

# RECENT FORAMINIFERA FROM THE WEST COAST OF SOUTH AMERICA

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During his recent collecting trip about South America, Dr. Waldo L. Schmitt, of the United States National Museum, as the Walter Rathbun Bacon travelling scholar of the Smithsonian Institution obtained bottom samples from numerous localities. Those from Juan Fernandez have already been studied and the results published.<sup>1</sup> The results of the study of the samples collected along the west coast of South America from Chile to Ecuador, inclusive, are given in the present paper. While the samples are not rich in number of species, nevertheless the number of specimens is often very large. Very few of the species are identical with those of Juan Fernandez, and the two faunas are very different also in the genera each contains. Along the west coast the sample from Santa Elena, Ecuador, is very distinct from those to the southward, as it contains tropical forms which are like those of the West Indian region and these do not occur in the samples from the colder waters farther to the south.

The foraminiferal fauna of the west coast of South America is very little known. In 1839, d'Orbigny published the results of his South American voyage, the Foraminifera appearing as Part 5, of the fifth volume of the *Voyage dans l'Amérique Méridionale*, with 86 pages and 9 very beautiful plates in color. It is not difficult to place most of the west coast species by consulting the figures and especially the descriptions in this work. Some of the samples collected by Doctor Schmitt are from the same locality as those from which d'Orbigny collected. Especially the rather rich collections from off Payta, Peru, have many of the older species present. Many of the d'Orbignyan species have been allowed to lapse or have been placed in the synonymy by later authors. The species from this region are really very distinctive, as one can readily see when they are studied and comparisons made with specimens from other areas.

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<sup>1</sup>Cushman and Wickenden, *Proc. U. S. Nat. Mus.*, vol. 75, art. 9, 1929.

Except for this classic work of d'Orbigny, very little has been collected or published from this area. There are a number of records in the *Challenger* report from collections made by the *Challenger* among the islands of the southern part of the Chilean coast, but only a few of these stations were included in those studied by Brady. The United States Bureau of Fisheries steamer *Albatross* in the voyage up the west coast of South America made a few collections off the coast, but for the most part these are not now available and nothing has as yet been published on them. Berry published a short note<sup>2</sup> on a new *Nonion* from the coast of Peru. His species we have found in some numbers in some of the samples we have studied. Altogether this is one of the least known of the oceanic areas unless we except the Western coast of Africa.

Very few of the forms are new but a few of them appear to be undescribed. Nearly all of the species are illustrated and we have to thank Miss Margaret S. Moore for her painstaking work in making the drawings from selected specimens. The following are the species obtained in the collections:

### Family SACCAMMINIDAE

#### Genus PROTEONINA Williamson, 1858

##### PROTEONINA FUSIFORMIS Williamson

##### Plate 1, figure 1

*Proteonina fusiformis* WILLIAMSON, Rec. Foram. Gt. Britian, 1858, p. 1, pl. 1, fig. 1.—RHUMBLER, Arch. Prot., vol. 3, 1903, p. 248, fig. 84 (in text).—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 1, 1910, p. 41, fig. 39 (in text); Bull. 104, U. S. Nat. Mus., pt. 1, 1918, p. 47; Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 49.

*Reophax fusiformis* (of Authors).

There is a single fusiform specimen from Lota, Chile. It has an arenaceous test and apparently a single chamber. The species is a widely distributed one known from a number of stations in the Pacific at various depths.

#### Genus SOROSPHERA H. B. Brady, 1879

##### SOROSPHERA CONFUSA H. B. Brady

##### Plate 1, figure 2

*Sorosphaera confusa* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 28, pl. 4, figs. 18, 19; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 251, pl. 18, figs. 9, 10.—WOODWARD, The Observer, vol. 4, 1893, p. 78.—KIAER, Rep't. Norwegian Fish. and Mar. Invest., vol. 1, No. 7, 1900, p. 14.—RHUMBLER, Arch. Prot., vol. 3, 1903, p. 235, fig. 63 (in text).—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 1, 1910, p. 37, figs. 31, 32 (in text).—PEARCEY, Trans. Roy. Soc. Edinburgh, vol. 49, 1914, p. 1000.—CUSHMAN, Bull. 104, U. S. Nat.

<sup>1</sup>Journal of Paleontology, vol. 1, No. 4, 1923, p. 269.

Mus., pt. 1, 1918, p. 39, pl. 15, figs. 4, 5; Contrib. Canadian Biol., 1921 (1922), p. 4.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zool., vol. 6, 1922, p. 84.—CUSHMAN, Spec. Publ. No. 1, Cushman Lab. Foram. Res., 1928, pl. 3, figs. 17, 18.

The records for this species are mostly from relatively cold water. Specimens are recorded from both the Arctic and Antarctic with a few intermediate records. The single specimen figured here is from off Payta, Peru, attached to a flake of mica.

Attention should be drawn to the peculiar forms figured by Heron-Allen and Earland from the Antarctic under the names *Trochammmina uriformis* Grzybowski and *T. moniliformis* Heron-Allen and Earland which somewhat resemble our specimen.

### Family TEXTULARIIDAE

#### Genus TEXTULARIA Defrance, 1824

TEXTULARIA, species (?)

Plate 1, figures 4 a, b

The figured specimen is broken at both ends and is the only one of this particular form found in the collection. The wall is thin, and the whole test much compressed. It is from off Eten, Peru.

#### Genus BIGENERINA d'Orbigny, 1826

BIGENERINA DELICATULA, new species

Plate 1, figures 3, 5

Test minute, elongate, slender, slightly tapering, somewhat compressed, early chambers biserial, later ones uniserial, the relative number of each group very variable; periphery rounded; earlier chambers low and broader than high, later ones increasing in height; sutures fairly distinct, very slightly depressed; wall composed of comparatively large arenaceous fragments, with a small amount of cement, the whole wall easily collapsible when wet; aperture terminal in the adult, narrowly elliptical.

