Recent Foraminifera From the Gulf of Alaska And Southeastern Alaska

By RUTH TODD *and* DORIS LOW

CONTRIBUTIONS TO PALEONTOLOGY

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A study resulting from a search for evidence that Pamplona Searidge is the foundered remnant of the 18th century "Pamplona Rock"

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RECENT FORAMINIFERA FROM THE GULF OF ALASKA AND SOUTHEASTERN ALASKA

By Ruth Todd and Doris Low

ABSTRACT

Pamplona Searidge is a northeast-trending submarine ridge, about 30 miles off the coast in the Gulf of Alaska, near the outer edge of the continental shelf. It now rises from surrounding depths of about 400 fathoms to within 68 fathoms of the surface and conceivably might have been what 18th century Spanish and Russian explorers reported to be the dangerous rocky shoal, "Pamplona Rock."

Three samples dredged between 85 and 100 fathoms from near the top of Pamplona Searidge contain rich assemblages of Foraminifera dominated by *Cassidulina californica* and *C. tortuosa.* Two samples were dredged from the sides of the searidge between 133 and 205 fathoms. The fauna of the shallower one—that between 133 and 148 fathoms—is similar to those on the summit, but the deeper sample is dominated by *Goesella flintii.*

For comparison with the Foraminifera of the searidge, six samples from depths between 10 and 215 fathoms, dredged in the channels and bays of the fjordland of southeastern Alaska were also studied. These six samples reveal the faunal distinctiveness of the various fjordland localities as contrasted with the comparative uniformity of the open environment of the searidge samples in the Gulf of Alaska.

Only two of the fjordland samples have dominating species, namely *Elphidiella groenlandica* and *Cassidulina limbata* at Excursion Inlet and *Rotalia columbiensis* at Gambier Bay. Elsewhere, each assemblage contains a group of major constituents with supplementary minor ones. Some of these major constituents are *Reophax scorpiurus, Haplophragmoides planissimus, Cribrostomoides crassimargo, Ammotium cassis, Gaudryina arenaria, Eggerella advena, Quinqueloculina akneriana, Globobulimina auriculata, Bolivina alata, Uvigerina peregrina, Angulogerina fluens, Rosalina ornatissima, Buccella frigida, Elphidium clavatum, E. frigidum, Cibicides lobatulus, Florilus labradoricus, Nonionella pulchella, Pseudononion auriculum,* and *Astrononion gallowayi.*

Altogether, 140 species are recorded, and their distribution and abundance indicated, but about 85 of them constitute a quantitatively negligible part of the whole population of Foraminifera. From the total of 140 species, about 56 percent have previously been recorded as inhabiting Arctic regions, and an additional 8 percent as inhabiting Antarctic regions. Only 36 percent have not been reported in either polar region.

Comparisons are made with Recent Foraminifera assemblages from elevated glacial sediment in southeastern Alaska, from dredged bottom sediment in southern British Columbia, from the northwestern Pacific, from shallow shelf water along the Arctic coast of eastern Siberia, and from off the coast of Chile. In each of these places numerous species were found in common with the present assemblages.

Comparisons were also made with three probably Pleistocene or Pliocene occurrences: a submarine beach deposit near Nome, Amchitka Island in the Aleutians, and Middleton Island in the Gulf of Alaska west of the searidge. Here, too, similarities were found with the present assemblages.

Search for evidence that Pamplona Searidge had formerly been at a higher elevation near sea level was fruitless, but at the same time the Foraminifera showed nothing that would rule out such an interpretation.

INTRODUCTION

Five bottom samples from Pamplona Searidge in the Gulf of Alaska and six samples from various localities in the fjords and bays of southeastern Alaska have yielded rich assemblages, consisting mostly of Recent smaller Foraminifera but undoubtedly including fossil specimens as minor elements.

Study of the Foraminifera from Pamplona Searidge was made originally as a search for evidence that the searidge had, within the last 180 years, foundered from a near-surface elevation where it may have been the ancient "Bajo Pamplona" reported in 1779 and charted by the Spanish explorers as a dangerous rocky shoal (Jordan, 1958, p. 3–4, fig. 2). Pamplona Searidge is now a 15-mile long submarine ridge, trending approximately northeast at right angles to the coastline, beginning about 30 miles offshore at the outer edge of the continental shelf. Its minimum depth, a rocky submarine promontory at 68 fathoms, is found at its outer (southwest) end.

Three dredgings on the top and one from each side of Pamplona Searidge (hereafter referred to as Pamplona 3, 4, 5, 7, and 8) were made by the U.S. Coast and Geodetic Survey Ship *Pathfinder* in 1958. In addition, six samples were obtained from various depths and localities in the inland waterways in southeastern Alaska and used for comparison with the five samples from the searidge. Two of the fjordland samples (Kasaan Bay and Clarence Strait) were also dredged by the *Pathfinder;* the remaining four (Excursion Inlet, Taku Harbor, Lynn Canal, and Gambier Bay) were obtained in 1958 by the late D. J. Miller of the U.S. Geological Survey. Figure 1 shows the geographic relationship of the two areas. Table 1 details all the localities and bottom conditions and lists the USGS locality numbers assigned to the samples of Foraminifera. The samples obtained from the top and sides of the searidge come from depths between 85 and 205 fathoms; those from the southeastern Alaska fjordlands from depths between 10 and 215 fathoms.

TABLE 1.—*List of stations and locality data for Foraminifera samples*

Station	USGS locality	Location	Depth (fathoms)	Type of sediment and conditions
Gulf of Alaska:				
Pamplona 3	f25949	Lat. 59°30.65′ N.; long. 142°36.40′ W.	95	Pebbly mud from trench on top of searidge.
Pamplona 4	f25950	Lat. 59°31′ N.; long. 142°35.70′ W.	85	Pebbly mud from top of searidge.
Pamplona 5	f25951	Lat. 59°32.65′ N.; long. 142°36.05′ W.	205	Mixed sand and clay with few pebbles from west slope of searidge.
Pamplona 7	f25952	Lat. 59°31.50′ N.; long. 142°35.45′ W.	100	Pebbly mud from trench on top of searidge.
Pamplona 8	f25953	Lat. 59°31.80′ N.; long. 142°35.00′ W.	133–148	Muddy sand with pebbles and cobbles from east slope of searidge.
Clarence Strait	f25954	Lat. 55°21.3′ N.; long. 131°57.5′ W.	215	Silty clay (ooze).
Kasaan Bay	f25955	Lat. 55°26′ N.; long. 132°14.2′ W.	47–57	Pebbly mud.
Excursion Inlet	f25956	West arm, 400 ft off west shore; 0.9 mile N. 60° W. of point between two arms.	25	Sandy mud; water turbid from glacial streams.
Taku Harbor	f25957	About 3,500 ft N. 42° E. of Stockade Point.	11½	Sand; strong tidal current at surface.
Lynn Canal	f25958	West shore, ±1,000 ft offshore, 2.90 miles N. 53° W. of south end of Sullivan Island.	10½	Silty clay.
Gambier Bay	f25959	Channel between Church Point and south end of island to north.	10	Coarse sand (partly inside shells of dead mollusks and brachiopods); very strong tidal currents.

Acknowledgments.—We owe our thanks to Don J. Miller, who provided us with the material that forms the basis of this report, as well as other material used for comparison. We are indebted for assistance of various kinds received from many colleagues, chiefly F. L. Parker and Erk Reimnitz of Scripps Institution of Oceanography.

DESCRIPTION OF FAUNAS

The searidge samples are the richest; 112 species were identified from the 5 samples taken in the Gulf of Alaska, whereas only 91 were identified from the 6 fjordland samples. More than one-half (56 percent) of the gulf species are known also in the fjordland. The 28 additional species in the 6 additional fjordland samples increased the total composite fauna by only 25 percent to a total of 140 species.

In the 11 samples taken together, a total of 137 species (including one subspecies) has been identified. Three more were left indeterminate. The benthonic part of this population accounts for 133 species, and the planktonic for 7.

From the entire 140 species, 85 (almost 60 percent) may be eliminated from consideration in this analysis because they constitute a quantitatively negligible part of the whole. The remaining 55 species (53 benthonic and 2 planktonic) are estimated to constitute between 90 and 100 percent of the specimens in the composite set of samples, but with no more than 18 of these 55 species constituting significant percentages of the specimens in any one sample.

Species having Arctic records are indicated by an asterisk in the distribution table (table 2). Of the total 140 species, 77 (or about 56 percent) have been recorded in Arctic regions, an additional 8 percent from Antarctic regions, and 36 percent have not been reported in the polar regions. When only the 55 quantitatively significant species are considered, not much change in these percentages is noted: 53 percent recorded from the Arctic, 5 percent from the Antarctic, and 42 percent in nonpolar regions.

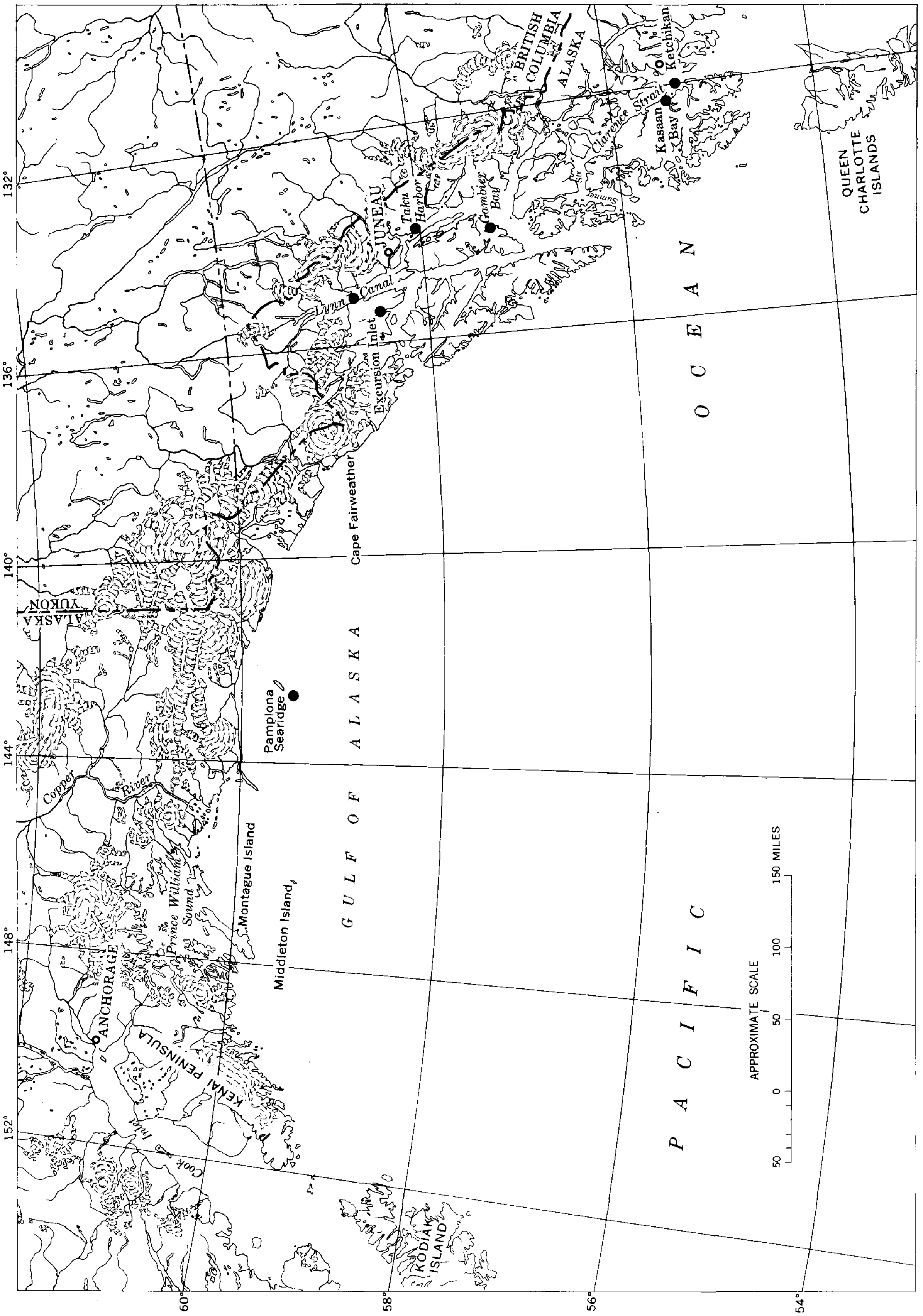

FIGURE 1.—Map of Gulf of Alaska and southeastern Alaska showing location of dredged samples (solid dots).

TABLE 2.—*Distribution and abundance of Recent Foraminifera off Alaska*

[A=abundant; C=common; R=rare; *=reported in the Arctic]

	Gulf of Alaska					Southeastern Alaska					
	Pamplona 4	Pamplona 3	Pamplona 7	Pamplona 8	Pamplona 5	Clarence Strait	Kasaan Bay	Excursion Inlet	Taku Harbor	Lynn Canal	Gambier Bay
Benthonic species											
Arenaceous families											
Astrorhizidae:											
**Rhabdammina abyssorum* M. Sars?		R									
Rhizamminidae:											
**Rhizammina indivisa* Brady	R										
Rhizammina? sp							R				
Saccamminidae:											
**Psammosphaera fusca* Schultze		R									
**Saccammina difflugiformis* (Brady)				R							
**Pelosina variabilis* Brady	R	R		R	R		R				
Hyperamminidae:											
**Hyperammina elongata* Brady?	R	R	R	C	R						
**Saccorhiza ramosa* (Brady)?					R						
**Psammatodendron arborescens* Norman	R			R						R	
Reophacidae:											
Reophax insectus Goës			R								
* *scorpiurus* Montfort	R	R	R	C	R		A	R	R	R	R
Ammodiscidae:											
**Ammodiscus arenaceus* (Williamson)	R						R				
* *gullmarensis* Höglund	R		R					R			R
Lituolidae:											
**Haplophragmoides bradyi* (Robertson)						R	R				
planissimus Cushman				R				R	C		
sphaeriloculus Cushman	R										
**Cribrostomoides crassimargo* (Norman)	R		R	R			C	R	R	C	R
* *jeffreysii* (Williamson)	R		R					R	R		R
scitulus (Brady)		R		R	R	C					
veleronis (Cushman and McCulloch)				R	R						
Recurvoides contortus Earland		R					R				R
* *turbinatus* (Brady)								R			?
Ammobaculites arenarius Natland	R	R									
**Ammotium cassis* (Parker)								R		C	
Textulariidae:											
**Spiroplectammina biformis* (Parker and Jones)								R			
Verneuilinidae:											
Gaudryina arenaria Galloway and Wissler	R	R	R				R	C	R		
Valvulinidae:											
**Eggerella advena* (Cushman)							R	C	R	C	R
Dorothia aff. *D. bradyana* Cushman	C	C	C	C							
Goesella flintii Cushman				C	C						
Goesella? sp			R								
Karreriella baccata (Schwager)	A	C	A	C	R		C				
Schenckiella primaeva (Cushman)		R	R	C	R						
Trochamminidae:											
Trochammina advena Cushman	R			R			R				
* *rotaliformis* J. Wright	R		R	R			R	R	R		R
* *squamata* Parker and Jones											R
Calcareous imperforate families											
Miliolidae:											
**Quinqueloculina agglutinata* Cushman		R								R	
akneriana d'Orbigny	C	C	R	C		A	C	C	R		R
* *arctica* Cushman								R			R
frigida Parker									R		
* *seminulum* (Linné)		R				C		R		R	R
* *stalkeri* Loeblich and Tappan						R	R	R			
* *subrotunda* (Montagu)											R
Sigmoilina distorta Phleger and Parker	R		R	R							
Triloculina rotunda d'Orbigny	R	R								R	R
Cruciloculina triangularis d'Orbigny	R	R									
Biloculinella globula (Bornemann)	R										
**Pyrgo abyssorum* (Goës)		R									
* *depressa* d'Orbigny				R		C					
* *lucernula* (Schwager)	R	C	R	R	R		R	R			
rotalaria Loeblich and Tappan						R					
**Pyrgo vespertilio* (Schlumberger)	C	C	R								
Pyrgoella sphaera (d'Orbigny)		R									

TABLE 2.—*Distribution and abundance of Recent Foraminifera off Alaska*—Continued

[A=abundant; C=common; R=rare; *=reported in the Arctic]

	Gulf of Alaska					Southeastern Alaska					
	Pamplona 4	Pamplona 3	Pamplona 7	Pamplona 8	Pamplona 5	Clarence Strait	Kassan Bay	Excursion Inlet	Taku Harbor	Lynn Canal	Gambier Bay
Benthonic species—Continued											
Calcareous imperforate families—Continued											
Ophthalmidiidae:											
**Cornuspira involvens* Reuss	R	R	----	----	----	----	R	----	----	----	----
Calcareous perforate families											
Lagenidae:											
Robulus nikobarensis (Schwager)	R	C	C	----	R	----	R	----	----	----	----
occidentalis (Cushman)	R	R	R								
strongi Church	----	----	----	----	----	----	R	----	----	----	----
Astacolus planulatus Galloway and Wissler	R	----	R	R	----	----	----	----	----	----	----
**Marginulina glabra* d'Orbigny	----	R	R	----	----	----	----	----	----	----	----
**Dentalina baggi* Galloway and Wissler	R	----	R	C	----	----	C	----	----	----	----
decepta (Bagg)	R	R	C	R	----	----	----	----	R	----	----
aff. *D. subsoluta* (Cushman)	R	----	R	----	R	----	----	----	----	----	----
Lagenonodosaria scalaris (Batsch)	R	C	R	----	----	----	----	----	R	----	----
**Pseudonodosaria radicula* (Linné)	----	----	R	R	----	----	----	----	----	----	----
Vaginulinopsis bacheii (Bailey)	R	----	R	----	----	----	----	----	----	----	----
Frondicularia gigas Church	R	R	C	----	----	----	R	----	----	----	----
**Lagena amphora* Reuss	----	----	----	R	----	R	----	----	----	----	----
* *distoma* Parker and Jones	R	R	----	----	----	R	R	----	----	----	----
* *elongata* (Ehrenberg)	R	----	R	R	----	R	----	----	----	----	----
hispidula Cushman	R	----	----	----	----	----	----	----	----	----	----
* *laevis* (Montagu)	R	R	R	----	----	----	----	----	----	----	----
* *meridionalis* Wiesner	R	----	R	----	----	----	R	----	----	----	----
pliocenica Cushman and Gray	R	R	R	----	----	----	----	----	----	----	----
* *striata* (d'Orbigny)	R	R	R	----	----	----	R	----	----	----	----
Polymorphinidae:											
Guttulina orientalis Cushman and Ozawa	----	R	R	----	----	----	----	----	----	----	----
Sigmomorphina trilocularis (Bagg)	C	C	R	----	----	----	----	R	----	----	----
Polymorphina charlottensis Cushman	R	R	R	R	----	----	C	R	----	----	----
kincaidi Cushman and Todd	R	R	R	----	----	----	----	----	----	----	----
Buliminidae:											
**Buliminella elegantissima* (d'Orbigny)	----	----	----	----	----	----	----	C	----	R	----
subfusiformis Cushman	----	----	R	R	?	R	----	----	----	----	----
**Globobulimina auriculata* (Bailey)	----	----	----	R	----	A	A	R	R	R	----
**Virgulina fusiformis* (Williamson)	----	----	----	----	----	R	----	R	----	----	----
Bolivina alata (Seguenza)	----	----	----	----	----	A	----	----	----	----	----
decussata Brady	R	R	R	R	----	R	R	R	R	----	R
oceanica Cushman	----	----	R	----	----	----	----	----	----	----	----
* *pacifica* Cushman and McCulloch	R	R	R	----	----	----	C	----	----	----	----
subaenariensis Cushman	----	----	----	----	----	R	----	----	----	----	----
Bolivina (Loxostomum) porrecta (Brady)	R	----	R	----	----	----	----	----	----	----	----
Fissurina agassizi Todd and Bronnimann	----	R	----	----	----	----	----	----	----	----	----
* *cucurbitasema* Loeblich and Tappan	----	R	----	----	----	----	----	----	----	----	----
* *lucida* (Williamson)	C	C	C	R	----	R	----	R	----	----	?
**Oolina apiopleura* (Loeblich and Tappan)	R	R	C	R	R	----	R	R	R	----	----
* *borealis* Loeblich and Tappan	R	R	R	----	----	----	----	R	----	----	----
* *hexagona* (Williamson)	----	R	R	----	----	----	----	----	----	----	----
laevigata d'Orbigny	----	R	R	----	----	----	----	----	----	----	R
* *lineatopunctata* (Heron-Allen and Earland)	----	----	R	----	----	----	----	----	----	----	----
* *melo* d'Orbigny	R	R	R	----	----	----	----	----	----	----	?
* *striatopunctata* (Parker and Jones)	R	----	R	R	----	----	----	----	----	----	----
williamsoni (Alcock)	----	R	----	----	----	----	----	----	----	----	----
**Uvigerina peregrina* Cushman	C	C	A	C	----	A	C	----	R	----	----
sp.	----	----	----	R	----	R	----	----	----	----	----
**Angulogerina fluens* Todd	C	C	R	R	----	----	C	R	R	----	R
Discorbidae:											
Rosalina ornatissima (Cushman)	----	----	----	----	----	----	R	----	----	----	C
* *wrightii* (Brady)	----	R	R	----	----	----	----	----	----	----	----
Eponides isabelleanus (d'Orbigny)	C	C	R	R	----	----	----	----	----	----	----
Rotaliidae:											
**Buccella frigida* (Cushman)	----	----	----	----	----	C	A	C	R	C	R
Rotalia columbiensis (Cushman)	----	----	----	----	----	----	----	----	----	----	A
Epistominella pacifica (Cushman)	----	----	----	R	----	C	----	----	----	----	----
vitrea Parker	----	----	R	----	----	----	R	R	R	R	----

TABLE 2.—*Distribution and abundance of Recent Foraminifera off Alaska*—Continued

[A = abundant; C = common; R = rare; * = reported in the Arctic]

	Gulf of Alaska					Southeastern Alaska					
	Pamplona 4	Pamplona 3	Pamplona 7	Pamplona 8	Pamplona 5	Clarence Strait	Kasaan Bay	Excursion Inlet	Taku Harbor	Lynn Canal	Gambier Bay
Benthonic species—Continued											
Calcaresus perforate families—Continued											
Elphidiidae:											
**Elphidium bartletti* Cushman	----	----	----	----	----	----	----	R	R	R	----
* *clavatum* Cushman	R	R	R	R	----	C	C	R	C	----	----
* *frigidum* Cushman	----	R	R	----	----	R	R	C	R	R	C
* *oregonense* Cushman and Grant	----	----	----	----	----	----	R	----	----	----	----
**Elphidiella arctica* (Parker and Jones)	----	----	----	----	----	----	R	----	----	R	----
* *groenlandica* (Cushman)	----	----	----	----	----	----	C	A	R	C	R
Anomalinidae:											
**Cibicides lobatulus* (Walker and Jacob)	C	C	C	C	R	R	A	A	C	R	A
Dyocibicides biserialis Cushman and Valentine	----	----	----	----	----	----	R	R	----	----	R
Rupertiidae:											
**Rupertia stabilis* Wallich	C	R	R	----	----	----	----	----	----	----	----
Nonionidae:											
**Florilus labradoricus* (Dawson)	R	----	R	R	----	A	C	R	----	----	----
Nonionella pulchella Hada	----	----	----	----	----	C	R	----	----	----	----
* *turgida* (Williamson)	R	R	----	----	R	R	----	----	----	----	----
turgida digitata Nøvarng	----	----	R	----	----	R	----	----	----	----	----
**Pseudononion auricula* (Heron-Allen and Earland)	R	R	R	R	----	----	C	C	R	R	R
**Astrononion gallowayi* Loeblich and Tappan	R	----	R	----	----	----	----	R	R	----	C
Cassidulinidae:											
Cassidulina californica Cushman and Hughes	A	A	A	A	C	?	A	R	R	----	C
* *islandica* Nøvarng	----	----	----	----	----	R	----	R	----	R	----
limbata Cushman and Hughes	----	R	----	----	----	----	----	A	C	----	C
* *norcrossi* Cushman	----	R	----	R	----	----	R	----	----	----	----
* *subglobosa* Brady?	R	R	R	----	----	----	----	----	----	----	----
* *teretis* Tappan	R	R	----	----	----	----	R	R	----	R	----
tortuosa Cushman and Hughes	A	A	A	R	R	----	R	----	----	----	----
Ehrenbergina compressa Cushman	C	----	R	----	----	----	----	----	----	----	----
Chilostomellidae:											
Pullenia salisburyi R. E. and K. C. Stewart	C	R	C	R	----	----	----	----	----	----	----
Aragonitic family											
Robertinidae:											
* *Robertina arctica* d'Orbigny	----	----	----	----	----	----	----	----	----	----	R
Planktonic species											
Globigerinidae:											
* *Globigerina bulloides* d'Orbigny	A	A	A	C	R	R	----	----	----	----	?
* aff. *G. eggeri* Rhumbler	----	----	R	----	----	----	----	----	----	----	----
* *pachyderma* (Ehrenberg)	C	C	C	C	C	----	R	----	----	----	----
quinqueloba Natland	----	R	----	----	----	----	----	----	----	----	----
Globigerinita glutinata (Egger)	----	R	R	R	R	----	----	----	----	----	----
* *Orbulina universa* d'Orbigny	R	R	----	----	----	R	----	----	----	----	----
Globorotaliidae:											
Globorotalia scitula (Brady)	R	R	R	----	----	----	----	----	----	----	----

ANALYSES OF SAMPLES

GULF OF ALASKA

The three shallowest Pamplona samples, taken near the top of the searidge, are the richest in the present collections: Pamplona 3, 4, and 7 contain 70, 71, and 72 species respectively. The two deepest Pamplona samples (5 and 8) contain more meager faunas, with 21 and 48 species respectively. The six fjordland samples range from 20 to 48 in number of species per sample.

