 25; USGS loc. f11509 (FSM–31, Shinzato); side view.

6. *Nodosaria tympaniplectiformis* Schwager (p. F24).
USNM 625113, × 81; USGS loc. f11512 (RS–322, Shinzato); side view.

7. *Nodosaria hochstetteri* Schwager (p. F24).
USNM 625123, × 38; USGS loc. f11521 (RS–377, Shinzato); side view.

8. *Rectoglandulina ambigua* (Neugeboren) (p. F23).
USNM 625122, × 39; Yonabaru 1–140 ft (Yonabaru); side view.

9. *Nodosaria fistuca* Schwager (p. F24).
USNM 625130, × 78; USGS loc. f11529 (FSM–41, Yonabaru); side view.

10. *Nodosaria pupa* Karrer (p. F24).
USNM 625121, × 77; USGS loc. f11531 (WF–45, Yonabaru); side view.

11. *Rectoglandulina tornata* (Schwager) (p. F23).
USNM 625115, × 37; USGS loc. f11512 (RS–322, Shinzato); side view.

12. *Nodosaria vertebralis* (Batsch) var. *albatrossi* Cushman (p. F25).
USNM 625116, × 26; USGS loc. f11537 (MD–25, Chinen); side view.

13. *Nodosaria spirostriolata* Cushman (p. F24).
USNM 625120, × 27; Yonabaru 1–140 ft (Yonabaru); side view.

14. *Nodosaria insecta* Schwager (p. F24).
USNM 625118, × 40; USGS loc. f11536 (WF–274, Yonabaru); side view.

15, 16. *Nodosaria setosa* Schwager (p. F25).
15, USNM 625119; 16, USNM 625217, × 40; Yonabaru 1–30 ft (Yonabaru); side views.

17. *Nodosaria soluta* (Reuss) (p. F25).
USNM 625112, × 38; USGS loc. f11538 (RS–351, Chinen); side view.

18. *Nodosaria pyrula* d'Orbigny var. *longi-costata* Cushman (p. F24).
USNM 625117, × 28; USGS loc. f11521 (RS–377, Shinzato); side view.

19. *Dentalina obliqua* (Linné) (p. F23).
USNM 625179, × 23; USGS loc. f11539 (FSM–27, Shinzato); side view.

20, 29. *Lagenonodosaria scalaris* (Batsch) (p. F27),
20, USNM 625219, × 39; USGS loc. f11508 (FSM–27, Shinzato); 29, USNM 625218, × 66; USGS loc. f11537 (MD–25, Chinen); side views.

21. *Nodosaria acuminata* Hantken var. *uniformata* LeRoy (p. F24).
USNM 625331, × 35; USGS loc. f11509 (FSM–31, Shinzato); side view.

22. *Dentalina reussi* Neugeboren (p. F23).
USNM 625181, × 39; USGS loc. f11516 (RS–339, Shinzato); side view.

23. *Nodosaria longiscata* d'Orbigny (p. F24).
USNM 625127, × 26; USGS loc. f11509 (FSM–31, Shinzato); side view.

24. *Rectoglandulina radicula* (Linné) (p. F23).
USNM 625125, × 39; USGS loc. f11521 (RS–377, Shinzato); side view.

25. *Nodosaria crassitesta* Schwager (p. F24).
USNM 625126, × 40; USGS loc. f11529 (FSM–41, Yonabaru); side view.

26. *Orthomorphina challengeriana* (Thalmann) (p. F29).
USNM 625297, × 39; USGS loc. f11536 (WF–274, Yonabaru); side view.

27. *Dentalina jarvisi* Cushman and Todd (p. F23).
USNM 625178, × 39; USGS loc. f11536 (WF–274, Yonabaru); side view.

28. *Dentalina communis* d'Orbigny (p. F23).
USNM 625177, × 23; USGS loc. f11509 (FSM–31, Shinzato); side view.