Maximum length, 0.35 mm.; breadth, 0.12 mm.; thickness, 0.06 mm.

*Holotype*—(Cat. No. 20783, U.S.N.M.). From off Payta, Peru.

This species is abundant at this locality, and specimens were also obtained in material from off Pinatel, Peru. It is a small, very delicate species and rather uniform in size. The larger specimens, which are apparently microspheric, assume the uniserial character fairly soon, but there are other smaller ones which prolong the biserial character, and if it were not that the forms occur together and are of the same general size and appearance, might be thought to be *Textularia*.

## Family MILIOLIDAE

## Genus QUINQUELOCULINA d'Orbigny, 1826

## QUINQUELOCULINA, species (?)

Plate 1, figures 6 a, b

The broken specimen here figured has a few longitudinal striations, but it is impossible to determine whether this is an adult or not and so no attempt has been made to place it specifically. It is from off Santa Elena, Ecuador.

## QUINQUELOCULINA, species (?)

Plate 1, figures 7 a-c

This smooth form also from off Santa Elena, Ecuador, has not enough specimens to give full specific characters. It appears to be quinqueloculine, but may be only the early stage of a smooth *Triloculina*. A very few specimens of this group were also obtained from off Corral, Chile, but not enough for identification.

## Family TROCHAMMINIDAE

## TROCHAMMINA PERUVIANA, new species

Plate 1, figures 8 a, b

Test trochoid, spire greatly flattened, dorsally very slightly convex, ventrally slightly concave, consisting of three or four whorls; chambers numerous, 10 or more in the last-formed whorl, of rather uniform size and shape increasing slowly in size as added; sutures on the dorsal side gently curved, very slightly depressed, only those of the last-formed whorl distinct, on the ventral side gently curved or with a sinuous, lobed condition especially in later portions, distinct; wall finely arenaceous with much chitin, thin, very flexible when wet; aperture ventral, along the inner margin of the last-formed chamber.

Diameter, 0.45 mm.

*Holotype*.—(Cat. No. 20784, U.S.N.M.) From off Eten, Peru.

This species is closely allied to *Trochammina ochracea* Williamson and *T. plicata* Terquem. The peculiar sinuous arrangement of the ventral side is different from either of these, of each of which we have had excellent series of recent European specimens for comparisons.

## Family NONIONIDAE

## Genus NONION Montfort, 1808

## NONION PIZARRENSIS Berry

Plate 1, figures 10 a, b; plate 2, figures 1 a, b

*Nonion pizarrensis* BERRY, Journ. Pal., vol. 1, 1927-28 (1928), p. 269, figs. 1-3 (in text).

Test nearly bilaterally symmetrical, slightly longer than broad in side view, periphery broadly rounded, umbilici depressed but not

open; chambers 12–15 in the last-formed coil, elongate, curved, the apertural face convex; sutures distinct, depressed strongly at the inner end, becoming less so toward the periphery, gently curved; wall smooth, polished, very finely perforate; aperture elongate, at the base of the apertural face, often slightly more extended on one side than the other.

Length, 0.50–0.63 mm.; breadth, 0.38–0.46 mm.; thickness, 0.22–0.26 mm.

Berry recently described this species from about 8 fathoms of water at the mouth of the Tumbes River at Puerto Pizarro, Peru. We have had specimens from Payta and Pimentel, Peru, which are evidently this same species. The adult specimens have slightly more chambers than does the type, but the measurements and proportions show that there is a single species in the series. There is a tendency as noted by Berry for the test to become slightly asymmetrical.

#### Genus *NONIONELLA* Cushman, 1926

##### *NONIONELLA AURIS* (d'Orbigny)

Plate 1, figure 9; plate 2, figures 2, 3

*Valvulina auris* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 47, pl. 2, figs. 15–17.

Test asymmetrical, slightly trochoid, the spire not raised, periphery in the adult broadly rounded; chambers 9–11 in the adult, low and broad, very distinct, slightly inflated, in the adult with the last-formed chamber having an enlarged portion extending over the umbilicus on the ventral side; sutures distinct, depressed, gently curved; wall smooth, polished, very finely perforate; aperture at the base of the last-formed chamber extending from the periphery ventrally, low and broad.

Maximum length, 0.40 mm.; breadth, 0.30 mm.; thickness, 0.18 mm.

D'Orbigny described this species from many localities along the west coast of South America from Chile to Ecuador saying that it makes up nine-tenths of the foraminifera of the Peruvian coast. We have found it in material from Payta, Pimentel, and Eten, Peru, and from Corral and Lota, Chile. The bulbous expansion of the chamber on the ventral side is often not taken on until the specimen is fully developed and specimens in this state are figured. Farther north and in the late Tertiary of California this is replaced by its probable ancestral form, *Nonionella miocenica* Cushman which has fewer and relatively larger chambers.

It was suspected that *Nonion pizarrensis* Berry might be the microspheric form of d'Orbigny's species but apparently they are distinct so far as the material we have will show. This relationship is however suggested for future studies.

**NONIONELLA CHILIENSIS, new species**

Plate 2, figures 4 a-c

Test asymmetrical, trochoid, the spire very much flattened, consisting of about  $2\frac{1}{2}$  whorls, periphery subacute, umbilicus depressed; chambers numerous, 10-12 in the last-formed whorl, low and broad, not inflated; sutures distinct, not depressed, strongly limbate, on the dorsal side oblique, ventrally strongly curved; wall smooth, polished, very finely perforate; aperture low, elongate, at the margin of the chamber extending from the periphery ventrally.