The three shallowest Pamplona samples are very similar in species composition and are discussed in order of increasing depth. Pamplona 4, dredged from 85 fathoms on top of the searidge, contains a rich assemblage dominated by *Cassidulina californica* and *C. tortuosa*. Other major constitutents are *Karreriella baccata*, *Dorothia* aff. *D. bradyana*, *Quinqueloculina akneriana*, *Fissurina lucida*, *Eponides isabelleanus*, *Cibicides lobatulus*, and *Rupertia stabilis*. Pamplona 3, dredged from 95 fathoms in a trench on top of the ridge at its outer end, contains the same two dominant species. With the exception of *Rupertia stabilis* (which is rare), the major constituents are the same and occur with approximately the same abundance. In Pamplona 7, dredged from 100 fathoms in a trench atop the ridge closer to shore than the first two samples mentioned, the same two species of *Cassidulina* dominate the fauna. Other major constituents, however, are somewhat different as follows: *Karreriella baccata*, *Dorothia* aff. *D. bradyana*, *Frondicularia gigas*, *Fissurina lucida*, *Uvigerina peregrina*, and *Cibicides lobatulus*.

The two deepest Pamplona samples are noticeably different. The fauna of Pamplona 8, dredged from 133 to 148 fathoms on the east slope of the ridge, is much less rich than those from the ridgetop. *Cassidulina californica* is the single dominant species. Other species occurring with significant percentages are *Reophax scorpiurus*, *Dorothia* aff. *D. bradyana*, *Goesella flintii*, *Schenckiella primaeva*, *Quinqueloculina akneriana*, *Dentalina baggi*, *Uvigerina peregrina*, *Eponides isabelleanus*, and *Cibicides lobatulus*. Pamplona 5, dredged from 205 fathoms on the west slope of the searidge, has a still more meager fauna. Its single dominant species is *Goesella flintii*. Only two others occur with significant frequencies: *Cassidulina californica* and *Schenckiella primaeva*.

Planktonic specimens (several species of *Globigerina*) are well represented in all the Pamplona Searidge samples, but none of the samples are dominated by planktonics.

Taken as a whole, the samples from the searidge contain, mostly as rare elements, 48 species that are unknown from the samples from the fjordlands. These differences may be not so much an effect of depth as a result of the ecologic differences between the environment of a submarine ridge surrounded by the open sea and subject to storm-generated and other bottom currents, as opposed to a fjordland environment with its locally strong tidal currents, enclosed basins, proximity of the littoral zone, and inflowing of turbid glacial discharge. Some of the commoner species, characteristic of the Pamplona Searidge samples and not found in the six samples from southeastern Alaska, are as follows:

Hyperammina elongata Brady?
Cribrostomoides veleronis (Cushman and McCulloch)
Ammobaculites arenarius Natland
Dorothia aff. *D. bradyana* Cushman
Goesella flintii Cushman
Schenkiella primaeva (Cushman)
Sigmoilina distorta Phleger and Parker
Cruciloculina triangularis d'Orbigny
Pyrgo vespertilio (Schlumberger)
Robulus occidentalis (Cushman)
Astacolus planulatus Galloway and Wissler
Marginulina glabra d'Orbigny
Dentalina aff. *D. subsoluta* (Cushman)
Pseudonodosaria radicula (Linné)
Vaginulinopsis bacheii (Bailey)
Lagena laevis (Montagu)
L. pliocenica Cushman and Gray
Guttulina orientalis Cushman and Ozawa
Polymorphina kincaidi Cushman and Todd
Oolina hexagona (Williamson)
O. striatopunctata (Parker and Jones)
O. williamsoni (Alcock)
Eponides isabelleanus (d'Orbigny)
Rupertia stabilis Wallich
Ehrenbergina compressa Cushman
Pullenia salisburyi R. E. and K. C. Stewart

SOUTHEASTERN ALASKA

The faunas of the fjordland samples have little to unite them; on the other hand, each appears to be distinctive and unique in composition.

A sample dredged from 215 fathoms in Clarence Strait lacks any dominating species, but its major constituents are *Quinqueloculina akneriana*, *Bolivina alata*, *Globobulimina auriculata*, *Uvigerina peregrina*, *Florilus labradoricus*, and *Nonionella pulchella*. This is the only record for *Bolivina alata* in the present group of 11 samples examined.

A rich and varied sample from Kasaan Bay dredged between 47 and 57 fathoms also lacks any dominating species. Its major constituents are *Reophax scorpiurus*, *Quinqueloculina akneriana*, *Globobulimina auriculata*, *Uvigerina peregrina*, *Angulogerina fluens*, *Cibicides lobatulus*, *Pseudononion auricula*, and *Cassidulina californica*.

A sample dredged from 25 fathoms in Excursion Inlet is dominated by *Elphidiella groenlandica* and *Cassidulina limbata*. Other major constituents are *Gaudryina arenaria*, *Buccella frigida*, *Elphidium frigidum*, *Cibicides lobatulus*, and *Pseudononion auricula*.

In Taku Harbor, a sample dredged from about 12 fathoms is moderately rich but has no dominant species. Among the more abundant species are *Haplophragmoides planissimus*, *Cassidulina limbata*, *Elphidium clavatum*, and *Cibicides lobatulus*.

In Lynn Canal, a sample dredged from about 11 fathoms is, like that from Taku Harbor, only moderately rich and lacks any dominating species. Its most abundant species are *Ammotium cassis*, *Cribrostomoides crassimargo*, *Eggerella advena*, *Elphidiella groenlandica*, and *Buccella frigida*.

At Gambier Bay, an extremely rich sample dredged from 10 fathoms is dominated by *Rotalia columbiensis*, a species described and reported from comparable depths in British Columbia but not found in any other of our Alaska samples. Besides this dominant species, the other major constituents are *Rosalina ornatissima*, *Cassidulina californica*, *Astrononion gallowayi*, and *Cibicides lobatulus*.

COMPARISON WITH OTHER ASSEMBLAGES

Several reports on Foraminifera from Arctic regions have furnished us with some knowledge of the probable bottom assemblages typical of various depths, ecologic conditions, and geographic locations in the Arctic from the Kara Sea (Stschedrina, 1936; 1938), Novaya Zemlya and Franz Josef Land (Brady, 1881; Stschedrina, 1964a), Spitzbergen (Nagy, 1965), Barents Sea (Jarke, 1960), White Sea (Mayer, 1962), Iceland (Nørvang, 1945), Greenland (Stschedrina, 1947; 1964b; Cushman, 1948), the Canadian Arctic (Phleger, 1952), the northern coast of Alaska (Loeblich and Tappan, 1953), and Chukchi Sea (Cooper, 1964). In addition, Stschedrina (1959) in a summarization of data has briefly described seven "standard" groups of Foraminifera characteristic of seven depth zones for Arctic and North Pacific regions.

Many species from these circumpolar areas are present in our Alaska samples. Species present in our southern Alaska samples that are absent in the Arctic may be noted in table 2.

RECENT AGE

Cockbain's (1963) quantitative studies of the Foraminifera in the Straits of Georgia and Juan de Fuca in southwestern British Columbia provide a good comparison for our material from southeastern Alaska. The Foraminifera in British Columbia (represented by 86 samples) include many of the same species present in our samples from southeastern Alaska. The patchiness of distribution in the two Canadian straits is similar to what we have observed among the few samples we have. Number of species per sample ranges between 1 and 35.

The assemblage in one sample from the Strait of Juan de Fuca, namely station 135 at 30 meters (16 fathoms), approaches that of Gambier Bay. In Cockbain's station 135 (1963, table 2), *Rosalina ornatissima* constitutes 40 percent of the assemblage and the only two other species having significant percentages are *Cassidulina limbata* and *Rotalia columbiensis*. At Gambier Bay, *Rotalia columbiensis* is the dominant species, and the other two are present in significant numbers.

In a beautifully illustrated report, Saidova (1961) described and recorded, with quantitative details as to depth range and geographic distribution, the bottom faunas of Foraminifera from several areas in the western sector of the North Pacific namely from the Sea of Okhotsk and the western part of the Bering Sea and off the Kurile Islands and as far south as about 31° N., off Japan. Among the rich assemblages in her report on this large region are many species identical with and others similar to (or only subspecifically distinct from) those in our material. Where sampling coverage was fairly complete, local distribution maps were included for a few selected species (Saidova, 1961, text figs. 4, 6, 8, 9, 13, 14, and 16). Such maps present a picture of highly localized distribution that is not necessarily coincident with depth and other environmental conditions, a picture in line with what we have observed in our much smaller and less completely sampled areas in the eastern sector of the North Pacific. We may, therefore, postulate with some assurance that Foraminifera across the northern part of the Pacific are generally similar, but the bottom distribution patterns include small random areas of high abundance of various species.

Thanks to Erk Reimnitz of Scripps Institution of Oceanography, we were given the opportunity to examine mounted Foraminifera assemblages from several short gravity cores, and a snapper sample taken 10–30 miles offshore from the Copper River delta in the Gulf of Alaska, in an area some 90 miles west-northwest of Pamplona Searidge. The samples come from depths between 40 and 70 fathoms, and the species in them represent Recent faunas from the surface mud, as well as faunas from the underlying glacial marine sediment that Reimnitz interprets as Pleistocene from lithologic and other considerations.

The assemblages from the tops of some of these cores are rather meager and include *Elphidium clavatum* (small, fragile specimens), *Epistominella vitrea*, *Globobulimina auriculata*, *Buccella frigida*, *Florilus labradoricus*, *Cassidulina teretis*, *Quinqueloculina stalkeri*, *Q. seminulum*, *Pyrgo rotalaria*, *Textularia earlandi*, *Virgulina fusiformis*, and *Globigerina pachyderma*. These species are more frequent in and characteristic of our fjordland samples than of our searidge ones.

A striking change in the assemblages is noted in the older glacial marine sediment between 10 and 92 centimeters below the tops of these cores, as well as in local exposures on the continental shelf. They are richer, contain large and robust specimens, and are quite similar to those from the Pamplona Searidge samples. Major constituents in these lower core samples are *Cassidulina californica*, *C. limbata*, *C. teretis*, *Elphidium clavatum* (large, robust individuals), *Uvigerina peregrina*, *Angulogerina fluens*, and *Cibicides lobatulus*. Minor constituents typical of the searidge samples that were also present on this offshore shelf during the time represented by the lower parts of the cores are *Florilus labradoricus*, *Sigmomorphina trilocularis*, *Pullenia salisburyi*, *Lagena laevis*, *L. pliocenica*, *L. striata*, *Fissurina lucida*, *Oolina borealis*, *Bolivina decussata*, *Eponides isabelleanus*, *Globigerina pachyderma*, and *G. bulloides*. These species reinforce the affinity of the lower core samples with the Pamplona Searidge samples.

From the constrast between the assemblage in the Recent mud and the assemblage from the older glacial marine sediment, we have speculated that the latter is characteristic of a somewhat greater water depth than exists today. This can be only a speculation because the depth from which the cores were taken (40–70 fathoms) is not too shallow to support the species that are now absent; they are absent for some other reason than exclusion by shallowness of depth.

An alternative interpretation of the contrast between the assemblage of the Recent mud and that of the underlying glacial marine sediment could conceivably be the significant age difference between the Recent mud and the older glacial marine sediments. The similarity between the Pamplona Searidge assemblages and those from the lower parts of the cores, combined with their dissimilarity from the assemblages from the tops of the cores, may likewise be interpreted in two different ways. First, the similarity may be regarded as evidence that the glacial sediments underlying the Copper River delta were deposited at greater water depths than the present sediments of the delta. Or, alternatively, the similarity may be regarded as evidence that the Pamplona Searidge sediments are equivalent in age to those of the glacial sediments underlying the Copper River delta, both being of Pleistocene age. We oppose this second interpretation, namely that the similarity of assemblages between the older sediments of the Copper River delta and the Pamplona Searidge sediments is one of age rather than of ecology.

It is a basic principle in Foraminifera as in other groups of animals that ecologic contrasts are far greater than age contrasts. In other words, when faunas are either similar or dissimilar, they are much likelier to be so for ecologic reasons than for age reasons. And as a corollary, using Foraminifera as an example, even Miocene assemblages from deep-sea oozes and littoral deposits have much more in common with their respective Recent counterparts (Recent deep-sea oozes and littoral deposits) than they have in common with each other.

Comparison was made with the Foraminifera in a series of Recent samples from marine till, rhythmically interbedded sediment, and terrace deposits of glacial origin in the northern part of southeastern Alaska (from near Juneau out to Cape Fairweather on the coast of the Gulf of Alaska); these sediments are elevated above sea level, some as much as 500 feet. The assemblages in these unconsolidated deposits, although much less rich than the present six bottom samples from the fjordland of southeastern Alaska, have much in common with them.

In all these elevated deposits, *Elphidium clavatum* is strongly dominant. This species, although occurring rarely on the searidge and rarely to commonly in four of the fjordland samples, is not found as a dominant species in any of our samples. Occurring with this dominating species, *Elphidium clavatum*, the following additional species comprise most of the remainder of the fauna from these unconsolidated sediments:

Buccella frigida (Cushman)
Cassidulina islandica Nørvang
C. teretis Tappan
Elphidium bartletti Cushman
E. frigidum Cushman
Florilus labradoricus (Dawson)
Pseudononion auricula (Heron-Allen and Earland)
Pyrgo lucernula (Schwager)
Quinqueloculina akneriana d'Orbigny
Q. stalkeri Loeblich and Tappan
Virgulina fusiformis (Williamson)

All these species are known from our fjordland samples and half of them occur on the searidge (table 2), but no major species characteristic of the searidge occur in the elevated Recent glacial deposits.

In a reconnaissance study of Foraminifera in a series of bottom samples dredged on the shallow shelf bordering the eastern part of the northern coast of Siberia, namely from the Chukchi Sea through the East Siberian Sea to the Laptev Sea, an impoverished fauna of Foraminifera was identified (Todd and Low, 1966) consisting chiefly of species of *Elphidium* and various arenaceous genera. Although poor in species, as well as in specimens, nearly half of the composite assemblage found in this shelf traverse occur also in the southeastern Alaska fjordland, and a few additional ones are found also in our samples from Pamplona Searidge. The chief species in common between the fjordland and the shallow shelf along the Arctic Ocean are:

Ammotium cassis (Parker)
Buccella frigida (Cushman)
Cassidulina islandica Nørvang
C. teretis Tappan
Cibicides lobatulus (Walker and Jacob)
Eggerella advena (Cushman)
Elphidium clavatum (Cushman)
Pseudononion auricula (Heron-Allen and Earland)
Reophax scorpiurus Montfort

All these species are widely known both in the Arctic and elsewhere.

Comparison with a distant group of cold-water samples, namely some from off the coast of Chile received from Dr. Fritz Theyer of the Instituto Central de Biologia of the Universidad de Concepción, provided some striking similarities as well as some contrasts. Nine rich samples taken by the Expedición Mar Chile I between lat 31° and 42°56′ S. and long 72°38′ and 74°30′ W. and at depths between 60 and 260 meters (about 33–145 fathoms) contained mostly species completely unrelated to anything in our Alaska collections, such as species of *Cyclammina*, *Textularia*, *Hoeglundina*, and *Valvulineria*. The following species present in our Alaska samples are, however, also present off Chile:

Angulogerina fluens Todd
Cassidulina californica Cushman and Hughes
Cibicides lobatulus (Walker and Jacob)
Ehrenbergina compressa Cushman
Globobulimina auriculata (Bailey)
Goesella flintii Cushman
Reophax scorpiurus Montfort
Schenckiella primaeva (Cushman)
Uvigerina peregrina Cushman

These and other Chilean samples are in process of study by Drs. Fritz Theyer and Esteban Boltovskoy, hence will not be discussed here other than to say that they give evidence of the extensive geographic distribution of cold-water species in both the Northern and Southern Hemispheres.

PLEISTOCENE OR PLIOCENE AGE

There are three reported fossil occurrences with which our Recent assemblages may be compared.

Cushman (1941) reported and illustrated the occurrence of 18 species in the Submarine Beach deposit about a mile N. 60° W. of Nome, Alaska. Specimens of *Elphidiella* appear to be the dominating forms. Reexamination of the total assemblage indicates that there is very little similarity between it and any of our present assemblages. In terms of the currently used taxonomy, only three species—*Elphidium bartletti* Cushman, *Elphidiella groenlandica* (Cushman), and *Buccella frigida* (Cushman)—are found both at Nome and in our fjordland samples.

Cushman and Todd (1947) described and illustrated an assemblage of Foraminifera from a quarry on Amchitka Island in the Aleutian chain. The assemblage, interpreted as Pleistocene or Pliocene in age, was much richer than that at Nome and shows considerable resemblance to our present assemblages. Of the 51 species reported from Amchitka, 19 are the same as ours: 5 in the searidge samples only, 4 in the fjordland samples only, and 10 in both.

In 1953, Miller (1953, table 6) recorded a list of Foraminifera identified by A. R. Loeblich, Jr., from seven samples representing more than 3,000 feet of section exposed around the coast of Middleton Island in the Gulf of Alaska. Middleton Island is a small low island well out in the Gulf of Alaska, at about lat 59°25′ N. and long 146°20′ W., that surmounts a rise near the margin of the continental shelf. It is thus only about 130 miles west of Pamplona Searidge.

The original interpretation of age based on fossils (Miller, 1953, p. 31) favored a Pleistocene age but did "not preclude either a Pliocene age or a Recent age." Miller (1953, p. 32) thought, however, that the degree of induration and the regional setting possibly favored Pliocene rather then Pleistocene. F. S. MacNeil, in an unpublished study based on marine mollusks (written commun. August 12, 1963), recognized two well-defined pecten zones at Middleton Island and dated the lower part of the section as late Pliocene or early Pleistocene and the upper part as "late early or middle Pleistocene, probably pre-Yarmouth."

Reexamination of the Foraminifera from the seven samples (mentioned above) taken from the Middleton Island section shows a poorly preserved fauna having some close similarities to the fauna now present on the searidge. In all but one sample near the middle of the section, the assemblages are dominated by *Cassidulina californica* and *C. limbata* and (or) *C. tortuosa*. Poor preservation makes precise determination difficult; hence the distinction between *C. limbata* and *C. tortuosa*, both of which have angled peripheries, is not clear. In the one excepted sample, near the middle of the section, *Elphidiella arctica* is dominant. This species was not found on the searidge but only in two of our fjordland samples, where it occurred rarely.

AGE OF PAMPLONA SEARIDGE SAMPLES

Although the samples obtained from Pamplona Searidge came from the surface of the sea bottom, there are several reasons for believing they are not strictly Recent. By their manner of collection—dredging—the samples undoubtedly include a mixture of modern and older sediments. Their position, where currents may have tended to sweep clean the top and sides of an undersea ridge, suggests the likelihood that the sediments are not contemporary. Their lithology—mud, clay, or sand with an admixture of pebbles and cobbles—is evidence of current winnowing on the top and sides of the searidge. In an open-sea environment, a strictly Recent deposit would not include pebbles and cobbles. The poor state of preservation of some but not all the specimens, such as worn and fragmentary specimens and opacity of normally translucent tests, likewise is suggestive that the fauna consists of a mixture of contemporary and ancient specimens.

In spite of this circumstantial evidence of age, we noted no species that we believe to be extinct. There is one clue, however, which may be interpreted either as supporting evidence of a pre-Recent age or as evidence of admixture of older specimens into the assemblage: namely the coiling ratio of *Globigerina pachyderma*.

Use of coiling ratios of *Globigerina pachyderma* has been proposed by Bandy (1960) to permit refinement of age determinations in the late Cenozoic of southern California. There the modern population is dextral, going back about 11,000 years. Coiling-ratio provinces are very imperfectly known and are apparently local and probably fluctuating. In California, specimens in the upper Pleistocene and the middle Pliocene are consistently sinistral, while those in the upper and lower Pliocene are dominantly dextral. An identical alternation of coiling ratios is not to be expected to extend as far north as the Gulf of Alaska where coiling ratio of the modern population is 97–100 percent sinistral for *Globigerina pachyderma*.

While the coiling ratio of living specimens of the species in the North Pacific is almost exclusively sinistral, our specimens of *Globigerina pachyderma* are only about 65 percent sinistral.

Upon reexamination of an older record of *G. pachyderma* in the North Pacific, we find that there the coiling is 100 percent dextral; this reported occurrence by Cushman and Todd (1947) was from Amchitka Island in the Aleutians and was interpreted as Pleistocene or Pliocene.

Patsy Smith (written commun., Jan. 24, 1966) has provided us with information on the coiling ratios of *Globigerina pachyderma* in four samples of the Middleton Island section. In MacNeil's upper zone, interpreted as late early or middle Pleistocene, in two samples where *Globigerina pachyderma* is common to abundant, the coiling ratios are 46 and 16 percent sinistral. In MacNeil's lower zone, interpreted as late Pliocene or early Pleistocene, the coiling ratios are 80 and 44 percent sinistral.

We therefore conclude that the admixture of fossil specimens of *Globigerina pachyderma* having lower sinistral ratios is responsible for the lowering of the sinistral ratio from the nearly 100 percent, which is typical of Recent *G. pachyderma* in the Gulf of Alaska, to the observed 65 percent in the Pamplona samples.

A possible Pleistocene-Recent boundary in the Gulf of Alaska was proposed by Smith (1963) on the basis of some changes of the benthonic assemblages of Foraminifera in three deep-sea cores. These cores were taken from the continental shelf southwest of Kodiak Island at depths of 117, 146, and 240 meters (about 65–130 fathoms), depths comparable with those of the Pamplona Searidge samples. In these cores Smith noted a change from boreal faunas in the upper parts to arctic faunas in the lower parts and adopted the transition between these two faunas as possibly the Pleistocene-Recent boundary.

In one of the cores showing the boundary between boreal and arctic assemblages, the Foraminifera in 12 samples are quantitatively recorded from three samples above the boundary and nine below. Out of a total of 60 benthonic species recorded, 44 are rare and (or) of negligible significance in connection with the boundary, leaving 16 common to abundant in one or both parts of the core. Of these, one is distributed more or less equally throughout the core, seven are restricted to the upper part (but three of these cross the boundary), and eight are restricted to the lower part (but one of these crosses the boundary).

Of the eight taxa that characterize the lower part of the core, Smith (1963, p. C77) has taken the five that are also characteristic of the Recent faunas around Point Barrow as diagnostic of the Pleistocene in the Gulf of Alaska. Whether the sediment from the lower parts of these cores was or was not deposited before the end of the Pleistocene can probably not be proved or disproved on the basis of evidence presented by Smith. Nevertheless, it seems most unlikely that the disappearance of the three species and a subspecies, plus a questionably identified species listed by Smith (1963, p. C77) as characteristic of her Pleistocene core section, can be accepted as diagnostic of Pleistocene elsewhere because they are all (except the questionably identified one) well known and widely distributed in the Recent.

Taking into consideration the probability of different specific names being assigned to the same species by different authors, we have found all but two of the taxa named by Smith (1963, p. C77) as characterizing the upper (boreal and Recent) fauna and the lower (arctic and Pleistocene) one in the cores to be present in our material.

The whole question of a Pleistocene-Recent boundary remains vague, especially in high latitude regions that approach the location of present-day continental or piedmont glaciers. All one can say of the faunal boundary in the cores on the continental shelf is that it is evidence of a climatic change which might be Pleistocene. But to utilize any of these arctic species as evidence of mixing of Pleistocene with Recent or to base Pleistocene correlations on species characteristic of the fauna below the boundary seems premature.

CONCLUSIONS

Depth zonations of Foraminifera are undoubtedly a result of a combination of many factors other than water depth alone, and probably some of these other factors exert more influence than depth in some localities. It is not to be expected that Foraminifera characteristic of a coastal environment, near sea level, would necessarily be identical with or even similar to those from an identical depth surrounded by open-sea conditions. As a result of comparison of the dredge samples from Pamplona Searidge with the fjordland samples, as well as with other assemblages of Foraminifera already reported from comparable regions and comparable ecologic conditions, we have failed to find any positive evidence that the ridge was formerly at a higher elevation nearer sea level. The Foraminifera, however, show nothing that would rule out such an interpretation.

In connection with the speculation that Pamplona Searidge may be the foundered remnant of "Pamplona Rock," it is of interest to note the results of some surveys made after the Alaskan earthquake of March 27, 1964. Data pertaining to tilting and vertical movement of the sea floor around Montague Island, only 180 miles west of the searidge, are discussed by Malloy (1965). Abrupt and large-scale changes of elevation of the sea floor along sea floor scarps are illustrated (Malloy, 1965, figs. 1, 6, 7, 8, 9). It is a curious coincidence that the northeast alinements of Pamplona Searidge, Middleton Island, and Montague Island are approximately parallel and that the highest elevations are at the southwest ends of these features (Miller, 1953, fig. 2; Malloy, 1965, p. 23).

Evidence in the form of raised terraces on the islands and along the coast of the Gulf of Alaska, however, indicates general emergence rather than subsidence of the shelf.

SYSTEMATIC DESCRIPTIONS

ARENACEOUS FAMILIES

Family ASTRORHIZIDAE

Genus RHABDAMMINA M. Sars, 1869

Rhabdammina abyssorum M. Sars?

Plate 1, figure 1

Two short broken fragments of large arenaceous tubes were found at Pamplona 3; they appear closely related to *Rhabdammina abyssorum* M. Sars (Brady, 1884, p. 266, pl. 21, figs. 1–8, 10–13). One has an outside diameter of 1.0 mm, the other an outside diameter of 1.3 mm. Sand grains composing the test reach a maximum diameter of about 0.5 mm; consequently the surface is rough.