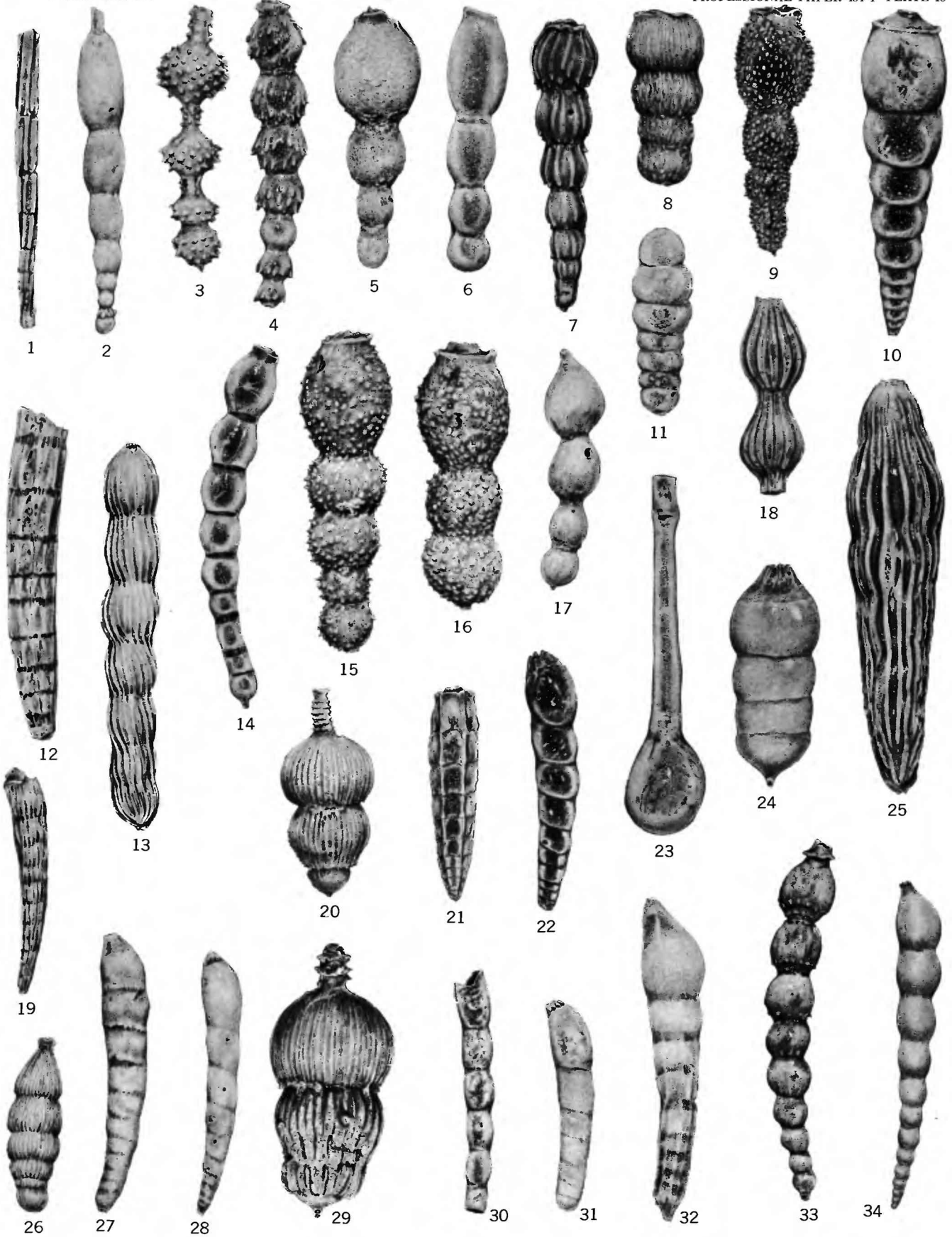
30. *Dentalina recta* (Schwager) (p. F23).
USNM 625180, × 23; USGS loc. f11521 (RS–377, Shinzato); side view.

31. *Dentalina advena* (Cushman) (p. F23).
USNM 625183, × 23; USGS loc. f11511 (RS–321, Shinzato); side view.

32. *Dentalina semilaevis* Hantken (p. F23).
USNM 625182, × 40; USGS loc. f11508 (FSM–27, Shinzato); side view.

33. *Stilostomella ketenziensis* (Ishizaki) (p. F35).
USNM 625081, ×40; USGS loc. f11508 (FSM–27, Shinzato); side view.

34. *Dentalina emaciata* Reuss (p. F23).
USNM 625184, × 22; USGS loc. f11521 (RS–377, Shinzato); side view.