Maximum height, 0.40 mm.; breadth, 0.35 mm.; thickness, 0.18 mm.

*Holotype*.—(Cat. No. 20785, U.S.N.M.). From off Corral, Chile. It also occurs in material from Lota, Chile.

At first glance this might not be thought to be a *Nonionella*, but the general characters of the test are much like the others noted except for the greater amount of asymmetry and the limbate sutures.

**Genus ELPHIDIUM Montfort, 1808****ELPHIDIUM ALVAREZIANA (d'Orbigny)**

Plate 2, figures 5 a, b

*Polystomella alvareziana* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5 "Foraminifères," p. 31, pl. 3, figs. 11, 12.

There are a very few specimens from the coast of Chile off Lota and Corral that are very close to this species described from d'Orbigny from the Falklands and the coast of Argentina. The number of chambers, the general shape and character of the retral processes and of the umbilical region are similar to the figure given by d'Orbigny. Our specimens are somewhat thicker in peripheral view.

Diameter, 0.45 mm.; thickness, 0.20 mm.

**Family BULIMINIDAE****Genus BULIMINELLA Cushman, 1911****BULIMINELLA ELEGANTISSIMA (d'Orbigny)**

Plate 3, figures 1-3

*Bulimina elegantissima* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, No. 5, "Foraminifères," p. 51, pl. 7, figs. 13, 14.—SCHLUMBERGER, Feuille Jeun. Nat., vol. 12, 1881, pl. 1, fig. 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 402, pl. 50, figs. 20-22.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 11, pl. 2, fig. 6.—CHAPMAN, Rep't. Foram. Subantarctic Ids., New Zealand, 1909, p. 330; Biol. Res. *Endeavour*, vol. 3, pt. 1, 1915, p. 18.—SIDEBOTTOM, Journ. Roy. Micr. Soc., 1918, p. 122.—HERON-ALLEN and EARLAND, British Antarctic Exped., Zool., vol. 6, 1922, p. 129.

*Buliminella elegantissima* CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 89; Proc. U. S. Nat. Mus., vol. 56, 1919, p. 606; Contr. Cushman Lab. Foram. Res., vol. 1, pt. 2, 1925, p. 40, pl. 6, figs. 5 a, b.

This species is many times recorded in the literature, but from a study of specimens from many parts of the present oceans as well as fossil ones it is apparent that several distinct forms are included under this name. D'Orbigny originally described the species from the west coast of South America from Payta, Peru, Cobija, Bolivia (now Cobija, Chile), and Valparaiso, Chile, and off Cape Horn. It has occurred abundantly in our material from Payta, Eten, and Pimentel, Peru, and from Lota and Corral, Chile. It is evident that the species is one of the cooler waters of the western coast of the Americas and probably to be found in a wider distribution, but this is to be proved. The species is recorded often from the region of the British Isles, but specimens do not closely match those from South America. The specimens from Samoa and from the Miocene of Australia are not the same.

The different stages in development show considerable differences in form. Plate 3, figure 3, is a young specimen and corresponds closely to that named by Sidebottom, var. *fusiformis*.<sup>3</sup> An older specimen is shown in Figure 2. An adult probably of the megalospheric form is shown in Plate 3, Figure 1.

#### Genus BULIMINA d'Orbigny, 1826

##### BULIMINA PATAGONICA d'Orbigny

Plate 3, figures 4 a, b

*Bulimina patagonica* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 50, pl. 1, figs. 8, 9.—CUSHMAN and WICKENDEN, Proc. U. S. Nat. Mus., vol. 75, 1929, p. 8, pl. 3, figs. 11 a, b.

D'Orbigny described this species in his South American monograph. It is allied in some respects to *B. marginata* and *B. pulchella*. It has a very distinctive set to the chambers and the teeth at the base of the chamber are never large nor are they usually regular. The specimens are from off Payta, Peru.

The species also occurs off Juan Fernandez.

#### Genus VIRGULINA d'Orbigny, 1826

##### VIRGULINA, species (?)

Plate 3, figures 5-7.

There are a few specimens such as figured here which are somewhat of a puzzle. They are smooth, and resemble the form called *Bulimina patagonica* d'Orbigny, var. *glabra* Cushman and Wickenden, but tend to become biserial in the later portion. No definite species of *Virgulina* was found in the collection.

<sup>3</sup>Journ. Roy. Micr. Soc., 1918, p. 123, pl. 3, figs. 8-10.

Genus *BOLIVINA* d'Orbigny, 1839*BOLIVINA COSTATA* d'Orbigny

Plate 3, figures 9 a-c

*Bolivina costata* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 62, pl. 8, figs. 8, 9.

Test small, tapering, broadest toward the apertural end in both front and side views, periphery broadly rounded; chambers numerous, the earlier ones low and broad, later ones becoming gradually higher until in the last-formed ones the height is often nearly equal to the breadth, slightly inflated; sutures somewhat indistinct, but appearing as irregular angular lines between the sutures pointing toward the aperture, due to the suture line extending out onto the costae and backward at the same time; wall very coarsely perforate, with a few sharp, raised longitudinal costae continuous over the sutures, usually five or six costae on a side, last-formed chambers of each series usually smooth on the outer face; aperture narrow, elliptical, extending in from the base nearly in the median line.

Maximum length, 0.40 mm.; breadth, 0.15 mm.; thickness, 0.12 mm.

D'Orbigny's types are from Cobija, Chile, in d'Orbigny's time Bolivian territory. In our material, the species has proved to be very abundant at Eten, less so at Pimentel, and rather scarce at Payta, Peru. It did not occur in the material from Chile or Ecuador. It is by far the dominant species at Eten, occurring by hundreds and showing very little variation. It is identical with d'Orbigny's figure and description, but not at all the same as *Bolivina costata* of Brady in the *Challenger* report.