These tubular fragments may be broken-off pieces of a single-chambered form with radiating arms, but this possibility cannot be verified, as no evidence of the enlarged central part has been observed in our material. The possibility of these being worm tubes seems unlikely but cannot be ruled out.

Family RHIZAMMINIDAE

Genus RHIZAMMINA Brady, 1879

Rhizammina indivisa Brady

Plate 1, figure 2

Rhizammina indivisa Brady, 1884, *Challenger* Rept., Zoology. v. 9, p. 277, pl. 29, figs. 5–7.

A single typical specimen was found at Pamplona 4. The test is flexible when moistened. The membranous tube is collapsed, with the plane of flattening different in various parts of the test. Sand grains and sponge spicules are attached to the membranous lining apparently without order.

Rhizammina? sp.

Plate 1, figure 3

In the Kasaan Bay sample dredged from 47 to 57 fathoms, a species represented by broken tubular sections was found. The agglutinated tubular sections are 0.5–0.6 mm in diameter and distinctive in being very thin walled and flexible. The inner surface is smooth and appears to be lined chiefly by sponge spicules arranged transverse to the length of the tube. The outer surface is very rough and composed of sand grains, sponge spicules, and tests of other Foraminifera. Invariably when a sand grain has one dimension longer than another, the grain is oriented with that longer dimension transverse to the length of the tube. As a result, the test appears as if it were transversely crinkled. Because of its property of flexibility and ability to spring back when pressed with a needle, the test is assumed to have a chitinous cement.

The generic assignment is questioned because among our specimens, all of which are fragmentary, there is no evidence of a branching, tapering, or curved shape. Otherwise, particularly in the flexibility of the test, the specimens appear to belong in the Rhizamminidae.

Family SACCAMMINIDAE

Genus PSAMMOSPHAERA Schulze, 1875

Psammosphaera fusca Schulze

Plate 1, figure 4

Psammosphaera fusca Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 249, pl. 18, figs. 1, 5–7.

A single specimen, about 2.6 mm in diameter, was found at Pamplona 3. It is built of coarse sand grains (individual grains as much as 1.3 mm in length) and a few broken sponge spicules. It is cemented with ferruginous cement and rather smoothly finished. The small irregular aperture exists as an unfilled crevice between sand grains. The wall is rigid and appears to be thin and only one sand grain thick.

Genus SACCAMMINA M. Sars, 1869

Saccammina difflugiformis (Brady)

Plate 1, figure 5

Reophax difflugiformis Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 289, pl. 30, figs. 1–5.

Saccammina difflugiformis (Brady). Todd and Bronnimann, 1957, Cushman Found. Foram. Research Spec. Pub. 3, p. 22, pl. 1, fig. 15.

One specimen was found at Pamplona 8. It is neatly constructed of a single layer of coarse and angular sand grains. The large size of the grains results in a highly irregular surface both inside and out, although smoothly finished.

In this species, construction of the test varies with the nature of the sea bottom, as was pointed out and illustrated by Brady (1884, p. 290, contrast figs. 3, 4, and 5). He noted that "especially in the northern habitats where the species is most plentiful, the test is constructed of coarse sand and has a very rough exterior, as shown in figure 5." Our specimen is comparable to Brady's figure 5 but is nearly twice as large.

Relation between size and construction of test is strikingly shown by the contrast between this specimen from Alaskan waters and those recorded from off Trinidad in the Gulf of Paria. Even a single sand grain in the Alaska specimen is larger than the entire test of the Trinidad ones. Yet, they are believed to be substantially the same: an agglutinated single-chambered test with one end drawn out into a tubelike aperture.

Genus PELOSINA Brady, 1879

Pelosina variabilis Brady

Plate 1, figure 7

Pelosina variabilis Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 235, pl. 26, figs. 7–9.

Typical specimens were found in Pamplona samples 3, 4, 5, and 8 and at Kasaan Bay. The shapes are variable; most are elongate and baglike, and most specimens are collapsed. The thick wall of compacted mud is usually cracked and crumbling.

This species is characteristic of deep and cold water.

Family HYPERAMMINIDAE

Genus HYPERAMMINA Brady, 1878

Hyperammina elongata Brady?

Plate 1, figures 11, 12

Although we have found fairly common specimens in all the searidge samples, none shows the bulbous initial end. For this reason the identification must remain questionable. Observable features which do support placement of the specimens in the genus *Hyperammina* are (a) rigidity of the test, (b) smooth surface of interior of the tubes, (c) rough exterior surface, and (d) presence of faint transverse constrictions. Specimens are somewhat larger in diameter than typical specimens of *Hyperammina elongata* Brady (1884, p. 257, pl. 23, figs. 4, 7, 8), approaching the diameter of *H. friabilis* Brady (1884, p. 258, pl. 23, figs. 1–3, 5, 6). They do not, however, have the friable outer surface characteristic of that species.

Genus SACCORHIZA Eimer and Fickert, 1899

Saccorhiza ramosa (Brady)?

Plate 1, figure 9

Two broken fragments from Pamplona 5 indicate the presence of a species consisting of a slender thin-walled arenaceous tube about 0.5 mm in diameter composed of a mixture of sand grains and small broken pieces of sponge spicules. The surface of the tube is decorated by longer, more complete spicules incorporated in the wall so that one end protrudes out at a slight angle, and the free protruding ends of the spicules are alined approximately with the length of the tube and all extending toward one end. The tubes are slightly tapering and slightly curved. As no evidence of branching was observed, the species can be only questionably placed in *Saccorhiza ramosa* (Brady, 1884, p. 261, pl. 23, figs. 15–19).

Genus PSAMMATODENDRON Norman, 1881

Psammatodendron arborescens Norman

Plate 1, figure 6

Hyperammina arborescens, Norman, sp. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 262, pl. 28, figs. 12, 13.

Rare but typical fragments of this species were found in Lynn Canal and Pamplona 4 and 8. The tubes are only 0.15 mm in diameter and are smooth surfaced and brown. The one illustrated extends into three instead of the customary two branches.

Although originally named by Norman (see Brady, 1881, p. 404), the species was not illustrated until the publication of the *Challenger* Report. At that time, Brady (1884) placed it in the genus *Hyperammina*, stating he found "no characters not already provided for in the definition of the genus *Hyperammina*." The generic distinctions now maintained for the genus *Psammatodendron* are its branching growth habit and its attachment by a bulbous proloculum.

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

Reophax insectus Goës

Plate 1, figure 8

Reophax insectus Goës, 1896, Harvard Coll., Mus. Comp. Zoology Bull., v. 29, p. 28, pl. 3, figs. 6, 7.
Cushman, 1910, U.S. Natl. Mus. Bull. 71, pt. 1, p. 89, text fig. 124.

This large species was found only at Pamplona 7. Although the wall is built of a mixture of fine to coarse sand grains, the size and shape of the test conform to that described for *Reophax insectus*, which was originally reported from off Mexico and near the Galapagos Islands, between 772 and 995 fathoms. It was also found at 617–680 fathoms off San Diego.

Our specimens measure between 3.5 and 6 mm (incomplete lengths), and maximum observed diameter of the final chamber is about 2 mm. Sand grains up to 1 mm in length are used in the construction of the tests, but the matrix consists of very fine sand and the surface is smoothly finished and in some specimens slightly polished in appearance.

Reophax scorpiurus Montfort

Plate 1, figures 13, 14

Reophax scorpiurus Montfort, 1808, Conchyliologie systématique, v. 1, p. 330–331.

This well-known and cosmopolitan species occurs in all but one of our samples and is common to abundant at Pamplona 8 and Kasaan Bay.

Most of the specimens used sand grains averaging 0.3 mm in length and included grains as long as 0.8 mm. As a result of the very large size of grains relative to the size of the chambers, the complete tests are very irregularly shaped, some appearing merely as rough agglomerations of angular sand grains.

A few specimens from Taku Harbor were built of finer grains (averaging 0.06 mm in diameter) but otherwise seem identical.

Family AMMODISCIDAE

Genus AMMODISCUS Reuss, 1861

Ammodiscus arenaceus (Williamson)

Plate 2, figure 12

Spirillina arenacea Williamson, 1858, Recent Foram. Great Britain, Ray Soc., p. 93, pl. 7, fig. 203.
Ammodiscus incertus (d'Orbigny). Cushman, 1918, U.S. Natl. Mus. Bull. 104, pt. 1, p. 95, pl. 39, figs. 1–8.

This widely recorded species has long been known under the name of *Ammodiscus incertus* (d'Orbigny). That name, however, was shown (Loeblich and Tappan, 1954, p. 308) to be not available for the coiled arenaceous tubes to which it had been given because the species *incertus* (originally placed in *Operculina*) was in reality a species of *Cornuspira*. The form described from Recent material around the British Isles, although smaller than usual for this species, seems to be the same as that formerly known as *Ammodiscus incertus*.

A few typical specimens were found at Pamplona 4 and at Kasaan Bay.

Ammodiscus gullmarensis Höglund

Plate 2, figure 9

Ammodiscus planus Höglund, 1947 (not Loeblich, 1946), Zool. Bidrag från Uppsala, v. 26, p. 123, pl. 8, figs. 2, 3, 8; pl. 28, figs. 17, 18; text figs. 85–89, 105, 106, 109.
Ammodiscus gullmarensis Höglund, 1948, Cushman Lab. Foram. Research Contr., v. 24, p. 45.
Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 83, pl. 13, figs. 8, 9.

Rare specimens of this minute species were found at four of our localities. The other records include Gullmar Fjord, Sweden, at 24–79 meters, and many stations in the Canadian and Greenland Arctic.

Family LITUOLIDAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides bradyi (Robertson)

Haplophragmoides bradyi (Robertson). Höglund, 1947, Zool. Bidrag från Uppsala, v. 26, p. 134, pl. 10, fig. 1; text fig. 111.
Haplophragmoides neobradyi Uchio, 1960, Cushman Found. Foram. Research Spec. Pub. 5, p. 51, pl. 1, figs. 15, 16.

This species, small for the genus, is distinguished by its incompletely involute coiling and its very smooth polished wall. It has been widely recorded on both sides of the Atlantic, in the Antarctic, and off San Diego, Calif.

Two single specimens were found at Kasaan Bay and Clarence Strait.

Haplophragmoides planissimus Cushman

Plate 1, figure 27

Haplophragmoides planissima Cushman, 1927, Scripps Inst. Oceanography Bull., Tech. ser., v. 1, no. 10, p. 135, pl. 1, fig. 6.

Typical specimens of this strongly compressed and coarsely arenaceous species were rather common in Excursion Inlet and Taku Harbor, and a single specimen was found at Pamplona 8. Previous records of this species indicate that it is found along the southern California coast, off Costa Rica, southern Brazil, and off southern British Columbia and the San Juan Islands of Washington.

Haplophragmoides sphaeriloculus Cushman

Plate 1, figure 20

Haplophragmoides sphaeriloculum Cushman, 1910, U.S. Natl. Mus. Bull. 71, pt. 1, p. 107, text fig. 165.

Two specimens from Pamplona 4 appear to belong in this species. The chambers are globular but laterally compressed; the periphery is lobulate, the sutures are radial and depressed, the umbilicus is depressed, and the final whorl is composed of four chambers with part of a fifth one showing.

Previous records of this species indicate it is found in the Pacific, Atlantic, and Antarctic.

Genus CRIBROSTOMOIDES Cushman, 1910

This name is used for those species that differ from *Haplophragmoides* in having an interio-areal aperture and from *Alveolophragmium* in having a simple instead of an alveolar wall.

Cribrostomoides crassimargo (Norman)

Plate 1, figure 24

Labrospira crassimargo (Norman). Höglund, 1947, Zool. Bidrag från Uppsala, v. 26, p. 141, pl. 11, fig. 1; text figs. 121–125.

Alveolophragmium crassimargo (Norman). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 29, pl. 3, figs. 1–3.

This species has been reported from cold waters of both the Arctic and Antarctic as well as elsewhere. We found typical specimens in most of our samples.

Specimens are typically, but not invariably, orange. The test is deeply umbilicate and the sutures incised, resulting in a faintly lobulate periphery. The wall is simple and built mostly of fine material but has a few very large grains incorporated in, and sometimes projecting outward from, the smoothly finished wall. Superficially, *Cribrostomoides crassimargo* is indistinguishable from *Alveolophragmium orbiculatum* Stschedrina from the Japan Sea, but it is easily separable when the test is broken revealing the alveolar wall of the latter species.

Cribrostomoides jeffreysii (Williamson)

Plate 1, figure 21

Nonionina jeffreysii Williamson, 1858, Recent Foram. Great Britain, Ray Soc., p. 34, pl. 3, figs. 72, 73.

Labrospira jeffreysi (Williamson). Höglund, 1947, Zool. Bidrag från Uppsala, v. 26, p. 146, pl. 11, fig. 3; text figs. 128, 129 on p. 139.

Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 401, pl. 2, figs. 15, 17–20.

Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 85, pl. 13, figs. 14, 15.

Alveolophragmium jeffreysi (Williamson). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 31, pl. 3, figs. 4–7.

Haplophragmoides columbiensis Cushman. Cushman and McCulloch, 1939 (not Cushman, 1925), Allan Hancock Pacific Exped., v. 6, no. 1, p. 72, pl. 5, figs. 8–10.

Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 11, pl. 2, fig. 1.

Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 4, pl. 1, fig 6.

Parker, 1948, Harvard Coll., Mus. Comp. Zoology Bull., v. 100, no. 2, p. 238, pl. 4, fig. 17.

This beautiful species was found rarely in several of our samples. It is characterized by its compressed test that is umbilicate and incompletely involute, by its thin and smoothly finished wall, and by its dowward-protruding, siphunclelike aperture.

As indicated in the above synonymy, the species is widely distributed in cold water of Sweden and the British Isles, North Atlantic and Arctic Oceans, and along the Pacific coast of North America.

Cribrostomoides scitulus (Brady)

Plate 1, figure 19

Haplophragmium scitulum Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 308, pl. 34, figs. 11–13.

Haplophragmoides scitulus (Brady). Earland, 1934, *Discovery* Repts., v. 10, p. 88, pl. 10, figs. 20, 21.

Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., v. 6, no. 1, p. 78, pl. 6, fig. 4.

Alveolophragmium scitulum (H. B. Brady). Parker, 1954, Harvard Coll., Mus. Comp. Zoology Bull., v. 111, no. 10, p. 487, pl. 1, figs. 20, 21.

Rare specimens of this widely distributed cold-water species were found in four of our samples. It is a compact close-coiled form, nearly as thick as broad, and has small and usually deep umbilici. The chambers are not inflated, and the wall is smoothly finished. The interio-areal aperture is surrounded by a sharp rim.

Cribrostomoides veleronis (Cushman and McCulloch)

Plate 1, figure 22

Haplophragmoides veleronis Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., v. 6, no. 1, p. 82, pl. 7, fig. 2.

Alveolophragmium veleronis (Cushman and McCulloch). Uchio, 1960, Cushman Found. Foram. Research Spec. Pub. 5, pl. 2, fig. 1.

We found only four specimens on the searidge of this distinctive species that has previously been known from off Guadalupe Island, Mexico, and off San Diego.

It resembles *Cribrostomoides scitulus* in shape and texture of wall but differs in that umbilici are broad and deep, as a result of the coiling being not completely involute. The inner edges of the chambers overhang the umbilici. Moreover, the chambers increase more in breadth than in height as added, thus giving the impression that the test is flattened around the periphery.

Genus RECURVOIDES Earland, 1934

Recurvoides contortus Earland

Plate 1, figure 29

Recurvoides contortus Earland, 1934, *Discovery* Repts., v. 10, p. 91, pl. 10, figs. 7–19; 1936, idem, v. 13, p. 35, pl. 1, figs. 20–22.

This species was found only rarely in three of our samples. It was described from the Antarctic but, as pointed out by Earland, has been reported from other areas under other names and is probably widely distributed in cold or deep waters.

It is characterized by the smooth umbilical bulge on one side, a result of the change of axis of coiling. Our specimens have a fine-grained and smoothly finished, almost glossy, surface. The interio-areal aperture surrounded by a projecting rim is well shown. *Recurvoides contortus*, as represented by a topotype in the U.S. National Museum collection (USNM 640980) is distinguishable from *R. turbinatus* (Brady), a species that has been widely recorded in the Arctic, by its larger and proportionally flatter test.

Recurvoides turbinatus (Brady)

Plate 1, figure 23

Haplophragmium turbinatum Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 312, pl. 35 fig. 9.
Recurvoides turbinatus (Brady). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 27, pl. 2, fig. 11.

A few typical specimens were found in our samples from Excursion Inlet. The species is characterized by its streptospiral coiling resulting in a test involute on one side and evolute on the other. The elongate areal aperture is set at an angle on the periphery. The chambers are not inflated but are somewhat irregular in shape, and the whole test appears deformed.

The species probably has a wide distribution, mostly in cold waters.

Genus AMMOBACULITES Cushman, 1910

Ammobaculites arenarius Natland

Plate 1, figure 26

Ammobaculites arenaria Natland, 1938, Scripps Inst. Oceanography Bull. Tech., ser., v. 4, no. 5, p. 139, pl. 3, figs. 7, 8.

Typical specimens occur rarely in two of the samples from Pamplona Searidge. This species was described from off California and reported to occur commonly in the San Pedro Channel, within the depth interval of 243–610 meters (or about 133–333 fathoms).

Genus AMMOTIUM Loeblich and Tappan, 1953

Ammotium cassis (Parker)

Plate 1, figure 25

Ammotium cassis (Parker). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 33, pl. 2, figs. 12–18.

This widley distributed Arctic and cold-water species occurs rather commonly in our samples from Excursion Inlet and Lynn Canal but was not found on the searidge. So far as we know, it is not known from the Antarctic.

Family TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

Spiroplectammina biformis (Parker and Jones)

Plate 2, figures 4, 5

Spiroplectammina biformis (Parker and Jones). Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 30, pl. 3, figs. 7, 8.

This small finely arenaceous species was found only in the Excursion Inlet sample. It has been widely recorded from cold waters in both Northern and Southern Hemispheres.

Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina arenaria Galloway and Wissler

Plate 1, figure 28; plate 2, figure 3

Gaudryina arenaria Galloway and Wissler. Cushman and McCulloch, 1939, Allan Hancock, Pacific Exped., v. 6, no. 1, p. 91, pl. 8, figs. 2, 3.

This species, which is widely known in the Pliocene, Pleistocene, and Recent along the western coast of North America and in Japan, is found commonly or rarely in six of our samples from both the searidge and fjordland. In most of our specimens the wall is composed of finer material than in the type.

Occurring together with the typically angular specimens of this species are a few smoothly rounded ones. As there appears to be gradation between these two extremes, they are regarded as variants. An example of each is illustrated.

Family VALVULINIDAE

Genus EGGERELLA Cushman, 1933

Eggerella advena (Cushman)

Plate 2, figure 8

Eggerella advena (Cushman). Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 32, pl. 3, fig. 12.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 36, pl. 3, figs. 8–10.

Eggerella advena was common to rare in the five shallowest samples (depths from 10 to 57 fathoms). As noted in previous records, the finely arenaceous tests are reddish orange to white, some being dark in the early part and light colored in the final chamber. It is characteristic of cold waters although it has been found as far south as Baja California.

Genus DOROTHIA Plummer, 1931

Dorothia aff. D. bradyana Cushman

Plate 2, figures 1, 2

Test large for the genus, only slightly wider than thick, tapering from the bluntly pointed initial end to the greatest diameter at the flaring and concave apertural end, biserial stage constituting the greatest part of the test, periphery lobulate; chambers distinct, inflated, lower than wide; sutures distinct, incised, straight; wall finely arenaceous, smoothly finished, usually roughened by the addition of a few coarse grains over the earliest chambers; aperture small and low, in the middle of the concave apertural end, at the base of the final chamber. Length 1.0–1.6 mm; thickness 0.65–0.90 mm.

This species may ultimately prove to be new. However, for the present it is regarded as a close relative of *Dorothia bradyana* Cushman (1937, p. 99, pl. 11, fig. 6) which was described from 450 fathoms, off Sombrero Island, east of Puerto Rico.

The present species, occurring commonly in four searidge samples, differs from types of *Dorothia bradyana* in that the chambers are much lower and more bulging between the incised sutures. Also, the Pamplona specimens are more nearly circular than those from the West Indies.

Genus GOESELLA Cushman, 1933

Goesella flintii Cushman

Plate 2, figures 6, 7, 13, 21

Goesella flintii Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 118, pl. 13, figs. 17–19.

Test irregular in shape with uniserial stage poorly developed and not represented in many specimens, tapering from the bluntly pointed initial end to the greatest diameter at the bulging apertural end; chambers distinct, inflated; sutures distinct, depressed; wall arenaceous, composed mostly of fine material having scattered angular sand grains incorporated in it, smoothly finished on the exterior, thick and vacuolar on the interior but not vacuolar in all parts of the wall; aperture simple, large, terminal (or arched at the final suture if the uniserial stage is lacking), the chamber wall infolded around the opening. Length 1.0–1.6 mm; diameter 0.7–0.9 mm.

The presence of a vacuolar wall within this genus was noted in the type species, *Goesella rotundata* (Cushman, 1937, p. 117), but had not previously been noted in *G. flintii*. Examination of the type and paratypes of *G. flintii* reveals the existence of a vacuolar wall in them. In most specimens the vacuoles are present only around the central part of the test and not around the initial and apertural ends. But there are exceptions, and some specimens seem to have a simple wall without vacuoles in any part of it. Thus, we must conclude that presence or absence of a vacuolar wall is not of fundamental significance.

We have illustrated specimens of both kinds; in some the exterior is enough eroded so that the vacuoles appear as coarse pores through the wall (pl. 2, fig. 21); in others a break in the wall permits us to observe that the wall is thin and solid and not thick and vacuolar (pl. 2, fig. 13); in still others breaking away of the final chamber or chambers (giving a transverse view of the wall) reveals the existence of radial partitions in the wall.

Goesella flintii was originally described from 185 fathoms, off San Pedro, Calif., and has been recorded from elsewhere off the California coast. In our material it was found only at two searidge localities, where it occurred commonly.

Goesella? sp.

Plate 1, figure 15

Three specimens from Pamplona 7 seem to belong in this genus and to be undescribed. The multiserial stage is short in comparison with the uniserial stage. The final chambers are distinct, being separated by incised sutures, and the aperture is small and depressed in the center of the final chamber.

Genus KARRERIELLA Cushman, 1933

Karreriella baccata (Schwager)

Plate 2, figure 10

Karreriella baccata (Schwager). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 133, pl. 15, figs. 20–24; pl. 16, fig. 1.

This well-known species is present in considerable numbers in the five Pamplona samples and at Kasaan Bay.

The neat and smooth-surfaced construction, narrow lipped aperture situated wholly within the final chamber, and the rapid increase in thickness, as well as in width, all serve to characterize this species.

Two Pliocene varieties, *japonica* (Asano, 1938, p. 90, pl. 10, fig. 1) and *alaskensis* (Cushman and Todd, 1947, p. 61, pl. 14, figs. 10, 11), were set up on the basis of minor variable features, such as shape of test and coarseness of wall; they seem undeserving of separate recognition. Examples of both these kinds of variable specimens may be found among the Pamplona specimens.

Karreriella baccata was originally described from the Pliocene of Kar Nicobar and has been widely reported from deposits of late Tertiary age around the Pacific.

Genus SCHENCKIELLA Thalmann, 1942

Schenckiella primaeva (Cushman)

Plate 1, fig. 10

Clavulina primaeva Cushman, 1913, U.S. Natl. Mus. Proc., v. 44, p. 635, pl. 80, figs. 4, 5.

Listerella primaeva (Cushman). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 8, p. 153, pl. 17, figs. 24–28.

This striking species was described from off Borneo in 476 fathoms and has been found at various other deep-water localities, particularly around the Philippine Islands.

It is characterized by its slender, evenly cylindrical test and its distinct but nonindented sutures. The suture pattern results in the appearance of annular rings in the uniserial part of the test but breaks down into an irregular pattern over the biserial and multiserial stages toward the slightly pointed initial end of the test.

Specimens were found commonly only at Pamplona 8 but occurred rarely at Pamplona 3, 5 and 7.

Family TROCHAMMINIDAE

Genus TROCHAMMINA Parker and Jones, 1860

Trochammina advena Cushman

Plate 1, figure 16

Trochammina advena Cushman, 1922, Carnegie Inst. Washington, Pub. 311, p. 20, pl. 1, figs. 2–4.

This small species was first described from the Dry Tortugas and has been widely reported from various localities in both the North Atlantic and South Atlantic.

It is characterized by its thick and compact test composed of 4 or 4½ chambers in the final whorl and by its deep ventral umbilicus.

Typical specimens occur rarely at Pamplona 4 and 8 and at Kasaan Bay.

Trochammina rotaliformis J. Wright

Plate 1, figure 18

Trochammina rotaliformis J. Wright. Cushman, 1920, U.S. Natl. Mus. Bull. 104, pt. 2, p. 77, pl. 16, figs. 1, 2.

Cushman and Parker, 1931, U.S. Natl. Mus. Proc., v. 80, art. 3, p. 6, pl. 2, fig. 5.

Cushman and McCulloch, 1939, Allan Hancock Pacific Exped., v. 6, no. 1, p. 107, pl. 12, fig. 2.

Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 42, pl. 4, fig. 16.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 51, pl. 8, figs. 6–9.

Detling, 1958, Cushman Lab. Foram. Research Contr., v. 9, p. 26, pl. 7, fig. 12.

Todd and Low, 1961, Cushman Found. Foram. Research Contr., v. 12, p. 16, pl. 1, fig. 17.