SMALLER FORAMINIFERA

PLATE 16

FIGURES 1, 2. *Textularia mayeriana* d'Orbigny (p. F18).
USNM 625410, × 24; USGS loc. f11541 (ME–21, Chinen); 1, apertural view; 2, side view.

3, 4. *Tritaxilina caperata* (H. B. Brady) (p. F18).
USNM 625398, × 25; USGS loc. f11538 (RS–351, Chinen); 3, apertural view; 4, side view.

5. *Nodosaria hochstetteri* Schwager var. *spinicosta* Koch (p. F24).
USNM 625405, × 40; USGS loc. f11539 (FSM–12, Shinzato); side view.

6. *Nodosaria scabriuscula* Costa (p. F25).
× 69; USGS loc. f11536 (WF–274, Yonabaru); side view.

7. *Uvigerina hispido-costata* Cushman and Todd (p. F35).
× 63; USGS loc. f11536 (WF–274, Yonabaru); side view.

8. *Uvigerina proboscidea* Schwager (p. F35).
USNM 625394, × 62; USGS loc. f11529 (FSM–41, Yonabaru); side view.

9. *Siphogenerina raphanus* (Parker and Jones) (p. F35).
USNM 625386, × 40; USGS loc. f11539 (FSM–12, side view.

10, 11. *Siphonina tubulosa* Cushman (p. F39).
USNM 625395, × 75; USGS loc. f11541 (ME–21, Chinen); 10, ventral view; 11, peripheral view.

12, 13. *Robulus himiensis* Chiji and Nakaseko (p. F22).
USNM 625403, × 28; USGS loc. f11529 (FSM–41, Yonabaru); 12, side view; 13, peripheral view.

14, 15. *Spiroloculina communis* Cushman and Todd (p. F20).
USNM 625406, × 38; USGS loc. f11541 (ME–21, Chinen); 14, side view; 15, peripheral view.

16. *Textularia lythostrota* (Schwager) (p. F17).
USNM 625389, × 42; USGS loc. f11528 (RS–198, Yonabaru); side view.

17, 18. *Robulus polygonatus* (Franke) (p. F22).
USNM 625404, × 38; USGS loc. f11521 (RS–377, Shinzato); 17, side view; 18, peripheral view.

19, 20. *Saracenaria angularis* Natland (p. F25).
USNM 625400, × 36; USGS loc. f11512 (RS–322, Shinzato); 19, peripheral view; 20, side view.

21, 22. *Sphaeroidina bulloides* d'Orbigny (p. F41).
USNM 625388, × 67; USGS loc. f11521 (RS–377, Shinzato); side views.

23, 24. *Robulus* sp. A. LeRoy (p. F22).
USNM 625408, × 30; USGS loc. f11539 (FSM–27, Shinzato); 23, side view; 24, peripheral view.

25, 26. *Robulus* sp. B. LeRoy (p. F22).
USNM 625409, × 21; Yonabaru 1–3,400 ft (Yonabaru); 25, apertural view; 26, side view.

27, 28. *Valvulineria laevigata* Phleger and Parker (p. F37).
USNM 625397, × 81; Yonabaru 1–1,960 ft (Yonabaru); 27, ventral view; 28, dorsal view.

29. *Marginulina glabra* d'Orbigny (p. F23).
USNM 625401, × 40; USGS loc. f11529 (FSM–41, Yonabaru); edge view.

30, 31. *Triloculina trigonula* (Lamarck) (p. F20).
USNM 625390, × 60; USGS loc. f11541 (ME–21, Chinen); 30, apertural view; 31; side view.

32, 33. *Sigmoilina tenuis* (Czjzek) (p. F20).
USNM 625399, × 80; USGS loc. f11520 (RS–376, Shinzato); 32, side view; 33, peripheral view.

34–36. *Rotalia stachi* Asano (p. F38).
USNM 625392, × 27; USGS loc. f11541 (ME–21, Chinen); 34, ventral view; 35, peripheral view; 36, dorsal view.

37, 38. *Robulus inornatus* (d'Orbigny) (p. F22).
USNM 625407, × 28; USGS loc. f11523 (RS–149, Yonabaru); 37, side view; 38, peripheral view.

SMALLER FORAMINIFERA