*BOLIVINA DONIEZI* Cushman and Wickenden

Plate 3, figures 8 a, b

*Bolivina doniezi* CUSHMAN and WICKENDEN, Proc. U. S. Nat. Mus., vol. 75, 1929, p. 9, pl. 4, figs. 3 a, b.

Test small, depressed, broadest near the apertural end; chambers comparatively few, consisting of eight or ten pairs; wall very coarsely perforate, the earlier chambers with a few coarse perforations near the basal margin, the adult chambers with the coarse perforations scattered over the general surface; chambers fairly narrow, but becoming higher toward the apertural end; sutures distinct, depressed, strongly oblique; aperture elongate, arched, in the median line at the base of the last-formed chamber.

Length of figured specimen, 0.21 mm.; breadth, 0.10 mm.; thickness, 0.7 mm.

This species described from Juan Fernandez is very rare at Payta, Peru. Its characters hold very distinctly.

## Genus REUSSIA Schwager, 1877

## REUSSIA SPINULOSA (Reuss)

Plate 3, figures 10 a, b

*Verneuilina spinulosa* REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 374, pl. 47, fig. 12.—(and later Authors).

*Reussia spinulosa* SCHWAGER, Boll. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 66.

There is a single specimen of *Reussia* from off Santa Elena, Ecuador which may be referred to this species. The apertural end is incomplete.

## Family ROTALIIDAE

## Genus DISCORBIS Lamarck, 1804

## DISCORBIS ISABELLEANA (d'Orbigny)

Plate 3, figures 12 a-c

*Rosalina isabelleana* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 43, pl. 61, figs. 10-12.

*Discorbina isabelleana* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 646, pl. 88, figs. 1 a-c (?).

*Discorbis isabelleana* CUSHMAN, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 160, pl. 4, fig. 4.

*Discorbina vilardeboana* H. B. BRADY (not d'Orbigny), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 645, pl. 88, fig. 2.

Test trochoid, in edge view biconvex, spire low; periphery acute but not carinate; six chambers in the last-formed coil, distinct, increasing regularly in size as added, ventrally with a slight lip in the umbilical region which is depressed; sutures very distinct, strongly curved; wall smooth, finely perforate; aperture, a narrow ventral slit below the umbilical border of the chamber.

Length, 0.25 mm.; breadth, 0.18 mm.; thickness, 0.10 mm.

This species is widely distributed along the Western Coast of the Americas. It is recorded under the name of *Discorbina vilardeboana* by various authors basing the determination on the *Challenger* figures rather than that of d'Orbigny which do not belong to the same species. Our specimens are from Lota, Chile, and Pimentel, Peru.

## DISCORBIS CHILIENSIS, new species

Plate 3, figures 11 a-c

Test plano-convex, dorsal side strongly convex, ventral side flattened or concave, periphery acute but not carinate, somewhat involute on the dorsal side; chambers distinct, about seven in the last-formed whorl, slightly inflated on the ventral side and ending in a distinct angle at the umbilical end; sutures distinct, on the dorsal side slightly limbate and raised, strongly curved, on the ventral side depressed, gently curved; wall rather coarsely perforate; aperture on the ventral side below the umbilical margin of the chamber.

Length, 0.30–0.35 mm.; breadth, 0.20–0.22 mm.; thickness, 0.10–0.12 mm.

*Holotype*.—(Cat. No. 20786, U.S.N.M.) From off Lota, Chile.

At the type locality the specimens show a considerable range of variation. The spire may become somewhat higher and the whole test slightly more rounded. The amount of limbation of the sutures may be greater in the earlier coils and slightly less than shown in the adult. The test has a peculiar silvery-white, opaque appearance in all specimens seen. There is a single specimen from Eten, Peru, that is probably the same.

**DISCORBIS CONSOBRINA (d'Orbigny)**

Plate 4, figures 1, 2

*Rosalina consobrina* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 46, pl. 7, figs. 4–6.

Test biconvex, the dorsal side more strongly so, ventral side depressed in the umbilical region, periphery rounded; chambers five to seven in the last-formed whorl, distinct, regularly increasing in size as added, slightly inflated, on the ventral side ending in distinct angles on the umbilical end; sutures distinct, on the dorsal side oblique, very slightly curved, very little if at all depressed, on the ventral side slightly curved, nearly radial, depressed; wall smooth, distinctly perforate; aperture below the distinct lip on the ventral side of the chamber and extending into the umbilical region.

Diameter, 0.30 mm.; height, 0.22 mm.

D'Orbigny described this species from off the coast of Peru, and it has occurred in our material from off Payta and Eten, Peru, and Corral, Chile. Plate 4, figure 1 shows the microspheric form which has many more chambers and more coils and a higher spire than in the megalospheric form (fig. 2). D'Orbigny's figured specimen was evidently a megalospheric one. A comparison of figure 2 with d'Orbigny's type figure will show the very close similarity of the two.

**Genus EPONIDES Montfort, 1808**

**EPONIDES PERUVIANA (d'Orbigny)**

Plate 4, figures 5 a–c

*Rosalina peruviana* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, pt. 5, "Foraminifères," p. 35, pl. 2, figs. 3–5.

Test trochoid, nearly equally biconvex, periphery carinate, generally circular in outline; chambers numerous, distinct, about eight in the last-formed whorl, on the dorsal side forming a very even polished surface, ventrally inflated, giving a very distinct appearance to the test; sutures very distinct on the dorsal side, curved, flush with

the surface, slightly limbate, on the ventral side radial, depressed; wall smooth, very finely perforate; aperture ventral, at the base of the chamber between the periphery and the umbilicus.