This species is low spired and flattened and tends to be irregular in outline and in shape of chambers. Four or five uninflated chambers make up the final whorl. The wall is smoothly finished.

The species has been widely recorded, occurring from tidal habitats to moderately deep water, in both the Atlantic and Pacific, and typical specimens were found in several of our samples.

Trochammina squamata Parker and Jones

Plate 1, figure 17

Trochammina squamata Parker and Jones. Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 10, p. 460, pl. 3, fig. 4.

A single specimen from Gambier Bay is entirely typical of this small, scalelike species that was originally described from the Hunde Islands, off western Greenland. Our specimen measures 0.2 mm in diameter and contains seven chambers in the final whorl. The ventral umbilicus is small and deep. The species probably has a wide distribution in the Atlantic and Pacific although, from the illustrations, some of the specimens referred to it belong in other species. The reference included in the synonymy, from Long Island Sound, shows the clearest and best illustration of the species.

CALCAREOUS IMPERFORATE FAMILIES

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina agglutinata Cushman

Plate 2, figure 16

Quinqueloculina agglutinata Cushman, 1917, U.S. Natl. Mus. Bull. 71, pt. 6, p. 43, pl. 9, fig. 2.

Single specimens from Pamplona 3 and Lynn Canal are similar to the types of this species that was originally reported to have come from "off Alaska." These specimens have a sandy wall, and the chambers are rather angular in section. The apertural tooth is short with two broad wings. Length 0.75 mm, breadth 0.50 mm.

Quinqueloculina akneriana d'Orbigny

Plate 2, figure 22

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

This species, originally described from the Miocene of the Vienna Basin, is found abundantly to commonly in six of our samples and rarely in several more. It is distinguished by its comparatively large triangular test, which is broadest in the middle and tapering toward both ends, and its highly polished wall.

Quinqueloculina arctica Cushman

Plate 2, figure 28

Quinqueloculina arctica Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 35, pl. 4, fig. 2.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 40, pl. 5, figs. 11, 12.

Rare but typical specimens were found at Excursion Inlet and Gambier Bay.

Quinqueloculina frigida Parker

Plate 2, figure 23

Quinqueloculina frigida Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 406, pl. 3, fig. 20.

This species, described from a depth of 37 meters (±20 fathoms), off Portsmouth, N. H., is well represented in our material from Taku Harbor. It is characterized by its fairly large size and coarsely arenaceous but smoothly finished wall. It can be distinguished from *Quinqueloculina agglutinata* by its rounded, not angular, periphery and consequently flatter test.

Quinqueloculina seminulum (Linné)

Plate 2, figure 19

Quinqueloculina seminula (Linné). Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 406, pl. 3, figs. 21, 22; pl. 4, figs. 1, 2; 1952, idem, v. 106, no. 10, p. 456, pl. 2, fig. 7.

This species has been very widely reported, both fossil and Recent. The references above illustrate it from off New Hampshire and in Long Island Sound in its most typical forms.

In general, *Q. seminulum* differs from *Q. akneriana* in being more rounded instead of triangular in section and in being of nearly equal breadth throughout instead of tapering toward both ends.

Quinqueloculina stalkeri Loeblich and Tappan

Plate 2, figure 17

Quinqueloculina stalkeri Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 40, pl. 5, figs. 5–9.

This species was described from a depth of 12.8 meters (7 fathoms) off northeast Greenland and is also reported from shallow water off Point Barrow, Alaska. It is characterized by its finely arenaceous and somewhat roughened wall. Its aperture is circular and is surrounded by a slightly thickened rim within which there is a very low and inconspicuous apertural tooth. The chambers are rounded in cross section, and the sutures are therefore distinctly depressed. The whole test is rather slender and of even width throughout. A few specimens were found in three fjordland samples.

Quinqueloculina subrotunda (Montagu)

Plate 2, figure 15

Quinqueloculina subrotunda (Montagu). Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 406, pl. 4, fig. 4 .
Jarke, 1960, Internat. Rev. Gesamten Hydrobiologie, v. 45, no. 4, pl. 4, fig. 2.
Quinqueloculina disciformis (Macgillivray). Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 15, pl. 2, figs. 17, 18.

A few typical specimens of this flattened, circular, glossy species were found at Gambier Bay.

Genus SIGMOILINA Schlumberger, 1887

Sigmoilina distorta Phleger and Parker

Plate 2, figure 18

Sigmoilina distorta Phleger and Parker, 1951, Geol. Soc. America Mem. 46, pt. 2, p. 8, pl. 4, figs. 3–5.
Parker, 1954, Harvard Coll., Mus. Comp. Zoology Bull., v. 111, no. 10, p. 499, pl. 4, figs. 17, 21; 1958, Swedish Deep-Sea Exped. Repts., v. 8, Sediment Cores, no. 4, p. 256, pl. 1, fig. 25.
Andersen, 1961, Louisiana Geol. Survey, Geol. Bull. 35, pt. 2, p. 34, pl. 7, fig. 8.

A few specimens found in three Pamplona samples are referred to this species, which was described from the Gulf of Mexico and also reported in the Mediterranean.

It is a small species (about 0.35 mm long), is flat, and tapering toward both ends, and has a glassy surface on which the sutures are only faintly defined.

Genus TRILOCULINA d'Orbigny, 1826

Triloculina rotunda d'Orbigny

Plate 2, figure 30

Triloculina rotunda d'Orbigny, 1826, Annales sci. nat., v. 7, p. 299.
Schlumberger, 1893, Soc. zool. France Mém., v. 6, p. 206, pl. 1, figs. 48–50; text figs. 11, 12.
Fornasini, 1902, Accad. sci. ist. Bologna Mem., ser. 5, v. 10, p. 22, fig. 12.
Cushman and Wickenden, 1929, U.S. Natl. Mus. Proc., v. 75, art. 9, p. 3, pl. 2, fig. 2.
Le Calvez and Le Calvez, 1958, Inst. océanog. Annales, nouv. sér., v. 35, pt. 3, p. 192, pl. 6, figs. 57, 58.

Rare typical specimens of this widely reported species were found on the searidge and in the fjordland area. They attain a rather large size, up to 1.5 mm.

Genus CRUCILOCULINA d'Orbigny, 1839

Cruciloculina triangularis d'Orbigny

Plate 2, figure 27

Cruciloculina triangularis d' Orbigny, 1839, Voyage dans l'Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 72, pl. 9, figs. 11, 12.

Loeblich and Tappan, 1957, U.S. Natl. Mus. Bull. 215, p. 234, pl. 74, figs. 1, 2.

Three typical specimens were found on Pamplona Searidge. With the exception of its cruciform aperture, the species appears to be identical with *Triloculina tricarinata* d'Orbigny.

Genus BILOCULINELLA Wiesner, 1931

Biloculinella globula (Bornemann)

Plate 2, figure 14

Biloculina globulus Bornemann, 1855, Deutsche geol. Gesell. Zeitschr., v. 7, p. 349, pl. 19, fig. 3.

Biloculinella globula (Bornemann). Le Calvez and Le Calvez, 1958, Inst. océanog., Annales, nouv. sér., v. 35, pt. 3, p. 201, pl. 7, fig. 76.

Boltovskoy, 1959, Argentina Servício Hidrografía Naval Pub. H1005, p. 57, pl. 6, fig. 11.

A single typical specimen was found at Pamplona 4.

This species described from the Oligocene of Germany, seems to be widely distributed, both as a fossil and in Recent seas. The test is globular and smoothly rounded and has a valvelike tooth nearly filling the aperture.

Genus PYRGO Defrance, 1824

Pyrgo abyssorum (Goës)

Plate 2, figure 25

Biloculina abyssorum Goës, 1894, Kgl. Svenska Vetenskapsakad. Handlingar, v. 25, no. 9, p. 118, pl. 23, figs. 888, 889.

A single specimen, about 1.5 mm in greater diameter, was found with specimens of *Pyrgo vespertilio* at Pamplona 3. It differs from *P. vespertilio* in the nature of the aperture which in this species is nearly completely closed by a platelike tooth, leaving only a narrow curved opening between the tooth and the wall of the final chamber. In *P. vespertilio*, on the other hand, the aperture is an elongate opening, only partly filled by a broad and bifid tooth, thus leaving a moderately wide opening between the tooth and the wall of the final chamber. *P. abyssorum* was described from deep water (500-2,000 meters, that is, about 273–1,093 fathoms) in the Arctic and around Spitzbergen. Similar large species of *Pyrgo* have been reported from the Antarctic and off Tasmania (Parr, 1950), where one, *P. subglobulus* Parr (1950, p. 298, pl. 7, fig. 10), possesses the same kind of aperture that is blocked by a plate that nearly closes it.

Pyrgo depressa d'Orbigny

Plate 2, figure 26

Biloculina depressa d'Orbigny, 1826, Annales sci. nat., v. 7, p. 298, no. 7; Modèles 91.

Parker, Jones, and Brady, 1865, Annals Mag. Nat. History, ser. 3, v. 16, p. 33, pl. 1, fig. 4; 1871, idem, ser. 4, v. 8, p. 247, pl. 8, fig. 5.

Schlumberger, 1891, Soc. zool. France Mém., v. 4, p. 160, pl. 9, figs. 48, 49; text figs. 1–5.

Pyrgo depressa (d'Orbigny). Asano, 1956, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 27, p. 76, pl. 9, fig. 4.

This large and strongly compressed species occurs in Clarence Strait in association with *P. rotalaria.*

Although *P. depressa* has been interpreted (Cushman, 1929, p. 71, pl. 19, figs. 4, 5) as possessing a straight, narrow, linear aperture situated in the plane of (not to one side of) the periphery, we choose to accept the interpretation given the species by d'Orbigny's model and by Parker, Jones, and Brady (references above) and by others, namely that it is a strongly compressed species with an elongate, narrow aperture situated slightly to one side of (but not within) the peripheral plane. Moreover, in our specimens the apertural opening is not merely a linear slit but has enlargements at each end. Also, among our specimens the smaller (presumably immature) specimens are elongate oval rather than circular in section.

The compressed specimens of *Pyrgo*, found commonly around the British Isles, that have a linear slit opening in the plane of the periphery probably should be identified with the species called "*Biloculina ringens* (Lamarck) var. *carinata* d'Orbigny" by Williamson (1858, p. 79, pl. 7, figs. 172–174). But "*B. ringens carinata* (d'Orbigny)" of Williamson is not the same as *Pyrgo carinata* (d'Orbigny) in which the aperture is enlarged at both ends as is typical of most species in the genus.

Pyrgo lucernula (Schwager)

Plate 2, figure 29

Biloculina lucernula Schwager, 1866, *Novara* Exped., Geol. Theil. v. 2, p. 202, pl. 4, figs. 14, 17.

Pyrgo lucernula (Schwager). Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 340, pl. 85, fig. 24.

This species is well represented in our material by typical and fairly common specimens in the Pamplona samples and two fjordland samples. It is characterized by its circular and protruding apertural neck. From a closely similar species, *Pyrgo murrhina* (Schwager), it is distinguished by its outline being slightly elongate rather than circular and by having a rounded rather than sharp periphery.

Described from Kar Nicobar, this species is widely reported in the present-day oceans.

Pyrgo rotalaria Loeblich and Tappan

Plate 2, figure 31

Pyrgo rotalaria Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 47, pl. 6, figs. 5, 6.

This species, described from deep water off southeastern Alaska, is found in Clarence Strait. Although it was reported to have a nearly circular aperture, reexamination of the holotype and paratypes shows the aperture to range from nearly circular to three or four times as long as wide. In all our specimens from Clarence Strait the aperture is elongate, but otherwise the specimens seem identical to the types in being nearly circular in outline, evenly bulging on both sides, and sharply keeled around the periphery.

Pyrgo vespertilio (Schlumberger)

Plate 2, figure 24

Biloculina vespertilio Schlumberger, 1891, Soc. Zool. France, Mém. v. 4, p. 174, pl. 10, figs. 74–76; text figs. 20–22.

Pyrgo vespertilio (Schlumberger). Andersen, 1961, Louisiana Geol. Survey Geol. Bull. 35, pt. 2, p. 40, pl. 8, fig. 5.

This large species is characteristic of the Arctic and Antarctic but is not restricted to those areas. It was described from the Gulf of Gascony and also reported from the Gulf of Mexico. It is well represented at Pamplona 3, 4, and 7.

Genus PYRGOELLA Cushman and White, 1936

Pyrgoella sphaera (d'Orbigny)

Plate 2, figure 20

Biloculina sphaera d'Orbigny, 1839, Voyage dans l'Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 66, pl. 8, figs. 13–16.

Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 141, pl. 2, fig. 4.

Goës, 1894, Kgl. Svenska Vetenskapsakad. Handlingar, v. 25, no. 9, p. 120, pl. 25, fig. 927.

Flint, 1899, U.S. Natl. Mus., Ann. Rept. for 1897, p. 295, pl. 41, fig. 2.

Pyrgoella sphaera (d'Orbigny). Le Calvez and Le Calvez, 1958, Inst. océanog. Annales, nouv. sér., v. 35, pt. 3, p. 198, pl. 7, fig. 72.

Parker, 1958, Swedish Deep-Sea Exped. Repts., v. 8, Sediment Cores, no. 4, p. 256, pl. 1, fig. 14.

Todd, 1958, Swedish Deep-Sea Exped. Repts., v. 8, Sediment Cores, no. 3, p. 188, pl. 1, fig. 4.

Andersen, 1961, Louisana Geol. Survey, Geol. Bull. 35, pt. 2, p. 42, pl. 9, figs. 7, 8.

A single immature specimen was found at Pamplona 3. The species is widely distributed in deep and moderately deep waters.

Family OPHTHALMIDIIDAE

Genus CORNUSPIRA Schultze, 1854

Cornuspira involvens (Reuss)

Plate 2, figure 11

Cornuspira involvens (Reuss). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 49, pl. 7, figs. 4, 5.

Single specimens were found in three of our samples, Pamplona 3 and 4 and Kasaan Bay. Compared with *Cornuspira planorbis* Schultze, this species is larger and more compressed, has more whorls, and the transverse growth lines or wrinkles on the wall tend to be more distinct. It appears to live deeper than *C. planorbis*.

CALCAREOUS PERFORATE FAMILIES

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

Robulus nikobarensis (Schwager)

Plate 3, figures 2, 3

Cristellaria nikobarensis Schwager, 1866, *Novara* Exped., Geol. Theil, v. 2, p. 243, pl. 6, fig. 87.

Robulus cushmani Galloway and Wissler, 1927, Jour. Paleontology, v. 1, p. 51, pl. 8, fig. 11.

This species, described from the Miocene of Kar Nicobar, is distinguished by a rather large central umbo to which the curved sutures are tangent. Eight or nine chambers make up the final whorl, and the periphery is surrounded by a keel, sharp and glassy in small specimens, limbate in large specimens. Specimens named *Robulus cushmani*, from the Pleistocene of Timms Point, Calif., appear to belong in this species, differing only in their maximum dimension, which is 1.5 mm for *R. nikobarensis* and 2.5 mm for *R. cushmani*.

Specimens occur in our material at Pamplona 3, 4, 5 and 7 and Kasaan Bay. Most of the specimens are more than 3 mm in greater diameter, a few are only about 1 mm. Most are heavy walled and opaque and look well worn. In some of the larger heavy-walled specimens, the central umbo is slightly raised and irregularly pitted. The few smaller ones are translucent and appear fresh. Examples of both kinds are illustrated.

Robulus occidentalis (Cushman)

Plate 3, figure 1

Cristellaria occidentalis Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 102, pl. 25, fig. 2; pl. 26, figs. 1, 2.

Robulus occidentalis (Cushman). Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 20, pl .3, fig. 1.

Ruscelli, 1949, Ist. Geol. Paleont, e Geogr. Fisica, Univ. Milano, ser. P, no. 62, p. 13 (list), pl. 2, fig. 7.

This large and variable species is represented by common specimens at three Pamplona stations. Described from off the northeastern coast of the United States, *Robulus occidentalis* has an angled but not keeled periphery, about 10 chambers making up the final whorl, a concave apertural face and protruding aperture, and in some specimens a tendency to uncoil.

Robulus strongi Church

Plate 3, figure 4

Robulus strongi Church, 1929, Jour. Paleontology, v. 3, p. 305, text fig. 3.
Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 295, pl. 37, figs. 1, 2.

This species, described from 30 to 40 fathoms, off Santa Catalina Island, Calif., is found rarely at Kasaan Bay. It is flattened, large (about 4 mm in greater dimension), and is surrounded by a broad glassy keel.

Robulus strongi has previously been recorded from along the coast of southern California and southward to Peru.

Genus ASTACOLUS Montfort, 1808

Astacolus planulatus Galloway and Wissler

Plate 3, figure 5

Astacolus planulatus Galloway and Wissler, 1927, Jour. Paleontology, v. 1, p. 46, pl. 8, fig. 5.
Planularia planulata (Galloway and Wissler). Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 303, pl. 40, figs. 1–5.

The rare specimens obtained from the searidge samples fit the original description well, being most distinctive in their flattened elongation and almost parallel sides and edges.

Cushman and McCulloch recorded the species in the Pacific from a depth range of 10–160 fathoms, with an average depth of 51 fathoms. Our specimens came from depths of 85–148 fathoms on the searidge. The species was described from beds of Pleistocene age in California and has been recorded by Asano (1951b, p. 12, fig. 61) from the Pliocene to Recent in Japan.

Genus MARGINULINA d'Orbigny, 1826

Marginulina glabra d'Orbigny

Plate 3, figures 8, 9

Marginulina glabra d'Orbigny, 1826, Annales sci. nat., v. 7, p. 259, Modèles 55.
Cushman, 1913, U.S. Natl. Mus. Bull. 71, pt. 3, p. 79, pl. 23, fig. 3.

This species was found to be rare in two of the searidge samples, some specimens occurring as short stout forms (pl. 3, fig. 9) and others as more elongate forms up to 4 mm in length (pl. 3, fig. 8). It was described from the Pliocene of Italy, and although it has been recorded from beds as old as Jurassic, we doubt it occurs in sediments any older than Miocene in age.

Recorded occurrences in the Recent are widespread and indicate it to be a deep-water species. Our specimens are from 95–100 fathoms.

Genus DENTALINA d'Orbigny, 1826

Dentalina baggi Galloway and Wissler

Plate 3, figures 10, 11

Dentalina baggi Galloway and Wissler, 1927, Jour. Paleontology, v. 1, p. 49, pl. 8, figs. 14, 15.
Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 313, pl. 41, figs. 13, 14.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 54, pl. 9, figs. 10–15.

Dentalina baggi was described from beds of Pleistocene age in California; its fossil record is no older than Pliocene with all occurrences being on the west coast of North America. Its Recent occurrences have been restricted to the eastern side of the Pacific Ocean and to the Arctic.

It has a distinctively large test with a bulbous initial chamber which exceeds the immediately succeeding chambers in size. Some specimens have a slight spine on the initial chamber (pl. 3, fig. 11), a fact not considered here to be of specific importance.

Cushman and McCulloch gave a depth range of 19–212 fathoms for their material. Our specimens were most common at Pamplona 8 (133–148 fathoms) and in Kasaan Bay (47–57 fathoms).

Dentalina decepta (Bagg)

Plate 3, figure 6

Nodosaria decepta Bagg, 1912, U.S. Geol. Survey Bull. 513, p. 55, pl. 16, fig. 1.
Dentalina decepta (Bagg). Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6. no. 6, p. 311, pl. 41, figs. 11, 12.

Longitudinal costae over the early part of the test distinguish this large species of *Dentalina* from others in the fauna. The largest complete specimen is about 7.5 mm long. In addition to the several complete forms obtained, there were many distinguishable fragments of broken tests in our material.

It was described from beds of Pleistocene age in California and has been recorded from the Pliocene to Recent of Japan (Asano, 1951b, p. 23, figs. 103, 104). The depth range given for the material discussed by Cushman and McCulloch was 16–267 fathoms. Most of our specimens are from the searidge.

Dentalina aff. D. subsoluta (Cushman)

Plate 3, figure 7

Rare specimens from three of the searidge samples are tentatively placed in this slender arcuate species that was described from off the coast of Brazil (Cushman, 1923, p. 74, pl. 13, fig. 1). They may, however, be only a slender variant of *Dentalina baggi* Galloway and Wissler, being distinguished from that species by more bulbous chambers and more deeply constricted sutures.

Genus LAGENONODOSARIA Silvestri, 1900

Lagenonodosaria scalaris (Batsch)

Plate 3, figure 39

Nodosaria scalaris Batsch, sp. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 510, pl. 63, figs. 23–31.

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

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

The specimens, mostly from Pamplona Searidge, do not exceed four chambers in length, and much of the material consists of single detached or immature chambers. They appear identical to Brady's figures and to the *Albatross* material studied by Cushman.

Brady's recorded depth was 95 fathoms and Cushman's was 24–890 fathoms with an average of 274 fathoms. The depths of our samples are 85–100 fathoms, with one occurrence at about 12 fathoms.

By regarding *Lagenonodosaria* as a megalospheric form and *Amphicoryne* as a microspheric form, *Lagenonodosaria* may be included as a synonym of *Amphicoryne* Schlumberger, 1881. But for convenience in referring to the present specimens among which no *Amphicoryne*-forms were observed, we will maintain the two as separate genera.

Genus PSEUDONODOSARIA Boomgaart, 1949

Pseudonodosaria radicula (Linné)

Plate 3, figure 12

Nodosaria radicula Linné. Parker and Jones, 1865, Royal Soc. [London] Philos. Trans., v. 155, p. 341, pl. 13, figs. 2–7.

Brady, 1884, *Challenger* Rept. Zoology, v. 9, p. 495, pl. 61, figs. 28–31.

Cushman, 1921, U.S. Natl. Mus. Bull. 100, v. 4, p. 190, pl. 34, fig. 4.

A few specimens from Pamplona 7 and 8 are referred to this species that has been reported widely in cold and deep waters.

Our largest specimen is 2.4 mm long, and the diameter of the final chamber is about 0.6 mm in all of the individuals. The species is characterized by inflated and nonembracing chambers and constricted sutures.

Genus VAGINULINOPSIS Silvestri, 1904

Vaginulinopsis bacheii (Bailey)

Marginulina bacheii Bailey, 1851, Smithsonian Contr., v. 2, p. 10, pl., figs. 2–6.

Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 129, pl. 36, figs. 7–9.

Parker, 1948, Harvard Coll., Mus. Comp. Zoology Bull, v. 100, p. 239 (list), pl. 3, fig. 1.

Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 309, pl. 40, fig. 12.

A few large, robust, well-worn and stained individuals were found at Pamplona 4 and 7. Most are about 3 mm in length (but one is 6 mm long), 0.7–0.9 mm in breadth, and about 0.65 mm in thickness. They have smooth surfaces and the sutures are indistinct, neither thickened nor raised. The radiate aperture is slightly protruding. The initial end shows an incipient coil, and the tests are compressed throughout.

Marginulina bacheii was described from off New York and has been reported in both the Atlantic and the Pacific. Because of its compression, it is transferred to *Vaginulinopsis*. The present specimens, although showing considerable variation, fall within the probable limits of this species.

Genus FRONDICULARIA Defrance, 1824

Frondicularia gigas Church

Plate 3, figure 33

Frondicularia gigas Church, 1929, Jour. Paleontology, v. 3, p. 303, text figs. 1, 2.

Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 327, pl. 43, figs. 1–4.

Typical specimens of this large species occur in Pamplona 3, 4 and 7 and Kasaan Bay. Our specimens attain a length of more than 5 mm. They have only a simple spine at the initial end, not a cluster of spines as on the types. The species has previously been reported only off California.

Genus LAGENA Walker and Jacob, 1798

Lagena amphora Reuss

Lagena amphora Reuss, 1862, Akad. Wiss. Wien Sitzungsber., v. 46, pt. 1, p. 330, pl. 4, fig. 57.

Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 329, pl. 43, figs. 11–14.

Single specimens from Pamplona 8 and Clarence Strait seem to belong in this species that was first described from the Oligocene of Germany. It has also been reported from along the western coasts of North and South America.

This species is distinguished by its high platelike costae and slender, tapering apertural neck.

Lagena distoma Parker and Jones

Plate 3, figure 18

Lagena distoma Parker and Jones *in* Brady, 1864, Linnean Soc. London Trans., v. 24, p. 467, pl. 48, fig. 6.
Flint, 1899, U.S. Natl. Mus., Ann. Rept. for 1897, p. 306, pl. 53, fig. 5.

This rare but widely represented species was found in four of our samples. It is a minute and fragile species, 0.10–0.13 mm in diameter, with a transparent wall on which the faint costae stand out as light lines. Both apical and apertural ends are drawn out into hair-size tubes, and, in many specimens, these slender extensions are broken off.

Lagena elongata (Ehrenberg)

Plate 3, figure 22

Lagena elongata Ehrenberg, sp. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 457, pl. 56, fig. 29.
Flint, 1899, U.S. Natl. Mus., Ann. Rept. for 1897, p. 306, pl. 53, fig. 1.
Hada, 1931, Tohoku Imp. Univ. Sci. Rept., ser. 4, Biology, v. 6. p. 104, text fig. 59.
Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6. p. 338, pl. 44, fig. 14.
Lagena gracillima Seguenza, sp. Brady (part), 1884, *Challenger* Rept., Zoology, v. 9, p. 456, pl. 56, figs. 27, 28 (not figs. 19–26).

This species is similar in shape to *Lagena distoma* but is larger and unornamented. The species consists of a simple tube of even diameter (not bulging at its mid point as does *Lagena gracillima*) that is drawn out toward both ends into tubes of smaller diameter. There is a thickened lip around the apertural opening, and the basal tube is usually broken off. Diameter of the main body of the test is 0.15–0.19 mm.