Diameter, 0.40 mm.; thickness, 0.25 mm.

D'Orbigny gives the following localities, common on the coast of Peru near the island of San Lorenzo, harbor of Callao and Arica; in sands from the island of Puna, at the mouth of the Rio de Guayaquil also at Valparaiso, Chile; Cobija, Bolivia (now Cobija, Chile), and at Payta and Acapulco, Peru. D'Orbigny says that it is probably to be found along the whole coast from 34° S. latitude to the equator.

In our material it was common at Lota, Chile, less so at Corral, Chile, and Payta, Peru.

This is a very distinctive species excellently illustrated by d'Orbigny. It is probably the same in part at least as the recent species referred by Brady to the cretaceous species *Rotalia karsteni* Reuss. In the *Challenger* report there is a small species recorded from numerous stations about the southern part of South America and a larger very similar one from the Arctic. Although the figures of these two in the *Challenger* plates look very much alike, it would seem to be worthy of interest to compare closely, specimens from these widely separated areas.

**EPONIDES REPANDA (Fichtel and Moll)**

Plate 4, figures 7 a-c

There are specimens from Santa Elena, Ecuador, that are very typical of this species as figured by Brady in the *Challenger* report, and by other authors. Whether or not these are the same as the original species of Fichtel and Moll is a matter to be left for further studies of specimens from the type localities. It is a thick-walled species of good size and evidently limited in its distribution in this area, not occurring in the collections from the more southern localities.

**EPONIDES MERIDIONALIS, new species**

Plate 4, figures 4, 6

Test trochoid, nearly circular, nearly equally biconvex, periphery in the young somewhat rounded, in the adult acute and carinate; chambers very distinct but not inflated, gradually increasing in size as added, about 12 in the last-formed coil in the adult; sutures distinct, limbate and with a raised ornamentation, oblique and slightly curved dorsally, nearly radiate ventrally; wall finely perforate, ornamented on the dorsal side by the raised sutural thickening and the thickened peripheral border of the chambers, on the ventral side by the beaded or raised suture lines often ending in a series of small knobs in the center and in some specimens with thickly scattered

raised beadlike protuberances covering the whole chamber wall between the radial sutures; aperture low, elongate, on the proximal third of the ventral border.

*Holotype*.—(Cat. No. 20787, U.S.N.M.). From off Corral, Chile. It occurred also off Lota, Chile and Pimentel, Peru in considerable numbers. The early stages are shown in plate 4, figure 4 *a-c*, and the adult characters in figures 6 *a-c*. The umbilicus is filled but does not have an isolated plug as in *Rotalia*.

**EPONIDES, species (?)**

Plate 4, figures 3 *a-c*

The small form figured is from off Pimentel, Peru. It is figured for record as it is evidently not an adult specimen and there are no others to give detailed characters.

**Genus ROTALIA Lamarck, 1804**

**ROTALIA INCA (d'Orbigny)**

Plate 5, figures 1 *a-c*

*Rosalina inca* D'ORBIGNY, Voy. Amér. Mérid., 1839, vol. 5, No. 5, "Foraminifères," p. 45, pl. 7, figs. 1-3.

Test trochoid, nearly circular in outline, biconvex, of about four whorls, the ventral side more convex than the dorsal, periphery rounded; chambers numerous and very distinct, uniformly increasing in size as added, 10 to 13 in the last-formed coil in the adult, somewhat inflated on the ventral side, ending at the umbilical end in distinct angles; sutures very distinct, slightly limbate above, oblique, not depressed nor raised, below nearly radial, deeply excavated, widening and deepening toward the umbilical end, umbilicus with a plug often broken on the exterior into several small bosses; wall on the dorsal side, smooth and polished, ventrally with two distinct areas, the sides of the chamber especially near the inner end very clear and with extremely fine pores, the middle portion of each chamber with coarser pores and much less clear wall; aperture on the ventral side part way between the periphery and central plug.

Diameter, 0.75 mm.; thickness, 0.40 mm.

This is evidently the species described by d'Orbigny as common from Callao, Peru. He says it is related to his *Rosalina parkinsoniana* which is evidently in turn related to *Rotalia beccarii* (Linnaeus). This is one of the most abundant species at Corral, Chile, but not found at other stations in the collections. It does not have the beaded edges on the ventral side so characteristic of *R. beccarii* in its typical form and seems to be close to the forms described from the West Indies but not identical. It is one of the species of the *R. beccarii* group that should be distinguished in various regions.

## ROTALIA ROSEA d'Orbigny

Plate 5, figures 2, 3

*Rotalia rosea* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 272, No. 7; Modèles No. 36.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 24, pl. 3, figs. 7-9.

*Rotalina rosea* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 72, pl. 3, figs. 9-11.

*Truncatulina rosea* H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 667, pl. 96, fig. 1.—FLINT, Ann. Rep't U. S. Nat. Mus., 1897 (1899), p. 334, pl. 78, fig. 2; Bull. U. S. Fish Commission No. 484, 1900, p. 416.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, No. 2, 1908, p. 30; Carnegie Instit. Washington, Publ. 213, 1918, p. 284; Proc. U. S. Nat. Mus., vol. 59, 1921, p. 56, pl. 13, figs. 1-3; Publ. 311, Carnegie Instit., 1922, p. 46, pl. 14, figs. 3-5; Publ. 344, 1925, p. 78.

Test trochoid, biconvex, the dorsal side often with a high spire, periphery acute, or with small spinose projections or with irregular plate-like extensions at each chamber, umbilical area with a distinct plug; chambers usually 9 to 10 in the last-formed whorl, increasing gradually in size as added, not inflated; sutures limbate but not raised, oblique on the dorsal side, nearly radial on the ventral side, flush on the dorsal side, depressed on the ventral side; wall coarsely perforate, smooth or ornamented with bead-like projections, especially near the periphery; aperture, an elongate slit at the inner margin of the ventral side of the chamber, with a considerable lip developed above it, color rose-red to reddish brown.

Diameter averaging about 0.40 mm.

The only station for this species in the material is Santa Elena, Ecuador, where it was fairly common. It shows the various forms that it develops in the West Indian region and the record is interesting as showing the occurrence of a typical restricted West Indian species on the Pacific side of America. Evidently this tropical fauna extends about as far south as the great western angle of South America after which it gives way to a colder-water fauna extending far to the south.

## Family CYMBALOPORETTIDAE

## Genus TRETOMPHALUS Moebius, 1880

## TRETOMPHALUS BULLOIDES (d'Orbigny)

*Rotalina bulloides* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 104, pl. 3, figs. 2-5.

*Cymbalopora bulloides* CARPENTER, PARKER, and JONES, Introd. Foram., 1862, p. 216.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 638, pl. 102, figs. 7-12; text figs. 20 a-c.

*Tretomphalus bulloides* MOEBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 98, pl. 10, figs. 6-9.—CUSHMAN, Publ. 311, Carnegie Instit. Washington, 1922, p. 42, text figs. 2, 3; Publ. 342, 1924, p. 36, pl. 11, figs. 1-3.—

CUSHMAN and WICKENDEN, Proc. U. S. Nat. Mus., vol. 75, 1929, p. 12, pl. 5, figs. 2-4.

Test free, subglobular, early chambers rotaliform, numerous, rather coarsely perforate, forming a cap to which is attached in the adult pelagic stage a large final "balloon-chamber," subspherical, with coarse perforations on the ventral side and within, a "float-chamber" with a single opening at the base from which a tubular neck projects inward; color of the early chambers dark brown, the large chamber colorless.

Diameter, 0.50 mm.

The only specimens in the collection are from the station off Santa Elena, Ecuador, at which the other tropical West Indian species were present. It is a very widely distributed species on account of its pelagic habit in the adult.

### Family GLOBIGERINIDAE

#### Genus GLOBIGERININA d'Orbigny, 1826

##### GLOBIGERINA BULLOIDES d'Orbigny

There is a single rather typical specimen of this species from off Santa Elena, Ecuador. In the collections along the coast northward to Oregon the species is represented by very few specimens and some of these may be the young of *Globigerinoides sacculifera* H. B. Brady.

##### GLOBIGERINA CONGLOMERATA Schwager

*Globigerina conglomerata* SCHWAGER, *Novara* Exped., Geol. Theil., pt. 2, 1866, p. 255, pl. 7, fig. 113.—CUSHMAN, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 172.

*Globigerina dutertrei* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 601, pl. 81, figs. 1 a-c (not d'Orbigny).

*Globigerina dubia* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 79, figs. 17 a-c (not Egger).

Test subglobose, in the early stages consisting of but four chambers in each whorl, closely grouped; aperture small and with a distinct lip; in later stages with five or six chambers in the whorl, the last whorl usually below the level of the preceding ones and with a distinct umbilicus.

This species described by Schwager from the Pliocene of Kar Nicobar is the most common species in the late tertiary and recent collections from the Pacific region. We have specimens for comparison from the original material of Schwager's from Kar Nicobar.

#### Genus GLOBIGERINELLA Cushman, 1927

##### GLOBIGERINELLA AEQUILATERALIS (H. B. Brady)

*Globigerina aequilateralis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 71; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 605, pl. 80, figs. 18-21.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 5, 1924, p. 25, pl. 4, figs. 7, 8.

*Globigerinella aequilateralis* CUSHMAN, Bull. Scripps Instit. Oceanography, Tech. Ser., vol. 1, 1927, p. 174.

Test composed of numerous inflated chambers, trochoid in the young, later in a bilaterally symmetrical, planispiral coil; chambers increasing rapidly in size as added, usually five or six visible in side view; sutures much depressed; wall reticulate; aperture, a large arched opening at the base of the chamber.

The only specimen is from off Eten, Peru. Like the specimen noted from farther north along the coast, the coil is much less open than is usual in specimens from the Tropical Atlantic.

## Family ANOMALINIDAE

### Genus ANOMALINA d'Orbigny, 1826

#### ANOMALINA SCHMITTI Cushman and Wickenden

Plate 5, figures 4 a-c

*Anomalina schmitti* CUSHMAN and WICKENDEN, Proc. U. S. Nat. Mus., vol. 75, 1929, p. 14, pl. 6, figs. 5 a-c.

Test with the dorsal side flattened, ventral side, especially in the central portion forming a fairly high spire, last-formed coil evolute on both sides, periphery smooth, keeled, especially in the earlier portion; chambers eleven to twelve in the last-formed coil in the adult, not inflated; sutures distinct, especially between the last few chambers, very slightly depressed, slightly limbate on the dorsal side, gently curved; wall coarsely perforate, especially on the dorsal side; aperture low, broad, at the peripheral margin.

Length, 0.45 mm.; breadth, 0.35 mm.; thickness, 0.20 mm.

This species has been recently described from Juan Fernandez. It is interesting to record several specimens from Corral, Chile, although it did not occur at any of the other stations. The high spire is a striking character although it is somewhat variable.