This cosmopolitan species is found in both warm and cold waters, and there are reported occurrences in the Arctic and Antarctic.

Lagena hispidula Cushman

Lagena hispidula Cushman, 1913, U.S. Natl. Mus. Bull. 71, pt. 3, p. 14, pl. 5, figs. 2, 3.

A single typical specimen was found at Pamplona 4. The species was described from several deep-water stations in various parts of the North Pacific, the shallowest at 518 fathoms. The species has also been reported from many other Recent localities—several in the Antarctic—and from a few fossil localities.

Lagena laevis (Montagu)

Plate 3, figure 17

Vermiculum laeve Montagu, 1803, Testacea Britannica, p. 524.
Lagena laevis Williamson, 1848, Annals Mag. Nat. History, ser. 2, v. 1, p. 12, pl. 1, figs. 1, 2.
Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 455, pl. 56, figs. 7–14, 30.
Flint, 1899, U.S. Natl. Mus., Ann. Rept. for 1897, p. 306, pl. 53, fig. 6.
Hada, 1931, Tohoku Imp. Univ. Sci. Rept., ser. 4, Biology, v. 6, p. 102, text fig. 56.
Cushman, 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 19, pl. 4, fig. 5.
Cushman and Gray, 1946, Cushman Lab. Foram. Research Spec. Pub. 19, p. 18, pl. 3, figs. 21–23.
Dorsey, 1948, Maryland Dept. Geology, Mines and Water Resources Bull. 2, p. 289, pl. 31, figs. 9, 10.
Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 47, pl. 5, fig. 11.
Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 341, pl. 45, figs. 14–16.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 51, pl. 11, figs. 5–8.
Lagena vulgaris Williamson, 1858, Recent Foram. Great Britain, Ray Soc., p. 3, pl. 1, fig. 5.

This well-known and widely reported species has a simple but highly variable shape and size. Our specimens are rather uniform, consist of a teardrop chamber about 0.28 mm in diameter and about 0.40 mm in length, have a slender neck, and are translucent in appearance.

Lagena laevis is found in three searidge samples, and there are several specimens at each locality.

Lagena meridionalis Wiesner

Plate 3, figure 21

Lagena gracilis var. *meridionalis* Wiesner, 1931, Deutsche Südpolar-Exped., v. 20, Zoologie, p. 117, pl. 18, fig. 211.
Lagena meridionalis Wiesner. Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 62, pl. 12, fig. 1.
Lagena gracilis Williamson. Brady (part), 1884, *Challenger* Rept., Zoology, v. 9, p. 464, pl. 58, fig. 19 (not figs. 2, 3, 7–10, 22–24).

This minute costate species is distinguished by its ornamentation in which short and long costae alternate. As a result, the main body of the test is covered by fine, sharp costae, and each alternate costa disappears toward the bluntly tapering base of the test and the more sharply tapering apertural end of the test.

Lagena meridionalis is similar to *L. amphora*. They are both costate but differ in that the costae of *L. meridionalis* are finer, lower, and more numerous, and do not extend onto the neck, whereas those of *L. amphora* are high, platelike, and do extend completely onto the apertural neck.

L. meridionalis was described from a depth of 385 meters (about 210 fathoms) in the Antarctic and has also been reported from the Arctic. It was found rarely at Pamplona 4 and 7 and at Kasaan Bay.

Lagena pliocenica Cushman and Gray

Plate 3, figure 19

Lagena pliocenica Cushman and Gray, 1946, Cushman Lab. Foram. Research Spec. Pub. 19, p. 19, pl. 3, figs. 39–42.

This species, known from the Pliocene to Recent along the west coast of North America and in Japan, is represented in our material by rare individuals from the searidge.

The species appears to be variable in shape. Our specimens are more globular than the types which tend to have a flattened base. Ornamentation consists of about 12 heavy but short costae surrounding a central smooth area at the base of the test and of several faint costae spiralling along the length of the apertural neck. *Lagena crenata* Parker and Jones (1865, p. 420, pl. 18, fig. 4) is somewhat similar in having basal costae, but the costae are more numerous and the test is more conical than globular in shape. *L. pliocenica* is rather like a specimen of *L. laevis* with the addition of ornamentation.

Lagena striata (d'Orbigny)

Plate 3, figure 20

Oolina striata d'Orbigny, 1839, Voyage dans l'Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 21, pl. 5, fig. 12.

Lagena striata (d'Orbigny). Heron-Allen and Earland, 1932, *Discovery* Repts., v. 4, p. 366, pl. 10, figs. 10–12.

Boltovskoy, 1954, Inst. Nac. Inv. Cienc. Nat., Mus. Argentino, Cienc. Nat. * * * Rev., v. 3, no. 3, p. 151, pl. 6, figs. 2, 3.

Asano, 1956, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 27, p. 32, pl. 5, figs. 28, 29.

Jarke, 1960, Internat. Rev. Gesamten Hydrobiologie, v. 45, pt. 4, pl. 5, fig. 2.

Andersen, 1961, Louisiana Geol. Survey, Geol. Bull. 35, pt. 2, p. 78, pl. 16, fig. 15.

Our specimens, occurring rarely on the searidge and at Kasaan Bay, are typical of this species as described from off the Falklands. It has been widely reported from both cold and warm waters, and specimens show great variability in shape and strength of costae. Our specimens, however, are quite uniform. They are 0.20–0.25 mm in diameter; the slender neck arises abruptly from the body of the test; the costae are very fine, delicate, evenly spaced, and there are more than 50 around the circumference of the test. The neck is also ornamented by a few oblique costae spiralling around it.

Family POLYMORPHINIDAE

Genus GUTTULINA d'Orbigny, 1839

Guttulina cf. G. orientalis Cushman and Ozawa

Five large poorly preserved specimens from depths of about 100 fathoms on the searidge compare closely with *Guttulina orientalis* Cushman and Ozawa (1928, p. 15, pl. 2, fig. 1), described from upper Pliocene sediments in Japan. The species has also been reported (Cushman and Ozawa, 1930, p. 24, pl. 3, figs. 2, 3) from dredgings of Recent sediments off Japan at depths of 100 and 114 fathoms. The present specimens are between 1.6 and 2 mm in length and appear worn and stained. Perforations of the wall, such as result from fistulose outgrowths on polymorphinids, are present near the apertural end. Opaqueness of the surface obscures the exact chamber arrangement.

Genus SIGMOMORPHINA Cushman and Ozawa, 1928

Sigmomorphina trilocularis (Bagg)

Plate 3, figures 15, 16

Polymorphina trilocularis Bagg, 1912, U.S. Geol. Survey Bull. 513, p. 75, pl. 22, figs. 15–18.

Sigmomorphina trilocularis (Bagg). Cushman and Ozawa, 1930, U.S. Natl. Mus. Proc., v. 77, art. 6, p. 136, pl. 36, fig. 5.

Records show this species occurs in the upper Tertiary and Recent sediments of Japan, the west coast of North America, and the North Pacific area. The present specimens vary in size, with a maximum length of 2.5 mm and a maximum breadth of 0.75 mm. The shape of the test is also variable with the sutures more deeply depressed in some specimens and the chamber arrangement giving a more twisted appearance in some than in others (pl. 3, fig. 15).

The state of preservation ranges from fairly fresh, translucent surfaces to worn, opaque tests and casts.

Genus POLYMORPHINA d'Orbigny, 1826

Polymorphina charlottensis Cushman

Plate 3, figure 13

Polymorphina charlottensis Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, pt. 2, p. 41, pl. 6, fig. 9.

Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 12, pl. 2, fig. 11.

This species was described from material from a depth of 25 fathoms in Queen Charlotte Sound, and most of the subsequent records have been from Recent and upper Tertiary sediments of the northern Pacific. Illustrations of specimens from beds of middle Pliocene age in the Netherlands (ten Dam and Reinhold, 1941, p. 51, pl. 3, figs. 2, 3) also seem to compare favorably with this identification. *Polymorphina charlottensis* occurs rarely in six of our samples, depths ranging from 25 to 148 fathoms. Many of our specimens are much worn, opaque, and even filled.

Polymorphina kincaidi Cushman and Todd

Plate 3, figure 14

Polymorphina kincaidi Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 12, pl. 2, figs. 9, 10.

Although many of our specimens of *Polymorphina kincaidi* from the searidge show signs of abrasion, the general shape of the test and the longitudinal costae make the identification fairly certain. Since being described from Recent shallow sediments from the coast of Washington, this species has been recorded only twice: beds of questionable Pliocene age on Amchitka island (Cushman and Todd, 1947, p. 64, pl. 15, figs. 16, 17) and Pliocene formations of Japan coastal areas (Asano, 1951a, p. 9, fig. 42).

Family BULIMINIDAE

Genus BULIMINELLA Cushman, 1911

Buliminella elegantissima (d'Orbigny)

Plate 3, figure 36

Buliminella elegantissima (d'Orbigny) Cushman. Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 67, pl. 17, figs. 10–12.

The diverse habitats of this species render it comparatively useless for close ecologic interpretation. It was common in the Excursion Inlet sample, but the only other specimen found in our material was in the sample from Lynn Canal. The specimens appear to have been living where collected. In addition to their fresh appearance, they show a faint green coloration through the translucent wall, a condition noted in specimens of *Elphidium galvestonense* Kornfeld, known to have been living when studied from the island of Martha's Vineyard, Mass. (Todd and Low, 1961, p. 19).

Buliminella subfusiformis Cushman

Plate 3, figure 37

Buliminella subfusiformis Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, pt. 2, p. 33, pl. 5, fig. 12.
Cushman and Parker, 1947, U.S. Geol. Survey Prof. Paper 210–D, p. 64, pl. 16, fig. 21.

Buliminella subfusiformis was described from the Monterey Shale (Miocene) in California and has since been recorded mostly from Tertiary sediments. Our specimens compare closely with the types, having distinctly depressed sutures and rounded chambers resulting in a lobulate periphery. They differ from specimens of *Bulimina exilis* var. *tenuata* (Cushman)—originally described as a variety of *Buliminella subfusiformis* from Recent sediments in the eastern Pacific—in not being long and slender. Also, the periphery of *Bulimina exilis* var. *tenuata* is smooth, not lobulated as in *Buliminella subfusiformis*.

Genus GLOBOBULIMINA Cushman, 1927

Globobulimina auriculata (Bailey)

Plate 3, figure 38

Bulimina auriculata Bailey, 1851, Smithsonian Contr., v. 2, art. 3, p. 12, pl., figs. 25–27.
Bulimina (*Desinobulimina*) *auriculata* Bailey. Cushman and Parker, 1940, Cushman Lab. Foram. Research Contr., v. 16, p. 20, pl. 3, figs. 19–21.
Globobulimina (*Desinobulimina*) *auriculata* (Bailey). Parker 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 416, pl. 5, fig. 29.

Globobulimina auriculata is widely distributed in upper Tertiary and Recent sediments. No attempt is made here to separate the specimens into the geographical formae or subspecies determined by Höglund (1947). Our specimens are abundant in Kasaan Bay and Clarence Strait. They are distinctly translucent and show the internal spiral tube culminating in the ear-shaped tooth.

Genus VIRGULINA d'Orbigny, 1826

Virgulina fusiformis (Williamson)

Plate 3, figure 35

Bulimina pupoides d'Orbigny var. *fusiformis* Williamson, 1858, Recent Foram. Great Britain, Ray Soc., p. 63, pl. 5, figs. 129, 130.
Virgulina fusiformis (Williamson). Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 417, pl. 6, figs. 3–6.

The species has been recorded only from North Atlantic waters (around the British Isles, off Sweden, Canadian and Greenland Arctic, and off New England). Four specimens obtained from the Clarence Strait sample seem to belong to this species although our material is very small and more translucent and less perforate than the specimens from off Portsmouth, N.H., in the U.S. National Museum collections. (See Parker reference in synonymy.)

Genus BOLIVINA d'Orbigny, 1839

Bolivina alata (Seguenza)

Plate 4, figures 6, 7

Bolivina alata (Seguenza). Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 106, pl. 13, figs. 3–11.
Bolivina pseudobeyrichi Cushman. Cushman, 1937, idem, p. 139, pl. 19, figs. 4, 5.

Excellent specimens of *Bolivina alata* (Seguenza) were found in abundance from a depth of 215 fathoms in Clarence Strait; it was not found, even rarely, in any other sample studied. The material appears fresh; the spinose keel is well preserved, and tops of early chambers are clearly visible through the perforate glassy wall.

The abundance of specimens has emphasized the range of variability within the species, indicating that the separation of *B. pseudobeyrichi* Cushman does not seem valid. There are both long and short forms with a distinct variance in the shape of the chambers. Mostly, however, the backward curvature of the chambers favors the chamber shape attributed to *B. alata.* The sutures are depressed but not limbate, only appearing to be so because the keel of preceding chambers is visible through the glassy wall. The perforations are coarse but rather widely spaced in the otherwise smooth wall surface. In most specimens the elongate narrow aperture has a distinct, raised lip.

The species was described from the Pleistocene of Italy, and most of its recorded occurrences as *Bolivina alata* are from the upper Tertiary and Recent sediments of the Mediterranean area. It has also been recorded and illustrated from the upper Tertiary sediments in Georges Bank canyons (Cushman, 1936, p. 431, pl. 5, fig. 9). Records of Recent occurrences of the species as *B. pseudobeyrichi* show it to be widely represented in the eastern Pacific Ocean at depths of 55–500 fathoms (Cushman and McCulloch, 1942, p. 203, pl. 25, figs. 1–3).

Bolivina decussata Brady

Plate 4, figure 11

Bolivina decussata H. B. Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 423, pl. 53, figs. 12, 13.
Cushman, 1937, Cushman Lab. Foram. Research Spec. Pub. 9, p. 125, pl. 16, figs. 7–9.

Typical specimens, distinctive in their sugary appearance, were found in all but two of our samples making this the most northern occurrence so far of this species. Previous records have been restricted to the colder and deeper waters of the Pacific, mostly in the Southern Hemisphere but a few occurrences near Japan.

Specimens from the Monterey shale (Miocene) of California attributed to this species (Cushman, 1925, p. 31, pl. 5, fig. 6) appear to be too thick to be true *decussata*, which is smaller and compressed.

Bolivina oceanica Cushman

Plate 4, figure 13

Bolivina oceanica Cushman, 1933, Cushman Lab, Foram. Research Contr., v. 9, p. 81, pl. 8, fig. 10.

Only two specimens were found in Pamplona 7, from a depth of 100 fathoms. They compare favorably with the types of *Bolivina oceanica* Cushman described from deep waters of the tropical Pacific. The species has also been recorded from short cores from San Jorge Gulf, Argentina (Boltovskoy, 1954a).

Bolivina pacifica Cushman and McCulloch

Plate 4, figure 14

Bolivina acerosa Cushman var. *pacifica* Cushman and McCulloch, 1942, Allan Hancock Pacific Exped., v. 6, no. 4, p. 185, pl. 21, figs. 2, 3.
Bolivina pacifica Cushman and McCulloch. Walton, 1955, Jour. Paleontology, v. 29, p. 1002, pl. 102, fig. 4.
Bolivina pseudopunctata Höglund, 1947, Zool. Bidrag från Uppsala, v. 26, p. 273, pl. 24, fig. 5; pl. 32, figs. 23, 24; text figs. 280, 281, 287.
Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 414, pl. 5, figs. 20, 21.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 111, pl. 20, figs. 13, 14.

This species was originally described from 10 fathoms in the Gulf of California. In Todos Santos Bay, Baja California, however, Walton (1955, p. 1002) found its peak distribution to be 50–100 fathoms. It occurs in three of our samples at depths ranging from 85 to 100 fathoms and in one (Kasaan Bay) at a depth of 47–57 fathoms.

Our specimens are fresh, and the structure is easily seen. The species is distinctive; the early part of each chamber is finely punctate and the later part of the chamber, in most specimens, is imperforate and transparent. This glassy part topping the chambers strongly accents the angled sutures.

The majority of recorded occurrences are from off the west coast of North America and from parts of the North Atlantic Ocean and the Arctic. *Bolivina pacifica* appears not to occur in warm waters. Specimens identified as *Bolivina pseudopunctata* Höglund (Todd and Bronnimann, 1957, p. 33, pl. 8, fig. 11) from the Gulf of Paria, Trinidad, do not belong in this species. In those specimens, the perforations are coarser, resulting in a sugary appearance, the sutures are not as oblique as in *B. pacifica*, and the early part of the test is distinctly and evenly striate.

Bolivina subaenariensis Cushman

Plate 4, figure 8

Bolivina subaenariensis Cushman, 1922, U.S. Natl. Mus. Bull. 104, pt. 3. p. 46, pl. 7, fig. 6.

The single specimen found in Clarence Strait compares well with the types from near Nantucket off the northeast shore of North America. Although the aperture and final chamber are broken, the slight keel, apical spine, and costae over the early part are intact.

Most of the records of this species, including the variants (Todd, 1958, p. 193), are from the Atlantic Ocean, the Mediterranean, and the Gulf of Mexico. Saidova (1960, p. 107, text fig. 6 (map)) has reported it without illustration from the Okhotsk Sea, the closest area in its recorded distribution to our source of material.

Subgenus LOXOSTOMUM Ehrenberg, 1854

Bolivina (Loxostomum) porrecta (Brady)

Plate 4, figure 12

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

This widely recorded species occurs rarely in two of the Pamplona samples.

Genus FISSURINA Reuss, 1850

Fissurina agassizi Todd and Bronnimann

Plate 3, figure 30

Fissurina agassizi Todd and Bronnimann, 1957, Cushman Found. Foram. Research Spec. Pub. 3, p. 36, pl. 9, fig. 14.

A single specimen from Pamplona 3 is referred to this species described from the Gulf of Paria, Trinidad. Except for its larger size (about 0.30 mm in length and 0.25 mm in diameter), it seems identical in consisting of a simple globular test that is compressed toward one end where an elongate slit serves as the apertural opening.

Fissurina cucurbitasema Loeblich and Tappan

Plate 3, figure 23

Fissurina cucurbitasema Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 76, pl. 14, figs. 10, 11,

Rare but typical specimens were found at Pamplona 3. This small species, resembling a melon seed in shape, was described from Ungava Bay and reported from various other localities in Arctic Canada and off Greenland and northern Alaska. It has also been recorded from the Barents Sea and from off the coasts of California and Oregon.

Fissurina lucida (Williamson)

Plate 3, figure 31

Entosolenia marginata var. *lucida* Williamson, 1848, Annals Mag. Nat. History, ser. 2, v. 1, p. 17, pl. 2, fig. 17.

Entosolenia lucida Williamson. Cushman and Gray, 1946, Cushman Lab. Foram. Research Spec. Pub. 19, p. 30, pl. 5, figs. 16–18.

Cushman, 1949, Inst. royal sci. nat. Belgique, Mém. 111, p. 35, pl. 7, fig. 2.

Fissurina lucida (Williamson). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 76, pl. 14, fig. 4.

Detling, 1958, Cushman Found. Foram. Research Contr., v. 9, p. 27, pl. 7, fig. 15.

This widely recorded species is represented by excellent specimens in Pamplona 3, 4, 7, and 8 and in the samples from Clarence Strait and Excursion Inlet.

This is a relatively large species for this genus. Our specimens range from 0.50 to 0.60 mm in length, 0.40 to 0.48 mm in breadth, and 0.28 to 0.32 mm in thickness. They are surrounded by a narrow keel on the periphery, and the flattened faces are somewhat translucent with a broad opaque band just within the periphery making a horseshoe pattern on the face of the test.

Genus OOLINA d'Orbigny, 1839

Oolina apiopleura (Loeblich and Tappan)

Plate 3, figure 24

Lagena apiopleura Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 59, pl. 10, figs. 14, 15.

Asano, 1956, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 27, p. 30, pl. 5, figs. 26, 27.

Jarke, 1960, Internat. Rev. Gesamten Hydrobiologie, v. 45, no. 4, pl. 6, fig. 10.

Lagena acuticosta Reuss. Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 20, pl. 3, fig. 5.

This species and *Oolina borealis* are similar, both being covered by smooth, robust, well-separated longitudinal ribs. They differ in the following respects: *O. apiopleura* is smaller (diameter about 0.20 mm) and somewhat elongated, whereas *O. borealis* is larger (diameter about 0.40 mm) and more nearly globular; the apertural opening is surrounded by a definitely raised smooth area like a collar in *O. borealis*, whereas in *O. apiopleura* the ribs grade onto the short apertural neck; there are fewer ribs (about 11) on *O. apiopleura* than on *O. borealis* (about 16), the difference being a result of the difference in size. In both species, the apertural neck is very short. The internal tube, visible only through a broken chamber wall, barely projects into the chamber cavity.

O. apiopleura was originally described from off Point Barrow, Alaska, and has been recorded from northwest Greenland, Ungava Bay in Northeastern Canada, the Barents Sea, the continental shelf off Japan, and off northern New England. Other reported occurrences, including occurrences under other names, indicate that this species is a widespread one, mostly in cold waters.

Oolina borealis Loeblich and Tappan

Plate 3, figure 34

Oolina borealis Loeblich and Tappan, 1954, Washington Acad. Sci. Jour., v. 44, no. 12, p. 384.

Entosolenia costata Williamson, 1858 (not *Oolina costata* Egger, 1857), Recent Foram, Great Britain, Ray Soc., p. 9, pl. 1, fig. 18.

Lagena costata (Williamson). Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 21, pl. 3, fig. 4.

Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 10, pl. 2, fig. 1.

Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 335, pl. 44, fig. 7.

Oolina costata (Williamson). Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 409, pl. 4, figs. 20, 21.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 68, pl. 13, figs. 4–6.

Boltovskoy, 1954, Inst. Nac. Inv. Cienc. Nat., Mus. Argentino, Cienc. Nat. * * * Rev., v. 3, no. 3, p. 156, pl. 6, fig. 7.

This species was originally described from off the British Isles. It has a probably worldwide distribution in cold waters. Its morphology and distinguishing characteristics are discussed with those of *Oolina apiopleura* to which it is similar and possibly related.

Oolina hexagona (Williamson)

Plate 3, figure 28

Oolina hexagona (Williamson). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 69, pl. 14, figs. 1, 2.

Andersen, 1961, Louisiana Geol. Survey, Geol. Bull. 35, pt. 2, p. 98, pl. 20, fig. 19.

Two single specimens, from Pamplona 3 and 7, are referred to this widely recorded species. It is distinguished by its honeycomb surface in which the pits are arranged at random and not alined. Our specimens are about 0.12 mm in diameter and have a very short apertural neck extending out from the tapering apertural end of the test.

Oolina laevigata d'Orbigny

Plate 3, figure 32

Oolina laevigata d'Orbigny, 1839, Voyage dans Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 19, pl. 5, fig. 3.

Todd, 1957, U.S. Geol. Survey Prof. Paper 294–F, p. 224 (table 1), pl. 29, figs. 5, 8 [1958].

Lagena laevigata (d'Orbigny). Heron-Allen and Earland, 1932, *Discovery* Repts., v. 4, p. 361, pl. 10, fig. 4.

We have found only six specimens—four at Pamplona 7 and one each at Pamplona 3 and Gambier Bay—that seem identical with this species originally described from off the Falklands. The only other believable illustrations of this species are of a single specimen, also found near the Falklands, and of several specimens from the upper Tertiary at Carter Creek in northeastern Alaska.

Our specimens are characterized by a collar of shell material surrounding the aperture and by a slender apical spine. The spine is broken in our specimens; only the stump of it remains attached to the base of the chamber. The tests are about 0.48 mm long (exclusive of spine) and about 0.40 mm in diameter. The wall is not clear enough to show the internal tube.

Oolina lineatopunctata (Heron-Allen and Earland)

Plate 3, figure 26

Lagena globosa var. *lineato-punctata* Heron-Allen and Earland, 1922, British Antarctic Exped., Zoology, v. 6, p. 142, pl. 5, figs. 12–14.

Oolina lineato-punctata (Heron-Allen and Earland). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 70, pl. 13, fig. 8.

Only two typical specimens were found at Pamplona 7. They are small, about 0.20 mm in length and 0.12 mm in diameter.

Oolina melo d'Orbigny

Plate 3, figure 27

Oolina melo d'Orbigny, 1839, Voyage dans Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 20, pl. 5, fig. 9.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 71, pl. 12, figs. 8–15.

Boltovskoy, 1954, Inst. Nac. Inv. Cienc. Nat., Mus. Argentino, Cienc. Nat. * * * Rev., v. 3, no. 3, p. 155, pl. 6, fig. 9.

Asano, 1956, Tohoku Univ. Sci. Repts., ser. 2 (Geology), v. 27, p. 43, pl. 5, figs. 44–50.

Detling, 1958, Cushman Found. Foram. Research Contr., v. 9, pt. 2, p. 27, pl. 7, fig. 14.

van Voorthuysen, 1960, Koninkl. Nederlands Geol.-Mijnb. Genoot., Verh., Geol. Ser., pt. 19, p. 247, pl. 10, fig. 16.

Andersen, 1961, Louisiana Geol. Survey, Geol. Bull. 35, pt. 2, p. 99, pl. 20, fig. 20.

This species has surface ornamentation similar to that of *Oolina hexagona* but differing in that the honeycomb pits are larger and are alined in vertical rows rather than randomly arranged. Diameter of our specimens is about 0.25 mm. *O. melo* was described from off the Falklands, has been reported from many other areas, and is found in both the Arctic and the Antarctic, as well as localities from lower latitudes.

Oolina striatopunctata (Parker and Jones)

Plate 3, figure 25

Lagena sulcata (Walker and Jacob) var. *striatopunctata* Parker and Jones, 1865, Royal Soc. [London] Philos. Trans., v. 155, p. 350, pl. 13, figs. 25–27.

Oolina striatopunctata (Parker and Jones). Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 74, pl. 12, figs. 2–5.