## EXPLANATION OF PLATES

### PLATE 1

- FIGURE 1. *Proteonina fusiformis* Williamson.  $\times 110$ .  
 2. *Sorosphaera confusa* H. B. Brady.  $\times 110$ .  
 3, 5. *Bigenerina delicatula* Cushman and Kellett, new species. Fig. 3,  $\times 150$ . Young. Biserial stage. Fig. 5,  $\times 110$ . Adult. Uniserial stage. a, front views; b, apertural views.  
 4. *Textularia* species (?)  $\times 150$ . a, front view; b, apertural view.  
 6. *Quinqueloculina* species (?)  $\times 60$ . a, front view; b, apertural view.  
 7. *Quinqueloculina* species (?)  $\times 60$ . a, front view; b, side view; c, apertural view.  
 8. *Trochammina peruviana* Cushman and Kellett, new species.  $\times 110$  a, dorsal view; b, ventral view.  
 9. *Nonionella auris* (d'Orbigny).  $\times 95$ . a, b, opposite sides; c, peripheral view.  
 10. *Nonion pizarrensis* Berry.  $\times 95$ . a, side view; b, peripheral view.

## PLATE 2

- FIGURES 1. *Nonion pizarrensis* Berry.  $\times 95$ . *a*, side view; *b*, peripheral view.  
 2, 3. *Nonionella auris* (d'Orbigny).  $\times 95$ . *a*, *b*, opposite sides; *c*, peripheral views.  
 4. *Nonionella chiliensis* Cushman and Kellett, new species.  $\times 95$ . *a*, *b*, opposite sides; *c*, peripheral view.  
 5. *Elphidium alvareziana* (d'Orbigny).  $\times 110$ . *a*, side view; *b*, peripheral view.

## PLATE 3

- FIGURES 1-3. *Buliminella elegantissima* (d'Orbigny).  $\times 110$ . Fig. 2*a*, side view; 2*b*, apertural view.  
 4. *Bulimina patagonica* d'Orbigny.  $\times 110$ . *a*, side view; *b*, apertural view.  
 5-7. *Virgulina* species (?).  $\times 150$ . *a*, front views; *b*, apertural views.  
 8. *Bolivina doniezi* Cushman and Wickenden.  $\times 150$ . *a*, front view; *b*, apertural view.  
 9. *Bolivina costata* d'Orbigny.  $\times 110$ . *a*, front view; *b*, side view; *c*, apertural view.  
 10. *Reussia spinulosa* (Reuss).  $\times 110$ . *a*, front view; *b*, apertural view.  
 11. *Discorbis chiliensis* Cushman and Kellett, new species.  $\times 110$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.  
 12. *Discorbis isabelleana* (d'Orbigny).  $\times 110$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