This well-known and very widely reported species was found at Pamplona 4, 7, and 8. Its distribution seems to be worldwide. It is a beautifully ornamented form, with 10–14 heavy longitudinal ribs, and the ribs themselves ornamented by longitudinal striations and pits or pores in transverse rows. The aperture is at the end of a slender neck and is surrounded by a narrow phialine lip.

Oolina williamsoni (Alcock)

Plate 3, figure 29

Entosolenia williamsoni Alcock, 1865, Manchester Lit. Philos. Soc. Proc., v. 4, p. 195.

Lagena williamsoni (Alcock). Wright, 1876–77, Belfast Nat. Field Club Proc., Appendix, p. 104, pl. 4, fig. 14.

Balkwill and Wright, 1885, Royal Irish Acad. Trans., v. 28, Sci., p. 339, pl. 14, figs. 6–8.

Halkyard, 1889, Manchester Micros. Soc. Trans., p. 12, pl. 1, fig. 15.

Cushman, 1933, U.S. Natl. Mus. Bull. 161, pt. 2, p. 34, pl. 8, fig. 8; 1949, Inst. royal sci. nat. Belgique Mém. 111, p. 22, pl. 4, fig. 11.

Cushman and McCulloch, 1950, Allan Hancock Pacific Exped., v. 6, no. 6, p. 362, pl. 48, figs. 14, 15.

Cushman, Todd, and Post, 1954, U.S. Geol. Survey Prof. Paper 260–H, p. 344, pl. 86, fig. 20.

Oolina williamsoni (Alcock). van Voorthuysen, 1951, Netherlands, Geol. Stichting, Mededeel., new ser., no. 5, p. 24 (list), pl. 1, fig. 14; 1960, Koninkl. Nederlands, Geol.-Mijnb. Genoot. Verh., Gelo. Ser., pt. 19, p. 247, pl. 10, fig. 18.

This species is similar to *Oolina apiopleura* in ornamentation, differing only in the addition of honeycomb cells around the upper part, surrounding the aperture.

Only a single specimen was found in Pamplona 3. *O. williamsoni* was originally named from off the Irish coast and has been widely reported from the Atlantic and the Pacific, but not from the Arctic or Antarctic.

Genus UVIGERINA d'Orbigny, 1826

Uvigerina peregrina Cushman

Plate 4, figures 1–3

Uvigerina peregrina Cushman, 1923, U.S. Natl. Mus. Bull. 104, pt. 4, p. 166, pl. 42, figs. 7–10.

Typical specimens of *Uvigerina peregrina* Cushman are distinguished by the platelike costae and hispid surface. Several varieties have been named within this species, but the departures from typical are so gradual in our specimens we are using only the original name and illustrating two extremes and the normal form within the species.

Elongate individuals lacking a granular surface between costae or on the costae themselves (pl. 4, fig. 1) compare most closely with specimens described as *U. peregrina* var. *bradyana* Cushman (1923, p. 168, pl. 42, fig. 12). These are common, the best individuals occurring in Pamplona 3, 4, 7, and 8 and the sample from Kasaan Bay. Some tests do tend to look a little sugary, and some lack typical costae over the final chamber.

There is a gradual transition to specimens typical of *U. peregrina* (pl. 4, fig. 2) which compare well with numerous paratypes in the National Museum collections. The sugary appearance progresses to a distinct granulation between the costae especially toward the apertural end of the test and even to a crystallization along the edges of the costae. The more typical specimens are not as common and occur only in the sample from Clarence Strait and sample 8 from Pamplona Searidge.

The second variation from the typical form is a gradual intensifying of hispidity to an almost completely spinose test (pl. 4, fig. 3). The granulation deepens on and between the costae but even in the extremely roughened surfaces, traces of the nearly obscured costae may be seen. Like the typical specimens, hispid tests are less common and occur only in Clarence Strait and Pamplona 8. These specimens compare best with *U. peregrina* var. *parvula* Cushman (1923, p. 168, pl. 42, fig. 11), paratypes and topotypes of which are much more spinose than the original description or illustration indicate.

The typical species and the variety *bradyana* were described from off the northeast coast of North America; the variety *parvula* was described from the Gulf of Mexico. All the forms have been widely recorded from warm and cold waters and from deposits as old as Miocene.

Uvigerina sp.

Plate 4, figure 4

Two specimens have been compared with *Uvigerina senticosa* Cushman (1927, p. 159, pl. 3, fig. 14). They differ, however, in being more coarsely hispid throughout and more evenly graduated in size from the rounded initial end to the broadest area of the final chamber. The sutures are straight and depressed, the periphery lobulate. The hispidity is evenly distributed over the test. The spines are not alined and do not seem to be following hidden costae as they do on the more spinose specimens of *U. peregrina.*

Genus ANGULOGERINA Cushman, 1927

Angulogerina fluens Todd

Plate 4, figure 5

Angulogerina fluens Todd *in* Cushman and McCulloch, 1948, Allan Hancock Pacific Exped., v. 6, no. 5, p. 288, pl. 36, fig. 1.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 112, pl. 20, figs. 10–12.

Angulogerina fluens is one of the more common and easily distinguished species in this material. The strongly curved sutures accent the compression of the walls of the later chambers, and the neck is short and has a rim. It was described from Wrangell, Alaska, and was common to abundant in material from the Arctic studied by Loeblich and Tappan (1953).

Family DISCORBIDAE

Genus ROSALINA d'Orbigny, 1826

Rosalina ornatissima (Cushman)

Plate 4, figure 23

Discorbis ornatissima Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 42, pl. 6, figs. 11, 12.
Detling, 1948, Cushman Found. Foram. Research Contr., v. 9, p. 30, pl. 8, figs. 9, 10.

The sample from Gambier Bay contained numerous rotaliform specimens having the distinctive features of *Rosalina ornatissima:* circular outline with little or no indentation, fragile concave ventral surface ornamented with coarse papillae (in many specimens part of this surface is broken away), and several specimens joined in plastogamy. In addition, a single specimen was found in Kasaan Bay. The entire suite compares very well with the holotype and many paratypes from Virago and Queen Charlotte Sounds, British Columbia, in the National Museum collections.

Rosalina ornatissima is probably related to *R. wrightii* (Brady), a species which has been widely reported in the Arctic under the name *Eponides wrightii.* The two species can be confused, but their differences are distinct. The periphery of the former is entire, the indentation marking the end of the final chamber not easily seen as in *R. wrightii.* The ornamentation on the ventral surface of *R. wrightii* is more like fine beading radiating from the umbilical area toward but not over the periphery, which is rounded and glassy smooth. On *Rosalina ornatissima* the ventral surface is completely covered by coarse papillae, more randomly arranged, which become finer at the peripheral edge. This ornamentation may be observed in peripheral view as a fine serration around the edge of each specimen even when the specimens are attached in plastogamy. The delicate ventral wall is broken out in some tests exposing as many as four chambers beneath.

In addition to the original record from British Columbia, *R. ornatissima* has been reported from the San Juan Islands and as far south as Sunset Bay, Oregon.

Rosalina wrightii (Brady)

Discorbina Wrightii Brady, 1881, Annals Mag. Nat. History, ser. 5, v. 8, p. 413, pl. 21, fig. 6.

Eponides wrightii (H. B. Brady). Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 72, pl. 8, fig. 4.

Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 420, pl. 6, figs. 14, 15; no. 10, p. 450, pl. 5, fig. 4.

Saidova, 1961, Ekologiya Foraminifer * * * severo-zapadnoi chasti Tikhogo okeana, p. 64, pl. 19, fig. 132.

Only two specimens of this species were found, one each in Pamplona 3 and 7. They are small (0.4 and 0.6 mm in diameter), low, cap-shaped specimens, with the flat or concave ventral surface ornamented by a crudely radial pattern of fine and irregular beading that diminishes some distance within the periphery, leaving the ventral border of the periphery smooth and rounded.

This species was described from Novaya Zemlya in the Arctic and has been widely reported in both the Atlantic and the Pacific, even as far south as Long Island Sound. In our collections it occurred only in the searidge samples, whereas its close relative, *R. ornatissima* (Cushman), was found only in two of the fjordland samples.

Genus EPONIDES Montfort, 1808

Eponides isabelleanus (d'Orbigny)

Plate 4, figures 22, 24

Rosalina isabelleana d'Orbigny, 1839, Voyage dans Amérique Méridionale, v. 5, pt. 5, Foraminifères, p. 43, pl. 6, figs. 10–12.

Test robust, trochoid, biconvex with umbilical area depressed, umbilicus containing low knobs of shell material which may be broken away, equatorial outline circular to subovate, slightly lobulate, periphery subacute, limbate, with blunt keel; chambers distinct, 5 or 6 in the adult whorl increasing in size as added, easily discernible on both sides, slightly inflated and rounded on ventral side to a slight shoulder toward umbilicus; sutures distinct on both sides, on dorsal side flush in early part to a slightly raised welt within a depression in later part, limbate, glassy, curved gently backward, on ventral side depressed, radial, straight to only slightly curved, made somewhat irregular in some specimens by traces of earlier apertures; wall thick, smooth, translucent, finely perforate, occasionally larger pores visible on face of final chamber on ventral side, fresh specimens colored cream to tan, darkening toward central area on both dorsal and ventral sides; aperture a slightly arched slit at base of final chamber, going from umbilicus part way to periphery, seldom extending as far as keel, traces of previous apertures appear as arches on inner ends of sutures near umbilical area. Diameter up to 1.8 mm; thickness up to 0.9 mm.

These heavy-walled specimens conform well with d'Orbigny's original description and illustrations of this species from the Falklands. As examination of material subsequently attributed to this species by various authors indicates a diverse interpretation of the form, only the original designation is being cited.

The following features support the placement of this species in the genus *Eponides*: Heavy wall, glassy in part yet perforate, thickened shell material around periphery, aperture extending outward from umbilicus but not to periphery. These features are also given by d'Orbigny for the species, and, furthermore, the present specimens agree with d'Orbigny's description in coloration. Older individuals tend to lose color, and those most worn become white and opaque.

There is a good representation of *Eponides isabelleanus* in the Pamplona Searidge material, especially in Pamplona 4.

Family ROTALIIDAE

Genus BUCCELLA Andersen, 1952

Buccella frigida (Cushman)

Plate 4, figure 20

Eponides frigidus (Cushman). Cushman, 1948, Cushman Lab. Foram. Research, Spec. Pub. 23, p. 71, pl. 8, fig. 7.

Buccella frigida (Cushman). Andersen, 1952, Washington Acad. Sci. Jour., v. 42, no. 5, p. 144, text figs. 4–6.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 115, pl. 22, figs. 2, 3.

This species was described from the Canadian Arctic and is typical of areas of cold water. It was not found in any of the searidge samples but was most common in Kasaan Bay and Excursion Inlet.

Genus **ROTALIA** Lamarck, 1804

Rotalia columbiensis (Cushman)

Plate 4, figure 25

Pulvinulina columbiensis Cushman, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 43, pl. 7, fig. 1.

Trichohyalus columbiensis (Cushman). Cockbain, 1963, Cushman Found. Foram. Research Contr., v. 14, table 2.

Trichohyalus pustulata Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 118, pl. 23, fig. 9 (not fig. 8).

This large, biconvex, heavily built species bears strong resemblance to the type of the genus from the Eocene of France, *Rotalia trochidiformis* Lamarck (Davies, 1932, p. 416, pl. 2, figs. 8, 10–15; pl. 3, figs. 1, 3–13; pl. 4, figs. 3–6, 9–11). The final whorl is visible only dimly on the dorsal side of a few specimens and consists of about eight chambers; the dorsal sutures are flush and mostly obscure. The distinctive ventral surface of *R. columbiensis* is covered completely to the peripheral edge by heavy pustules, unlike *R. trochidiformis* in which the pustules are neatly contained by a rim of solid shell material around the perimeter. This heavy rugose surface is broken up on some specimens of *R. columbiensis* by relatively smooth elongate blisterlike swellings radiating from the center. The aperture is at the base of the final chamber within the ventral surface. The final chamber itself curves gently into the almost circular outline of the test, sometimes distinguished only by the less rugose surface of its silhouette on the ventral side and the slight indentation of the aperture. These characteristics are obscured, however, by the overall coarse pustules.

This species was described from two localities in British Columbia—20 fathoms in Queen Charlotte Sound and 8–15 fathoms in Virago Sound. It has been reported as constituting an appreciable proportion (17 percent) of the assemblage at one station in Juan de Fuca Strait, south of Victoria, British Columbia (Cockbain, 1963, table 2).

The report of this species (as *Eponides columbiensis*) from fossil material on Amchitka Island (Cushman and Todd, 1947, p. 68) proves to have been in error.

The holotype of the species described as *Trichohyalus pustulata* Loeblich and Tappan (1953, p. 118) from *Albatross* D3600 off the Aleutian Islands from a depth of 16.5 meters (9 fathoms) appears to belong in *R. columbiensis*. The species was based on only two specimens, one of which is a broken test which probably belongs in *Rosalina ornatissima* (Cushman.)

Our abundant specimens come from a depth of 10 fathoms in Gambier Bay and compare most favorably with the types of the species. We can find little comparison between *Rotalia* and *Trichohyalus*, however, and we believe they are generically distinct.

Genus **EPISTOMINELLA** Husezima and Maruhasi, 1944

Epistominella pacifica (Cushman)

Plate 5, figure 18

Pulvinulinella pacifica Cushman, 1927, Scripps Inst. Oceanography Bull., Tech. ser., v. 1, no. 10, p. 165, pl. 5, figs. 14, 15.

Epistominella pacifica (Cushman). Bandy, 1953, Jour. Paleontology, v. 27, no. 2, p. 172, pl. 23, fig. 2.

Lipps, 1965, Tulane Studies in Geology, v. 3, no. 2, p. 126, pl. 2, figs. 5, 7.

Epistominella pulchella Husezima and Maruhasi, 1944, Jour. Sigenkagaku Kenkyusyo, Tokyo, v. 1, no. 3, p. 398, pl. 34, fig. 10.

Asano, 1951, Illus. Cat. Japanese Tertiary smaller Foram, pt. 7, Cassidulinidae, p. 7, text figs. 37–39.

Lipps, 1965, Tulane Studies in Geology, v. 3, no. 2, p. 129, pl. 2, fig. 4.

This species was described from off the west coast of America from Panama to Oregon, the type being from 735 fathoms off California. The genus *Epistominella* was subsequently erected with *E. pulchella* from the Pliocene of Japan as its type species. Comparison between the type of *Pulvinulinella pacifica* and topotypes and other Japanese Pliocene specimens of *Epistominella pulchella* confirms that they are the same species. Thus the earlier name is used.

Epistominella pacifica is nearly flat on the dorsal side and high conical on the ventral, with each subsequent chamber progressively more peaked at the inner end, leaving a high apertural face. The periphery is angled, bluntly keeled, and slightly lobulated around the last several chambers. The dorsal sutures are oblique and curved, the ventral sutures are radial and only slightly curved. The wall is smooth, finely punctate, and translucent; in some so nearly transparent that the septal walls separating the chambers can be seen within the test. The aperture is a narrow elongate opening parallel with and just ventral to the peripheral keel. Our specimens are entirely typical, and their empty translucent tests show clearly their Recent origin.

Epistominella pacifica probably has a large but discontinuous area of distribution in and around the North Pacific basin. We have found this species to occur commonly at Clarence Strait and rarely at Pamplona 8, but nowhere else in our collections.

Epistominella vitrea Parker

Plate 5, figure 15

Epistominella vitrea Parker *in* Parker, Phleger, and Peirson, 1953, Cushman Found. Foram. Research Spec. Pub. 2, p. 9, pl. 4, figs. 34–36, 40, 41.

Parker, 1954, Harvard Coll., Mus. Comp. Zoology Bull., v. 111, no. 10, p. 534, pl. 10, figs. 20, 26.
Phleger, 1954, Am. Assoc. Petroleum Geologists Bull., v. 38, p. 639, pl. 2, figs. 11, 12.
Warren, 1956, Gulf Coast Assoc. Geol. Socs. Trans., v. 6, p. 139 (list), pl. 4, figs. 25, 26.
Lankford, 1959, Am. Assoc. Petroleum Geologists Bull., v. 43, p. 2098, pl. 3, fig. 14.
Andersen, 1961, Louisiana Geol. Survey, Geol. Bull. 35, pt. 2, p. 104, pl. 24, fig. 1.

Pseudoparrella cf. *exigua* (H. B. Brady). Phleger and Parker (part), 1951, Geol. Soc. America Mem. 46, pt. 2, p. 28, pl. 15, fig. 7 (not fig. 6).

Described from the Mississippi Delta at a depth of 17 meters (9 fathoms), this small species has also been recorded from off southwestern Texas and from various other localities in the Gulf of Mexico. Specimens illustrated and recorded as *Pseudoparrella exigua* (Brady) from off Argentina (Boltovskoy, 1954a, p. 206, pl. 17, figs. 9–11; pl. 18, figs. 1, 2, 9; 1954b, p. 288, pl. 28, fig. 3) may also belong in this species.

In our material typical specimens of *Epistominella vitrea* occur rarely in four fjordland samples and at Pamplona 7.

Confusion between *E. vitrea* and its deep-water counterpart, *E. exigua* (Brady), is possible. *E. vitrea*, however, is recognizable by the following characteristics: 6–6½ chambers per final whorl, a rounded periphery, and sutures slightly curved and slightly depressed, especially so at their inner ends on the ventral side.

The genus *Pseudoparrella* Cushman and ten Dam has been resurrected (Lipps, 1965, p. 120) for species of *Epistominella*, such as this one, that differ in having a rounded instead of keeled periphery and a biconvex rather than planoconvex shape. We do not think, however, these characters of sufficient importance to justify their being in different genera.

Family ELPHIDIIDAE

Genus ELPHIDIUM Montfort, 1808

Elphidium bartletti Cushman

Plate 4, figure 19

Elphidium bartletti Cushman, 1933, Smithsonian Misc. Colln., v. 89, no. 9, p. 4, pl. 1, fig. 9.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 96, pl. 18, figs. 10–14.

This species, originally described from off Labrador and recorded from many Arctic localities, is represented rarely at three of our fjordland stations.

It is characterized by a rather shiny wall, rounded periphery, chambers slightly inflated and sutures slightly depressed, and a broadly open and depressed umbilicus. Number of chambers per final whorl is about 10.

Elphidium clavatum Cushman

Plate 4, figures 16, 17

Elphidium clavatum Cushman. Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 98, pl. 19, figs. 8–10.
Todd and Low, 1961, Cushman Found. Foram. Research Contr., v. 12, p. 18, pl. 2, fig. 1.

This well-known and widely reported species is most common in Clarence Strait and was also found in seven other of our samples. It has been reported from the Arctic and from as far south as New York on the Atlantic side and as far south as British Columbia on the Pacific side of the North American Continent. *Elphidium clavatum* is also a common or abundant constituent of Pleistocene deposits.

Our specimens are found in two forms. One is light-orange and has a translucent wall in which the chambers look dark; the wall pores appear as white dots, and the sutural pores are indistinct because of the translucency of the shell material. The other form is white, has an opaque wall, and the sutural pores are well defined. In this white opaque form the minute wall pores are indistinct and in most specimens unnoticeable other than giving the wall a granular rather than shiny surface. In both these forms the chambers per final whorl number about 11. The periphery is bluntly angular and entire as the chambers are not at all inflated. The test is thickest through the umbilicus.

Elphidium frigidum Cushman

Plate 4, figures 9, 10

Elphidium frigidum Cushman, 1933, Smithsonian Misc. Colln., v. 89, no. 9, p. 5, pl. 1, fig. 8.
Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 14, pl. 2, fig. 18.
Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 57, pl. 6, figs. 9–11.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 99, pl. 18, figs. 4–9.

Elphidium subarcticum Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 27, pl. 3, figs. 34, 35; 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 58, pl. 6, fig. 12.
Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 412, pl. 5, fig. 9; no. 10, p. 449, pl. 4, figs. 3–6, 8.
Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 84, pl. 14, fig. 8.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 105, pl. 19, figs. 5–7.

Nonion pauciloculum Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 24, pl. 3, fig. 25.

Three species (as indicated in the foregoing synonymy), the first two occurring widely in the Arctic, have been described and discriminated. Further consideration of the features used to discriminate these three species, however, leads us to reassess their value and to conclude that they are not consistently developed and are not, alone, of sufficient importance upon which to base a reliable separation of species. Hence, the three species are combined as one species, and the earliest name is used.

The features by which these species were formerly separated are the parallel opaque bands on either side of the suture lines in *Elphidium subarcticum*, the slightly greater incision of the sutures in *E. subarcticum*, the tendency in *E. frigidum* of the last several chambers to be elongated away from the axis of coiling, the rare presence in *E. frigidum* of faint grooves parallel to the periphery on the walls of the last few chambers, and the development in *Nonion pauciloculum* of elongate sutural slits rather than true retral processes.

In our material, specimens are found in all but three of our stations. Most of them (pl. 4, fig. 9) are what would formerly have been placed in *E. frigidum* in its restricted sense. But a few (pl. 4, fig. 10), with distinct bands of opacity along slightly incised sutures, are more characteristic of what would have been called *E. subarcticum*. Nevertheless, we regard them all as belonging to a single species.

Elphidium oregonense Cushman and Grant

Plate 4, figure 18

Elphidium oregonense Cushman and Grant, 1927, San Diego Soc. Nat. History Trans., v. 15, no. 6, p. 79, pl. 8, fig. 3.

This large (as much as 1.85 mm in diameter) and complanate species, known from the Pliocene and Pleistocene of Oregon, California, and the Netherlands and the Recent of the Arctic, is represented by only a single typical example from Kasaan Bay.

Genus ELPHIDIELLA Cushman, 1936

Elphidiella arctica (Parker and Jones)

Plate 4, figure 15

Polystomella crispa Linné var. *arctica* Parker and Jones, 1865, Royal Soc. [London] Philos. Trans., v. 155, p. 401, pl. 14, figs. 25–30.

Polystomella arctica Parker and Jones. Brady, 1878, Annals Mag. Nat. History, ser. 5, v. 1, p. 437, pl. 21, fig. 13.

Elphidiella arctica (Parker and Jones). Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 83, pl. 14, fig. 14.

Two single specimens were found, at Kasaan Bay and Lynn Canal. They are recognizable by the double rows of sutural pores. Otherwise they superficially resemble specimens of *Elphidium frigidum* in their complanate shape, nonindented sutures, and opaque wall. The present specimens are less inflated and less robust than is typical for this species, and there is no suggestion of thickening along the earlier suture lines.

Elphidiella arctica appears to be mostly restricted to the Arctic, where it has been reported from many localities, although it has been reported as far south as the St. Lawrence River.

Elphidiella groenlandica (Cushman)

Plate 4, figure 21

Elphidium groenlandicum Cushman, 1933, Smithsonian Misc. Colln., v. 89, no. 9, p. 4, pl. 1, fig. 10.

Elphidiella groenlandica (Cushman). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 66, pl. 19, fig. 3; 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 60, pl. 6, fig. 14.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 106, pl. 19, figs. 13, 14.

Elphidiella nitida Cushman, 1941, Cushman Lab. Foram. Research Contr., v. 17, p. 35, pl. 9, fig. 4.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 107, pl. 19, figs. 11, 12.

This smooth species, originally described from off Greenland and redescribed from the Pleistocene or Pliocene of Nome, Alaska, occurs abundantly at Excursion Inlet and commonly at Lynn Canal and Kasaan Bay.

Reexamination of the types of *Elphidium groenlandicum* and *Elphidiella nitida* indicates that there are no significant differences between them. Hence, we have combined them and are using the earlier name. There is considerable variation within the species with respect to size and flatness of the test and degree of angularity of the periphery. Our specimens are similar to the types.

Family ANOMALINIDAE

Genus CIBICIDES Montfort, 1808

Cibicides lobatulus (Walker and Jacob)

Plate 5, figures 1, 2, 4

Cibicides lobatulus (Walker and Jacob). Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 118, pl. 21, fig. 3.
Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 10, p. 446, pl. 5, fig. 11.
Nyholm, 1961, Zool. Bidrag från Uppsala, v. 33, p. 157 ff., pls. 1–5.

Specimens of this well-known and almost cosmopolitan species were found in all our samples and were well represented in some samples. In most of the samples the species is present in two forms—one, the normal planoconvex form in which the wall is smooth and coarsely perforate and all the sutures visible (pl. 5, fig. 4), and another, in which the wall is thickened by shell material (particularly on the involute conical side) to such a degree that the surface becomes rugose and covered by numerous closely set blisters that obscure the sutures and appear to close the pores through that part of the wall (pl. 5, figs. 1, 2). These two forms are gradational to one another.

Cibicides lobatulus is attached during life by the evolute side, which usually reflects the shape of the surface of attachment. In the light of Nyholm's (1961) discussion of the morphogenesis and biology of this species as observed in cultures, the variability we have noted among our specimens is to be expected, as well as a close relationship to *Dyocibicides biserialis*, which in reality is only a growth stage of *Cibicides lobatulus*.

Genus DYOCIBICIDES Cushman and Valentine, 1930

Dyocibicides biserialis Cushman and Valentine

Plate 5, figure 3

Dyocibicides biserialis Cushman and Valentine, 1930, Stanford Univ. Contr. Dept. Geology, v. 1, no. 1, p. 31, pl. 10, figs. 1, 2.

A few specimens from Kasaan Bay, Excursion Inlet, and Gambier Bay are referable to this spreading growth form of *Cibicides lobatulus* which has been separated as a distinct genus. Our specimens exhibit the same variability of wall surface from smooth to blistery.

While recognizing that these forms cannot be regarded as biologically distinct from *Cibicides lobatulus*, we nevertheless do follow the convention of using the separate name for them as a convenience in referring to this biserial growth form.

Family RUPERTIIDAE

Genus RUPERTIA Wallich, 1877

Rupertia stabilis Wallich

Plate 5, figure 5

Rupertia stabilis Wallich, 1877, Annals Mag. Nat. History, ser. 4, v. 19, p. 502, pl. 20, figs. 1–13.
Schlumberger, 1883, Feuille Jeunes Nat., Ann. 13, p. 119, pl. 2, figs. 6–8.
Brady, 1884, *Challenger* Rept., Zoology, v. 9, p. 680, pl. 98, figs. 1–12.
Goës, 1894, Kgl. Svenska Vetenskapsakad. Handlingar, v. 25, no. 9, p. 92, pl. 15, fig. 789.
Flint, 1899, U.S. Natl. Mus., Ann. Rept. for 1897, p. 336, pl. 79, fig. 4.
Cushman, 1931, U.S. Natl. Mus. Bull. 104, pt. 8, p. 138, pl. 25, figs. 3–9.
Earland, 1934, *Discovery* Repts., v. 10, p. 185, pl. 10, figs. 23–25.

Above are only a few of the many references to this distinctive sessile species. It was described from the North Atlantic and has been reported widely in both the Northern and the Southern Hemispheres. Our specimens are well developed and well preserved and were found commonly at Pamplona 4.

Family NONIONIDAE

Genus FLORILUS Montfort, 1808

The genus *Florilus*, resurrected by Voloshinova (1958), has as its type species *Nautilus asterizans* Fichtel and Moll. It seems related to the genera *Nonionella* Cushman, 1926, and *Pseudononion* Asano, 1936, differing from them in being symmetrically coiled. *Nonionellina* Voloshinova, 1958, having *Nonionina labradorica* Dawson as its type species, seems to us not to differ substantially from *Florilus*.

Florilus labradoricus (Dawson)

Plate 5, figure 9

Nonionina scapha var. *labradorica* Dawson, 1870, Canadian Naturalist, new ser., v. 5, p. 177, pl., fig. 5.
Nonion labradoricum (Dawson). Cushman, 1930, U.S. Natl. Mus. Bull. 104, pt. 7, p. 11, pl. 4, figs. 6–12; 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 52, pl. 6, fig. 2.
Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 85, pl. 14, fig. 5.
Martin, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 123, pl. 19, fig. 1.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 86, pl. 17, figs. 1, 2.
Feyling-Hanssen, 1954, Norsk Geol. Tidsskr., v. 33, pt. 1–2, p. 139, pl. 2, fig. 8.
Asano, 1960, Tohoku Univ. Sci. Repts., ser. 2 (Geology), Spec. Vol. 4, p. 191, pl. 21, fig. 8.
Jarke, 1960, Internat. Rev. Gesamten Hydrobiologie, v. 45, pt. 4, p. 625, pl. 7, fig. 8.
Saidova, 1961, Ekologiya Foraminifer * * * severo-zapadnoi chasti Tikhogo okeana, p. 72, pl. 22, fig. 151.

This species occurs in typical form and in some abundance in Kasaan Bay and Clarence Strait, and more rarely in four other samples. It is distinctive in its broadly triangular and bulging apertural face.

This species was described from 313 fathoms in the Gulf of St. Lawrence, in eastern Canada. It has been widely reported in the Recent especially in the Arctic as indicated by the partial synonymy above. It has also been found in beds as old as Pliocene in California.

Genus NONIONELLA Cushman, 1926

Nonionella pulchella Hada

Plate 5, figure 14

Nonionella pulchella Hada, 1931, Tohoku Imp. Univ. Sci. Rept., ser. 4, Biology, v. 6, p. 120, text fig. 79.
Asano, 1938, Geol. Soc. Japan Jour., v. 45, no. 538, p. 598, pl. 15 (4), fig. 12.
Boltovskoy, 1954, Inst. Nac. Inv. Cienc. Nat., Mus. Argentino, Cienc. Nat. * * * Rev., v. 3, no. 3, p. 168, pl. 8, fig. 2.

Common specimens found in Clarence Strait are referred to this species that was described from Mutsu Bay, Japan, from depths between 4 and 33 fathoms. It has also been recorded from beds as old as Pliocene in Japan and from the Recent of San Jorge Gulf, Argentina. The species is distinguished by the crenate margin of its umbilical lobe.

Our specimens have been compared with specimens from the Pliocene of Japan and differ from them only in being slightly thicker through the last several chambers.

Nonionella turgida (Williamson)

Rotalina turgida Williamson, 1858, Recent Foram. Great Britain, Ray Soc., p. 50, pl. 4, figs. 95–97.

Nonionella turgida (Williamson). Cushman, 1939, U.S. Geol. Survey Prof. Paper 191, p. 32, pl. 9, figs. 2, 3.

Todd and Bronnimann, 1957, Cushman Found. Foram. Research Spec. Pub. 3, p. 32, pl. 6, figs. 3, 4.

This small species, about 0.28 mm in length and 0.10 mm in thickness, is found only rarely in our material. It was described off the British Isles and has been reported widely, with no restriction to cold water. Our specimens seem typical.

Nonionella turgida digitata Nørvang

Plate 5, figure 8

Nonionella turgida (Williamson) var. *digitata* Nørvang, 1945, Zoology of Iceland, v. 2, pt. 2, Foraminifera, p. 29, text fig. 4.

Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 413, pl. 5, figs. 15, 16.

This subspecies in which the lobe is crenulated deeply into several slender fingers was described from off Iceland. We have found only a few typical specimens of this distinctive form. Other records of it are from off Portsmouth, New Hampshire, and in southwestern British Columbia.

Genus PSEUDONONION Asano, 1936

This genus, represented by its type species, *Pseudononion japonicum* Asano, seems worthy of distinction from *Florilus* because of its involute-evolute character and from *Nonionella* because of its lack of an umbilical lobe on its involute side.

Pseudononion auricula (Heron-Allen and Earland)

Plate 5, figures 6, 7

Nonionella auricula Heron-Allen and Earland, 1930, Royal Micros. Soc. Jour., v. 50, p. 192, pl. 5, figs. 68–70.

Cushman and McCulloch, 1940, Allan Hancock Pacific Exped., v. 6, no. 3, p. 159, pl. 17, figs. 6, 7.

Cushman, 1944, Cushman Lab. Foram. Research Spec. Pub. 12, p. 25, pl. 3, figs. 26, 27.

Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 13, pl. 2, fig. 14.

This species, originally described from off Plymouth, England, is only sparsely represented in our material except in Kasaan Bay and Clarence Strait, where it was found commonly. Other recorded occurrences of this species are along the west coast of California southward to Peru, the San Juan Islands of Washington, British Columbia, and off New England.

From the coiled side this species resembles *Nonionella pulchella* Hada but is somewhat less thick and, of course, lacks the bulging umbilical lobe. Specimens range from 0.25 to 0.60 mm in length and from 9 to 12 in number of chambers in the final whorl. In the larger specimens, with the greater number of chambers, the sutures are distinctly curved backward, while in those with fewer chambers the sutures are more nearly straight, being curved only at the periphery. We have illustrated two specimens to show the extremes of this species.

Genus ASTRONONION Cushman and Edwards, 1937

Astrononion gallowayi Loeblich and Tappan

Plate 5, figure 17

Astrononion gallowayi Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 90, pl. 17, figs. 4–7.

Astrononion stellatum Cushman and Edwards, 1937 (not *Nonionina stellata* Terquem), Cushman Lab. Foram. Research Contr., v. 13, p. 32, pl. 3, figs. 9–11.

Cushman and McCulloch, 1940, Allan Hancock Pacific Exped,. v. 6, no. 3, p. 168, pl. 18, fig. 11.

Cushman and Todd, 1947, Cushman Lab. Foram. Research Spec. Pub. 21, p. 13, pl. 2, fig. 15.

Parker, 1952, Harvard Coll., Mus. Comp. Zoology Bull., v. 106, no. 9, p. 410, pl. 5, figs. 2, 3.

Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 83, pl. 14, fig. 11.

Described from off the southern coast of Iceland, this species is found commonly at Gambier Bay and rarely in our material from four other localities. *Astrononion gallowayi* has been reported in the Arctic and along the Pacific coast from Mexico northward and along the Atlantic coast as far south as Massachusetts.

Family CASSIDULINIDAE

Genus CASSIDULINA d'Orbigny, 1826

Recently this genus was subdivided on the basis of wall structure, nature of aperture, and presence or absence of a toothplate into various other genera namely *Islandiella* Nørvang (1958), *Cassilamellina*, *Globocassidulina*, and *Cassilongina* Voloshinova (1960). The first two of these genera have, moreover, been removed from the family Cassidulinidae to be placed in the family Islandiellidae of the superfamily Buliminacea, leaving the last two in the family Cassidulinidae of the superfamily Cassidulinacea.

Because the significance of wall structure in the generic classification of Foraminifera is not firmly established—has even been shown to cut across generic lines in the families Cassidulinidae and Elphidiidae—and because a reclassification to make generic lines conform with family lines serves to separate rather than unite like forms, we prefer not to follow the recommended subdivision of *Cassidulina*.

This philosophical question is unresolvable. One might argue that the now-rejected Brady (1884) classification that included the agglutinated Textularinae and calcareous Bulimininae together in the Textulariidae and that gave more weight to manner of coiling than to wall composition, is no less justifiable than the combining of the radial Islandiellidae with the granular Cassidulinidae. Still, 80 years after Brady's work, we are unable to prove satisfactorily that one feature or another can serve as an infallible basis for classification. Rather we look for combinations of features and find in general resemblances a basis for family classifications. The better classification is the one that unites like forms and does not set them apart.

Cassidulina californica Cushman and Hughes

Plate 5, figure 13

Cassidulina californica Cushman and Hughes, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 12, pl. 2, fig. 1.

This species is a major constituent in all the Pamplona samples, occurring abundantly in all but Pamplona 5. In addition, it is found abundantly in Kasaan Bay and commonly in Gambier Bay.

Cassidulina californica was originally described from the Pleistocene of Timms Point, Calif., where it is abundant. It has been reported to occur widely and is found along the Pacific coast and in the North Pacific, both as Recent and as fossil forms in sediments dating as far back as Pliocene. Our specimens are typical. Maximum dimensions range between 0.9 and 1.2 mm.

Cassidulina islandica Nørvang

Cassidulina islandica Nørvang, 1945, Zoology of Iceland, v. 2, pt. 2, Foraminifera, p. 41, text figs. 7, 8d–f.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 118, pl. 24, fig. 1.

Islandiella islandica (Nørvang). Nørvang, 1958, Dansk naturh. Foren. Vidensk. Medd., v. 120, p. 27, pl. 6, figs. 1–5; pl. 7, figs. 6, 7.

Rare specimens, about 0.2 mm in maximum dimension, were found in three of our fjordland samples. They possess the apertural tooth characteristic of this species, and the sutures are slightly depressed.

Cassidulina limbata Cushman and Hughes

Cassidulina limbata Cushman and Hughes, 1925, Cushman Lab. Foram. Research Contr., v. 1, p. 12, pl. 2, fig. 2.

Crouch, 1952, Am. Assoc. Petroleum Geologists Bull., v. 36, p. 838, pl. 6, fig. 9.

Bandy, 1953, Jour. Paleontology, v. 27, p. 182, pl. 25, fig. 2.

This species occurs in considerable numbers in three of our fjordland samples. Together with *Cassidulina californica* and *C. tortuosa*, it was described from the Pliocene of Timms Point, Calif., and has been reported from Recent sediments along the Pacific coast, even as far north as off the southern part of the Kamchatka Peninsula (Saidova, 1961, p. 94).

It is distinguishable from *C. tortuosa* by its limbate sutures and periphery and by a slight lobulation of its periphery.

Cassidulina norcrossi Cushman

Plate 5, figure 11

Cassidulina norcrossi Cushman, 1933, Smithsonian Misc. Colln., v. 89, p. 7, pl. 2, fig. 7.

Parker, 1948, Harvard Coll., Mus. Comp. Zoology Bull., v. 100, p. 237 (list), pl. 6, fig. 2.

Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, p. 83, pl. 14, fig. 22.

Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 120, pl. 24, fig. 2.

Islandiella norcrossi (Cushman). Nørvang, 1958, Dansk naturh. Foren. Vidensk. Medd., v. 120, p. 32, pl. 7, figs. 8–13; pl. 8, fig. 14.

This species was found only at Kasaan Bay and at Pamplona 3 and 8. It occurs rarely and in typical form. It was originally described from off northeastern Greenland and has been recorded from numerous Arctic localities and as far south as New England.

It is a distinctive species in this genus, having straight and limbate, but not depressed, sutures and having chambers that extend almost equally onto both sides.

Cassidulina subglobosa Brady?

Rare specimens from three Pamplona stations are referred questionably to the widely reported species, *Cassidulina subglobosa* Brady (1884, p. 430, pl. 54, fig. 17). They are smaller (0.38–0.48 mm in maximum dimension) and more compressed than is typical of this species. They are distinctive, however, in the kind of aperture they possess; an aperture fundamentally different from that found in all the other species of *Cassidulina* present in our Alaska collections.

In these specimens the aperture can clearly be seen to consist of two parts; an erect narrow loop-shaped opening extending into the apertural face and another slit opening branching off from the lower end of the loop opening and extending along the suture at the base of the chamber. This kind of aperture has been illustrated and described as a tripartite aperture and has been interpreted as being invariably associated with a granulate wall (Nørvang, 1958, p. 36, pl. 8, figs. 18, 19); it thus serves as the means of recognition of two genera in what was formerly regarded as the genus *Cassidulina*. The other genus thus derived from the subdivision of the original genus *Cassidulina*, characterized by a large basal rounded triangular aperture with an internal tooth and a free projecting tongue and by having a radiate wall, was given the name *Islandiella* (Nørvang, 1958, p. 26).

Cassidulina teretis Tappan

Plate 5, figure 10

Cassidulina teretis Tappan, 1951, Cushman Found. Foram. Research Contr., v. 2, pt. 1, 1951, p. 7, pl. 1, fig. 30.
Loeblich and Tappan, 1953, Smithsonian Misc. Colln., v. 121, no. 7, p. 121, pl. 24, figs. 3, 4.
Jarke, 1960, Internat. Rev. Gesamten Hydrobiologie, v. 45, pt. 4, pl. 11, fig. 9.

This species, described from the Pleistocene in a well near Point Barrow, Alaska, has also been reported from numerous Recent localities along the coasts of northern Alaska, the Canadian Arctic and Greenland. It has been recorded in the Barents Sea.

Cassidulina teretis is found in both searidge and fjordland samples but never abundantly. Morphologically the species is transitional between *C. tortuosa* and *C. norcrossi*. From the former it differs in having straight, oblique, but not angled sutures; in being somewhat evolute and thus possessing a central umbo; and in its chambers being slightly inflated so that the surface of the test is undulating rather than smooth and flat as in *C. tortuosa*. From *C. norcrossi*, it differs in that the alternating chambers are distinctly unequal and in that the periphery is slightly lobulate rather than smooth and entire. In these respects, the two species (*C. teretis* and *C. norcrossi*) differ in degree rather than in substance.

Cassidulina tortuosa Cushman and Hughes

Plate 5, figure 12

Cassidulina tortuosa Cushman and Hughes, 1925, Cushman Lab. Foram. Research Contr., v. 1, pt. 1, p. 14, pl. 2, fig. 4.
Bandy, 1953, Jour. Paleontology, v. 27, p. 182, pl. 25, fig. 3.
Uchio, 1960, Cushman Found. Foram. Research Spec. Pub. 5, p. 69, pl. 9, fig. 23.

Like *Cassidulina californica*, this species was described from the Pleistocene of Timms Point, Calif. It has also been recorded from the Recent of the Pacific coast of North America but appears not to have been previously reported from farther north than British Columbia. It has been recorded as a fossil only from California.

It occurs in all our searidge samples, abundantly in three of them and also, rarely, in Kasaan Bay. Together with *C. californica*, it constitutes the dominant element in the three shallower Pamplona samples, those from between 85 and 100 fathoms. Our specimens range from 0.6 to 0.9 mm in diameter. They are characterized by the angularity of their suture pattern.

By comparison with *C. teretis*, they are slightly smaller; most specimens are opaque instead of translucent. The sutures are flush and not depressed, and consequently, the periphery is smooth and not lobulated.

Genus EHRENBERGINA Reuss, 1850

Ehrenbergina compressa Cushman

Plate 5, figure 16

Ehrenbergina compressa Cushman, 1927, Scripps Inst. Oceanography Bull., Tech. ser., v. 1, no. 10, p. 168, pl. 6, fig. 7.
Cushman, Stewart and Stewart, 1930, San Diego Soc. Nat. History Trans., v. 6, p. 75, pl. 6, fig. 9.
Natland, 1950, Geol. Soc. America Mem. 43, pt. 4, p. 35, pl. 9, fig. 11.
Crouch, 1952, Am. Assoc. Petroleum Geologists Bull., v. 36, p. 841, pl. 6, fig. 20.
Walton, 1955, Jour. Paleontology, v. 29, p. 1007, pl. 104, figs. 5, 10.
Uchio, 1960, Cushman Found. Foram. Research Spec. Pub. 5, pl. 9, figs. 28–31.

Described from the Pacific off Panama, this species has also been reported from the Recent and Pliocene of the coast of California and Mexico. In our material it is represented most commonly at Pamplona 4. The peripheral spines are short and poorly developed.

Family CHILOSTOMELLIDAE

Genus PULLENIA Parker and Jones, 1862

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

Plate 5, figure 20

Pullenia salisburyi R. E. and K. C. Stewart, 1930, Jour. Paleontology, v. 4, p. 72, pl. 8, fig. 2.

Typical specimens of this widely reported species occur in all the Pamplona samples except Pamplona 5; none were found in the fjordland material. They are distinctive in their large, compressed, and lobulated test with chambers increasing in both size and thickness as they are added.

Records of *Pullenia salisburyi* indicate that it ranges from the Miocene to the Recent along the Pacific coast, even as far north as northeastern Alaska. As a fossil it is widespread, occurring in Japan, Italy, Greece, and probably other areas. As a Recent species it probably has an equally wide distribution.

ARAGONITIC FAMILY

Family ROBERTINIDAE

Genus ROBERTINA d'Orbigny, 1846

Robertina arctica d'Orbigny

Robertina arctica d'Orbigny, 1846, Foram. Fossiles Vienne, p. 203, pl. 21, figs. 37, 38.
Earland, 1934, *Discovery* Repts., v. 10, p. 123, pl. 5, figs. 52, 53.
Cushman and Parker, 1936, Cushman Lab. Foram. Research Contr., v. 12, p. 93, pl. 16, fig. 1.
Höglund, 1947, Zool. Bidrag från Uppsala, v. 26, p. 219, pl. 18, fig. 2; pl. 19, fig. 1; text figs. 198, 203.
Cushman, 1948, Cushman Lab. Foram. Research Spec. Pub. 23, p. 61, pl. 6, figs. 16–18.

Parker, 1948, Harvard Coll., Mus. Comp. Zoology Bull., v. 100, p. 239 (list), pl. 5, fig. 8.

Saidova, 1961, Ekologiya Foraminifer * * * severo-zapadnoi chasti Tikhogo okeana, p. 66, pl. 20, fig. 138.

Two specimens only, found at Gambier Bay, appear to belong to this aragonitic species that has been reported from localities in or near the Arctic and Antarctic.

PLANKTONIC FAMILIES

Family GLOBIGERINIDAE

Genus GLOBIGERINA d'Orbigny, 1826

Globigerina bulloides d'Orbigny

Plate 5, figures 19, 21

Globigerina bulloides d'Orbigny. Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, pp. 81, 87, pl. 14, figs. 27, 28.

Bradshaw, 1959, Cushman Found. Foram. Research Contr., v. 10, p. 33, pl. 6, figs. 1–4.

Smith, 1963, Cushman Found. Foram. Research Contr., v. 14, p. 2, pl. 1, figs. 1–4.

Together with *Globigerina pachyderma*, this species occurs in all the searidge samples, abundantly at Pamplona 3, 4, and 7. These two species, *G. bulloides* and *G. pachyderma*, together constitute virtually all the planktonic population found in our samples; the remaining five planktonic species constitute only a negligible part.

Globigerina bulloides has four chambers in the final whorl and, in some specimens, a large aperture opening into the umbilicus. Many of our specimens are rather tightly coiled, with compact and noninflated chambers, a small or closed umbilicus, and only a low arched aperture.

Globigerina aff. G. eggeri Rhumbler

Plate 5, figure 25

In our material this species is very rare being represented by only five specimens at Pamplona 7 (two are left coiling and three right coiling), and these five are not entirely typical. Instead they fall more into what Parker (1958, p. 277, pl. 5, figs. 5, 9) illustrated—both as *Globigerina eggeri* and *G. pachyderma*—from core samples that reflected cold periods in the Mediterranean. Bradshaw (1959, p. 36) stated that typical individuals are not to be expected in the subarctic part of the range of *G. eggeri* in the Pacific, and it is quite possible that these specimens have no true connection with *G. eggeri*.

Globigerina pachyderma (Ehrenberg)

Plate 5, figure 22

Globigerina pachyderma (Ehrenberg). Phleger, 1952, Cushman Found. Foram. Research Contr., v. 3, pp. 81, 87, pl. 14, figs. 31, 32.

Bradshaw, 1957, Cushman Found. Foram. Research Contr., v. 10, p. 36, pl. 6, figs. 20–23.

Bé, 1960, Cushman Found. Foram. Research Contr., v. 11, p. 65, text fig. 1.

Parker, 1962, Micropaleontology, v. 8, p. 224, pl. 1, figs. 26–35; pl. 2, figs. 1–6.

Smith, 1963, Cushman Found. Foram. Research Contr., v. 14, p. 2, pl. 2, figs. 15–18.

Typical specimens of this well-known species of the Arctic and Antarctic occur commonly at all the Pamplona stations plus a single specimen at Kasaan Bay.

Globigerina quinqueloba Natland

Globigerina quinqueloba Natland. Bradshaw, 1959, Cushman Found. Foram Research Contr., v. 10, p. 38, pl. 6, figs. 24, 25.

A single typical specimen was found at Pamplona 3.

Genus GLOBIGERINITA Bronnimann, 1951

Globigerinita glutinata (Egger)

Globigerinita glutinata (Egger). Bradshaw, 1959, Cushman Found. Foram. Research Contr., v. 10, p. 40, pl. 7, figs. 7, 8.

This cosmopolitan species is represented in our material by rare, but typical, individuals in four searidge samples.

Genus ORBULINA d'Orbigny, 1839

Orbulina universa d'Orbigny

Plate 5, figure 24

Orbulina universa d'Orbigny. Bradshaw, 1959, Cushman Found. Foram. Research Contr., v. 10, p. 49, pl. 8, figs. 17, 18.

Smith, 1963, Cushman Found. Foram. Research Contr., v. 14, p. 3, pl. 2, figs. 19, 20.

Rare specimens were found in Pamplona 3 and 4, and a single specimen in the Clarence Strait sample. Associated with the spherical ones at Pamplona 4 there are three multilobate forms, two similar to those found in living plankton in the Pacific (see the two references cited above) and a third one (pl. 5, fig. 24) identical with what would be identified as *Orbulina suturalis* Bronnimann in the Miocene. The finding of rare multilobate individuals in collections of living plankton make it seem unlikely that these multilobate individuals from bottom sediments are any older than Recent.

Family GLOBOROTALIIDAE

Genus GLOBOROTALIA Cushman, 1927

Globorotalia scitula (Brady)

Plate 5, figure 23

Globorotalia scitula (Brady). Phleger, Parker, and Peirson, 1953, Swedish Deep-Sea Exped. Repts., v. 7, Sediment Cores, no. 1, p. 21, pl. 4, figs. 13, 14.

Boltovskoy, 1959, Argentina Servício Hidrografía Naval, Pub. H1005, p. 114, pl. 20, fig. 5.

Bradshaw, 1959, Cushman Found. Foram. Research Contr., v. 10, p. 44, pl. 8, figs. 5, 6.
Parker, 1962, Micropaleontology, v. 8, p. 238, pl. 6, figs. 4–6.
Smith, 1963, Cushman Found. Foram. Research Contr., v. 14, p. 3, pl. 2, figs. 22, 23.

This cold water species is known from both the Arctic and the Antarctic and from scattered occurrences in both oceans. It is represented by only a few specimens found at Pamplona 3, 4, and 7.

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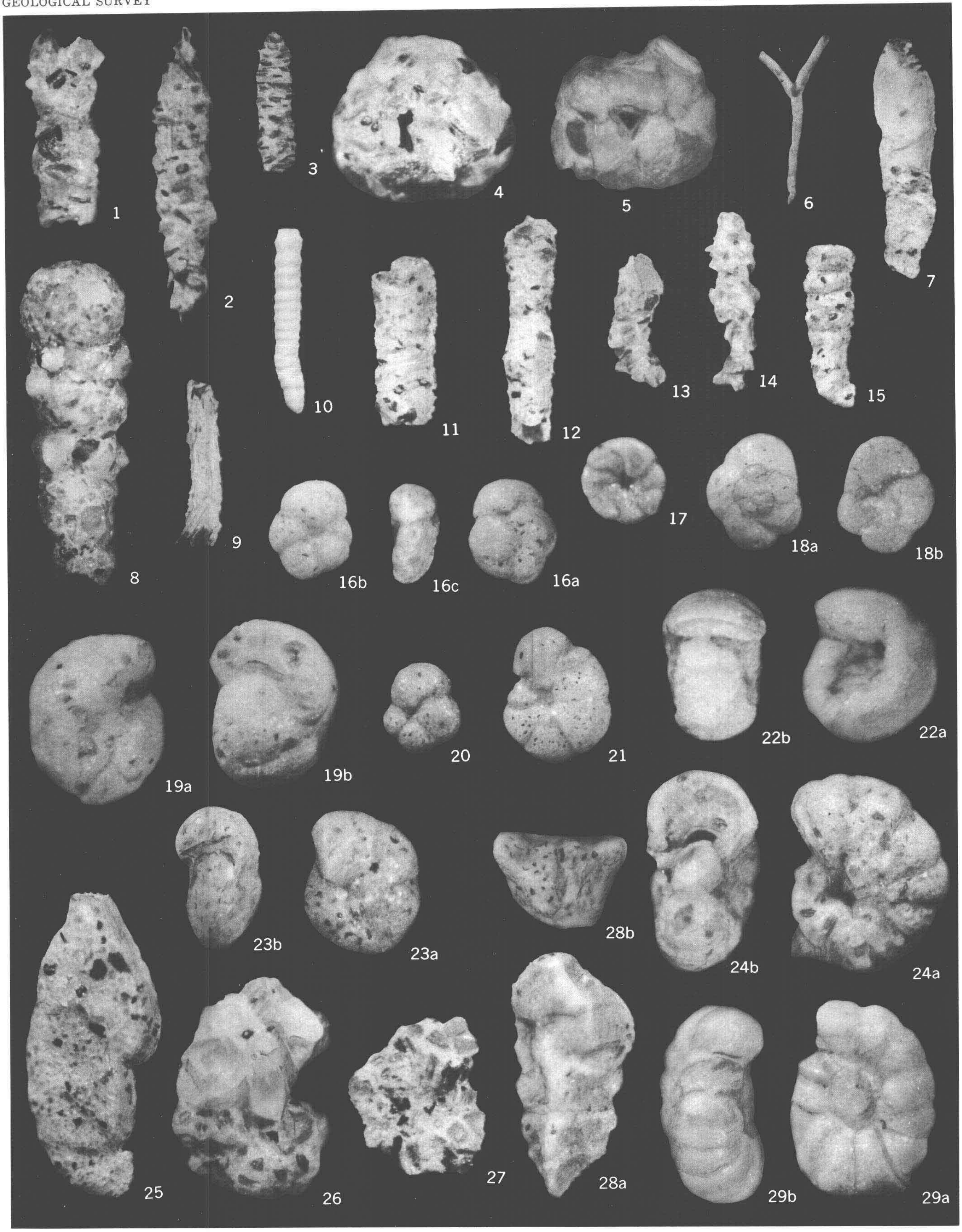

RECENT ARENACEOUS FORAMINIFERA

PLATE 2

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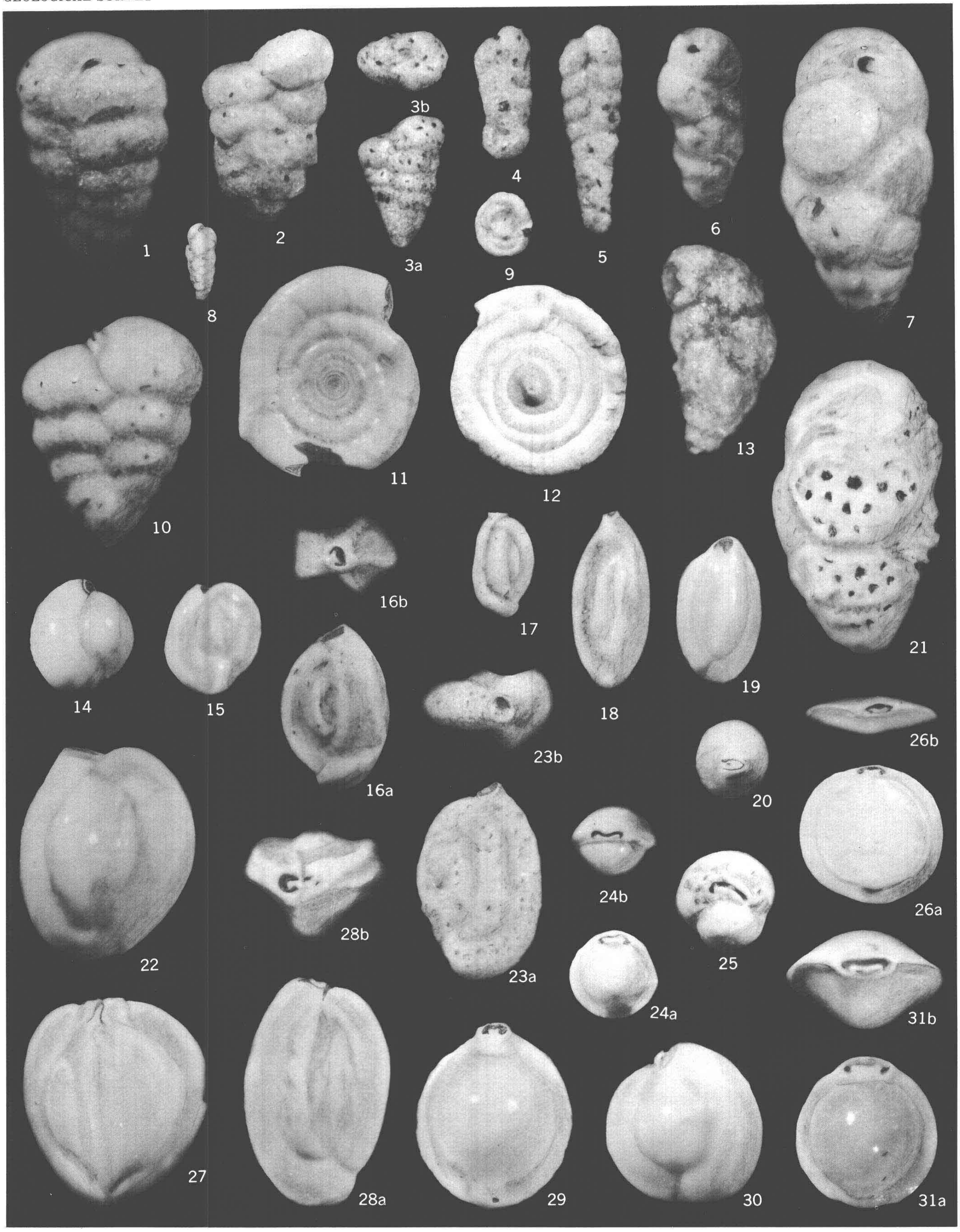

RECENT ARENACEOUS AND PORCELLANEOUS FORAMINIFERA

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14. *Polymorphina kincaidi* Cushman and Todd (p. A25).
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36. *Buliminella elegantissima* (d'Orbigny) (p. A26).
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37. *Buliminella subfusiformis* Cushman (p. A26).
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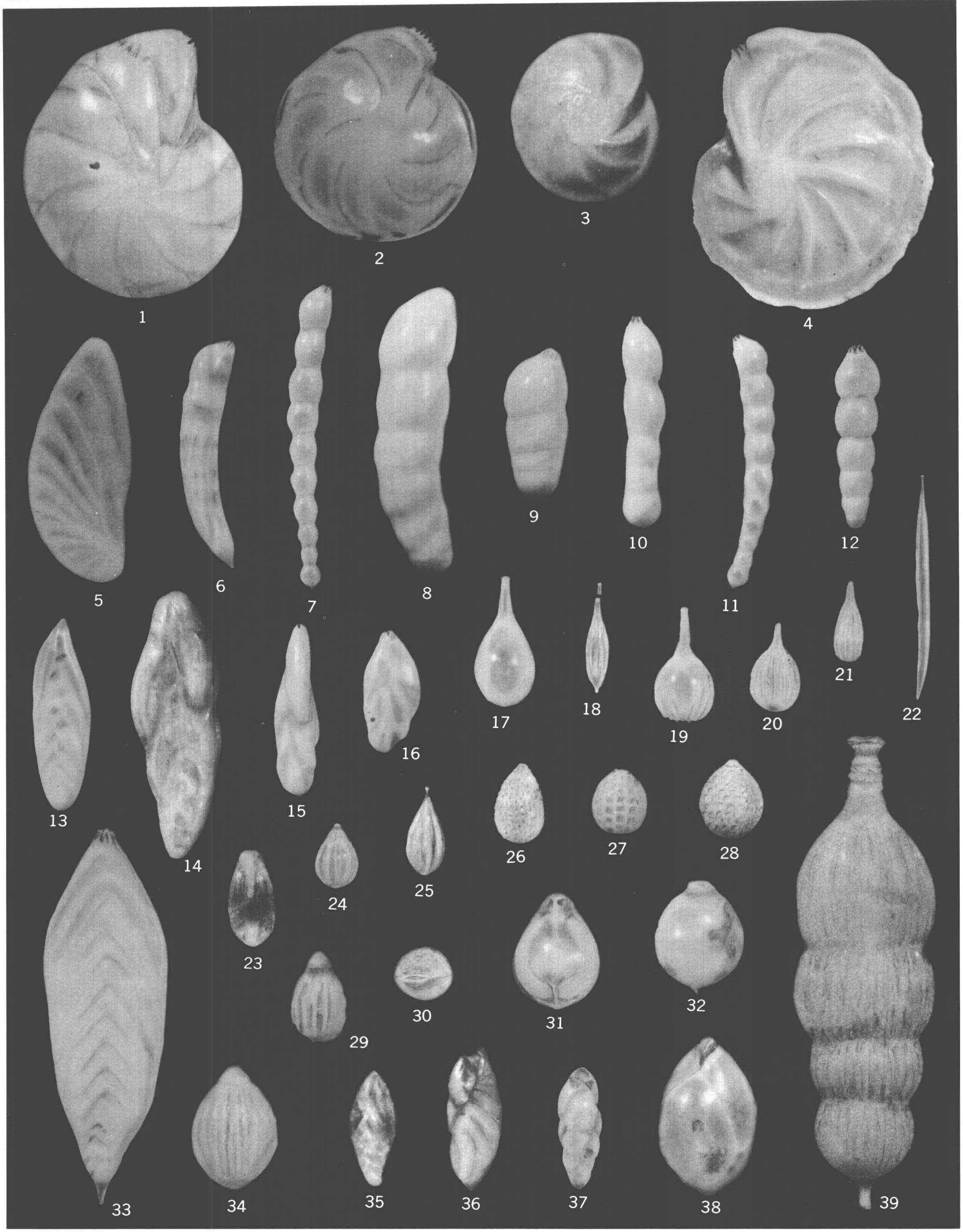
38. *Globobulimina auriculata* (Bailey) (p. A26).
USNM 642486, × 40; USGS loc. f25954 (Clarence Strait).

39. *Lagenonodosaria scalaris* (Batsch) (p. A23).
USNM 642424, × 75; USGS loc. f25950 (Pamplona 4).



RECENT LAGENIDAE, POLYMORPHINIDAE, AND BULIMINIDAE

PLATE 4

FIGURES 1–3. *Uvigerina peregrina* Cushman (p. A30).

1. USNM 642400, × 40; USGS loc. f25949 (Pamplona 3); smooth, elongate extreme of the species.
2. USNM 642490, × 45; USGS loc. f25954 (Clarence Strait); typical specimen.
3. USNM 642491, × 40; USGS loc. f25954 (Clarence Strait); spinose extreme of the species.

4. *Uvigerina* sp. (p. A30).
USNM 642492, × 40; USGS loc. f25954 (Clarence Strait).

5. *Angulogerina fluens* Todd (p. A30).
USNM 642464, × 40; USGS loc. f25952 (Pamplona 7).

6, 7. *Bolivina alata* (Seguenza) (p. A26).

6. USNM 642487, × 40; USGS loc. f25954 (Clarence Strait).
7. USNM 642488, × 40; USGS loc. f25954 (Clarence Strait).

8. *Bolivina subaenariensis* Cushman (p. A27).
USNM 642489, × 40; USGS loc. f25954 (Clarence Strait).

9, 10. *Elphidium frigidum* Cushman (p. A33).

9. USNM 642520, × 40; USGS loc. f25956 (Excursion Inlet); *a*, side view; *b*, edge view.
10. USNM 642521, × 40; USGS loc. f25956 (Excursion Inlet); *a*, side view; *b*, edge view.

11. *Bolivina decussata* Brady (p. A27).
USNM 642430, × 80; USGS loc. f25950 (Pamplona 4).

12. *Bolivina* (*Loxostomum*) *porrecta* (Brady) (p. A27).
USNM 642432, × 40; USGS loc. f25950 (Pamplona 4).

13. *Bolivina oceanica* Cushman (p. A27).
USNM 642459, × 80; USGS loc. f25952 (Pamplona 7).

14. *Bolivina pacifica* Cushman and McCulloch (p. A27).
USNM 642431, × 80; USGS loc. f25950 (Pamplona 4).

15. *Elphidiella arctica* (Parker and Jones) (p. A34).
USNM 642529, × 40; USGS loc. f25958 (Lynn Canal); *a*, side view; *b*, edge view.

16, 17. *Elphidium clavatum* Cushman (p. A33).

16. USNM 642493, × 40; USGS loc. f25954 (Clarence Strait); *a*, side view; *b*, edge view.
17. USNM 642494, × 40; USGS loc. f25954 (Clarence Strait); *a*, side view; *b*, edge view.

18. *Elphidium oregonense* Cushman and Grant (p. A34).
USNM 642509, × 14; USGS loc. f25955 (Kasaan Bay); *a*, side view; *b*, edge view.

19. *Elphidium bartletti* Cushman (p. A33).
USNM 642519, × 40; USGS loc. f25956 (Excursion Inlet); *a*, side view; *b*, edge view.

20. *Buccella frigida* (Cushman) (p. A31).
USNM 642518, × 40; USGS loc. f25956 (Excursion Inlet); *a*, dorsal view; *b*, ventral view; *c*, edge view.

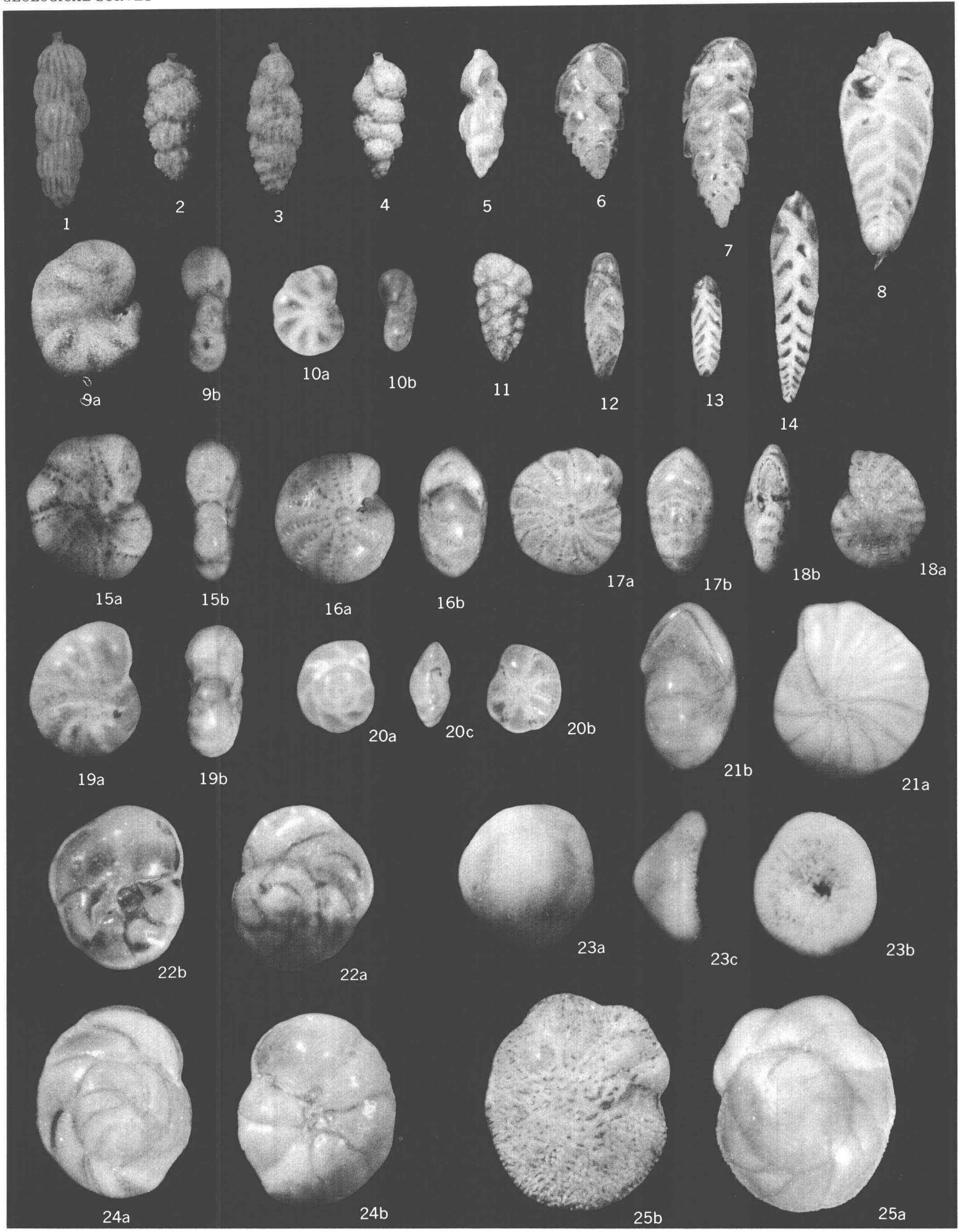
21. *Elphidiella groenlandica* (Cushman) (p. A34).
USNM 642522, × 40; USGS loc. f25956 (Excursion Inlet); *a*, side view; *b*, edge view.

22, 24. *Eponides isabelleanus* (d'Orbigny) (p. A31).

22. USNM 642401, × 28; USGS loc. f25949 (Pamplona 3); *a*, dorsal view; *b*, ventral view.
24. USNM 642402, × 28; USGS loc. f25949 (Pamplona 3); *a*, dorsal view; *b*, ventral view.

23. *Rosalina ornatissima* (Cushman) (p. A30).
USNM 642508, × 40; USGS loc. f25955 (Kasaan Bay); *a*, dorsal view; *b*, ventral view; *c*, edge view.

25. *Rotalia columbiensis* (Cushman) (p. A32).
USNM 642533, × 28; USGS loc. f25959 (Gambier Bay); *a*, dorsal view; *b*, ventral view.



RECENT BULIMINIDAE, ELPHIDIIDAE, DISCORBIDAE, AND ROTALIIDAE

PLATE 5

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

FIGURES 1, 2, 4. *Cibicides lobatulus* (Walker and Jacob) (p. A34).
1. USNM 642404, × 28; USGS loc. f25949 (Pamplona 3).
2. USNM 642403, × 28; USGS loc. f25949 (Pamplona 3).
4. USNM 642405, × 40; USGS loc. f25949 (Pamplona 3).

3. *Dyocibicides biserialis* Cushman and Valentine (p. A35).
USNM 642510, × 25; USGS loc. f25955 (Kasaan Bay).

5. *Rupertia stabilis* Wallich (p. A35).
USNM 642436, × 25; USGS loc. f25950 (Pamplona 4).

6, 7. *Pseudononion auricula* (Heron-Allen and Earland) (p. A36).
6. USNM 642527, × 40; USGS loc. f25957 (Taku Harbor).
7. USNM 642523, × 40; USGS loc. f25956 (Excursion Inlet).

8. *Nonionella turgida digitata* Nørvang (p. A36).
USNM 642497, × 40; USGS loc. f25954 (Clarence Strait); *a*, ventral view; *b*, edge view.

9. *Florilus labradoricus* (Dawson) (p. A35).
USNM 642495, × 40; USGS loc. f25954 (Clarence Strait); *a*, side view; *b*, edge view.

10. *Cassidulina teretis* Tappan (p. A38).
USNM 642511, × 80; USGS loc. f25955 (Kasaan Bay).

11. *Cassidulina norcrossi* Cushman (p. A37).
USNM 642480, × 80; USGS loc. f25953 (Pamplona 8).

12. *Cassidulina tortuosa* Cushman and Hughes (p. A38).
USNM 642406, × 40; USGS loc. f25949 (Pamplona 3).

13. *Cassidulina californica* Cushman and Hughes (p. A37).
USNM 642438, × 25; USGS loc. f25950 (Pamplona 4).

14. *Nonionella pulchella* Hada (p. A35)
USNM 642496, × 40; USGS loc. f25954 (Clarence Strait).

15. *Epistominella vitrea* Parker (p. A32).
USNM 642524, × 80; USGS loc. f25956 (Excursion Inlet).

16. *Ehrenbergina compressa* Cushman (p. A38).
USNM 642439, × 75; USGS loc. f25950 (Pamplona 4).

17. *Astrononion gallowayi* Loeblich and Tappan (p. A36).
USNM 642437, × 75; USGS loc. f25950 (Pamplona 4).

18. *Epistominella pacifica* (Cushman) (p. A32).
USNM 642498, × 75; USGS loc. f25954 (Clarence Strait).

19, 21. *Globigerina bulloides* d'Orbigny (p. A39).
19. USNM 642407, × 40; USGS loc. f25949 (Pamplona 3).
21. USNM 642408, × 40; USGS loc. f25949 (Pamplona 3).

20. *Pullenia salisburyi* R. E. and K. C. Stewart (p. A38).
USNM 642440, × 75; USGS loc. f25950 (Pamplona 4); *a*, side view; *b*, edge view.

22. *Globigerina pachyderma* (Ehrenberg) (p. A39).
USNM 642466, × 80; USGS loc. f25952 (Pamplona 7).

23. *Globorotalia scitula* (Brady) (p. A39).
USNM 642467, × 80; USGS loc. f25952 (Pamplona 7).

24. *Orbulina universa* d'Orbigny (p. A39).
USNM 642441, × 85; USGS loc. f25950 (Pamplona 4).

25. *Globigerina* aff. *G. eggeri* Rhumbler (p. A39).
USNM 642465, × 80; USGS loc. f25952 (Pamplona 7).

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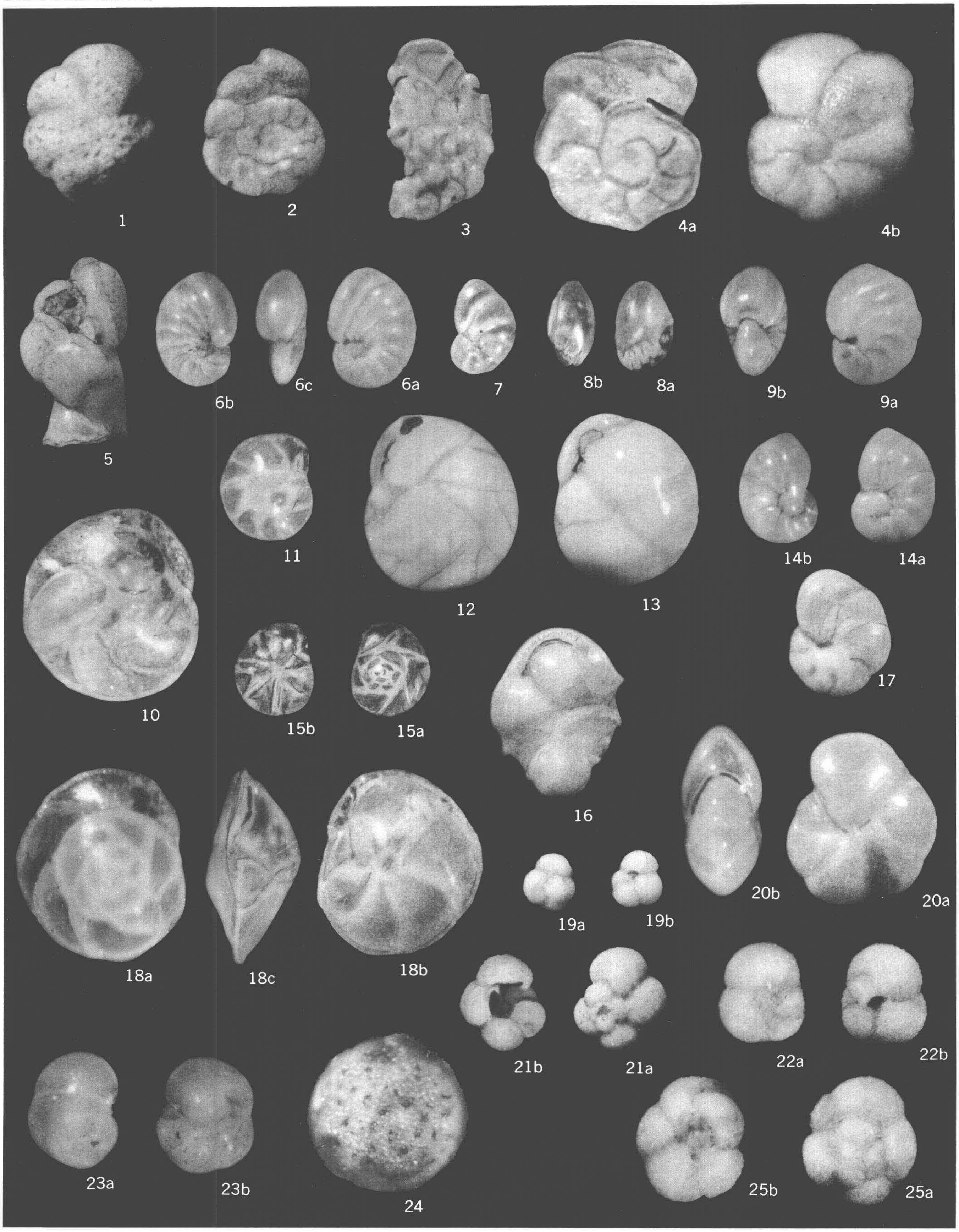

RECENT MISCELLANEOUS BENTHONIC AND PLANKTONIC FORAMINIFERA