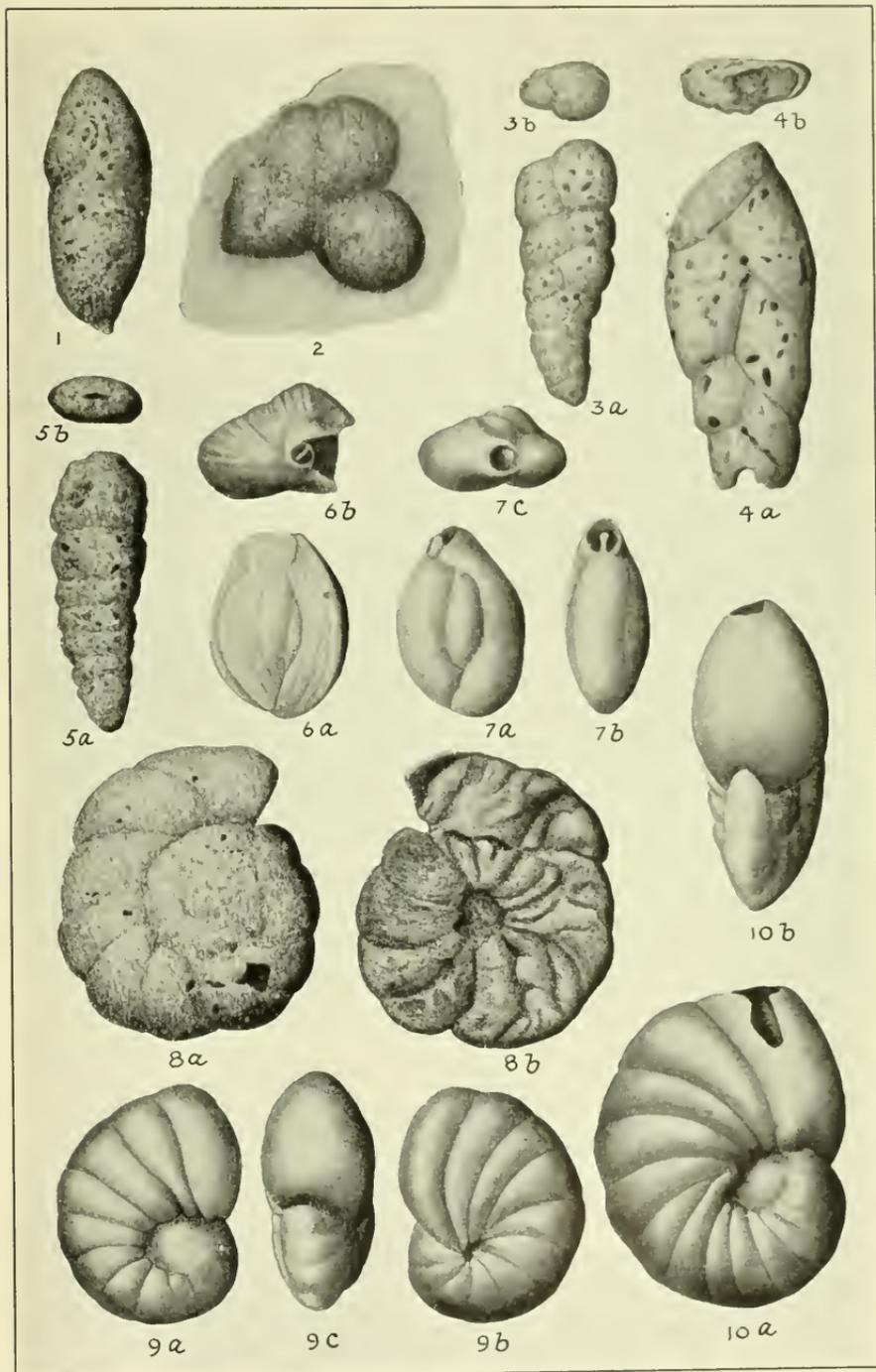
## PLATE 4

- FIGURES 1, 2. *Discorbis consobrina* (d'Orbigny).  $\times 110$ . *a*, dorsal views; *b*, ventral views; *c*, peripheral views.  
 3. *Eponides* species (?).  $\times 110$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.  
 4, 6. *Eponides meridionalis* Cushman and Kellett, new species. Fig. 4,  $\times 110$ . Fig. 6,  $\times 60$ . *a*, dorsal views; *b*, ventral views; *c*, peripheral views.  
 5. *Eponides peruviana* (d'Orbigny).  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.  
 7. *Eponides repanda* (Fichtel and Moll).  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

## PLATE 5

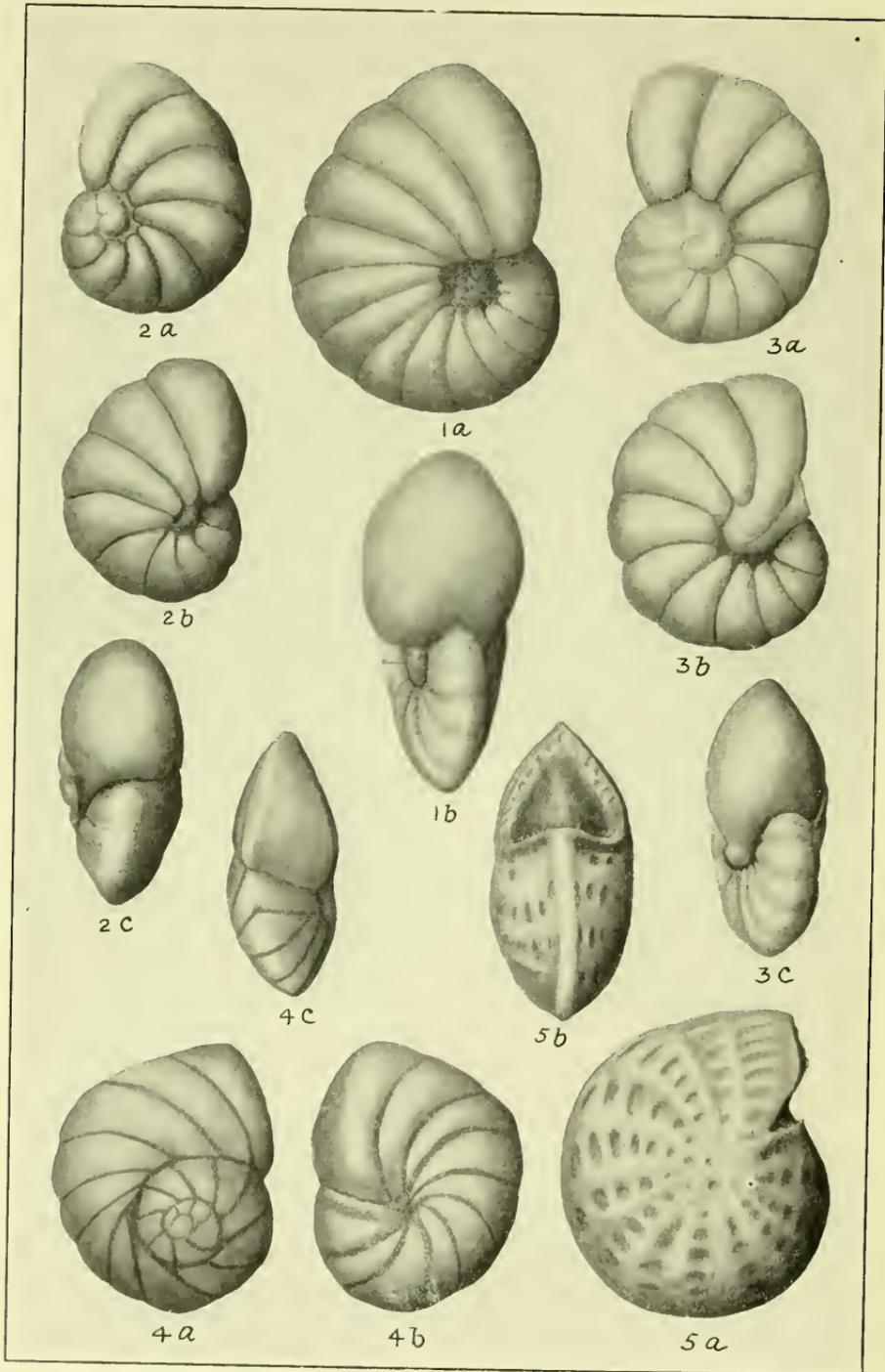
- FIGURES 1 *a-c*. *Rotalia inca* (d'Orbigny).  $\times 60$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.  
 2, 3 *a-c*. *Rotalia rosea* d'Orbigny.  $\times 110$ . 3*a*, dorsal view; 3*b*, ventral view; 3*c*, peripheral view.  
 4 *a-c*. *Anomalina schmitti* Cushman and Wickenden.  $\times 110$ . *a*, dorsal view; *b*, ventral view; *c*, peripheral view.





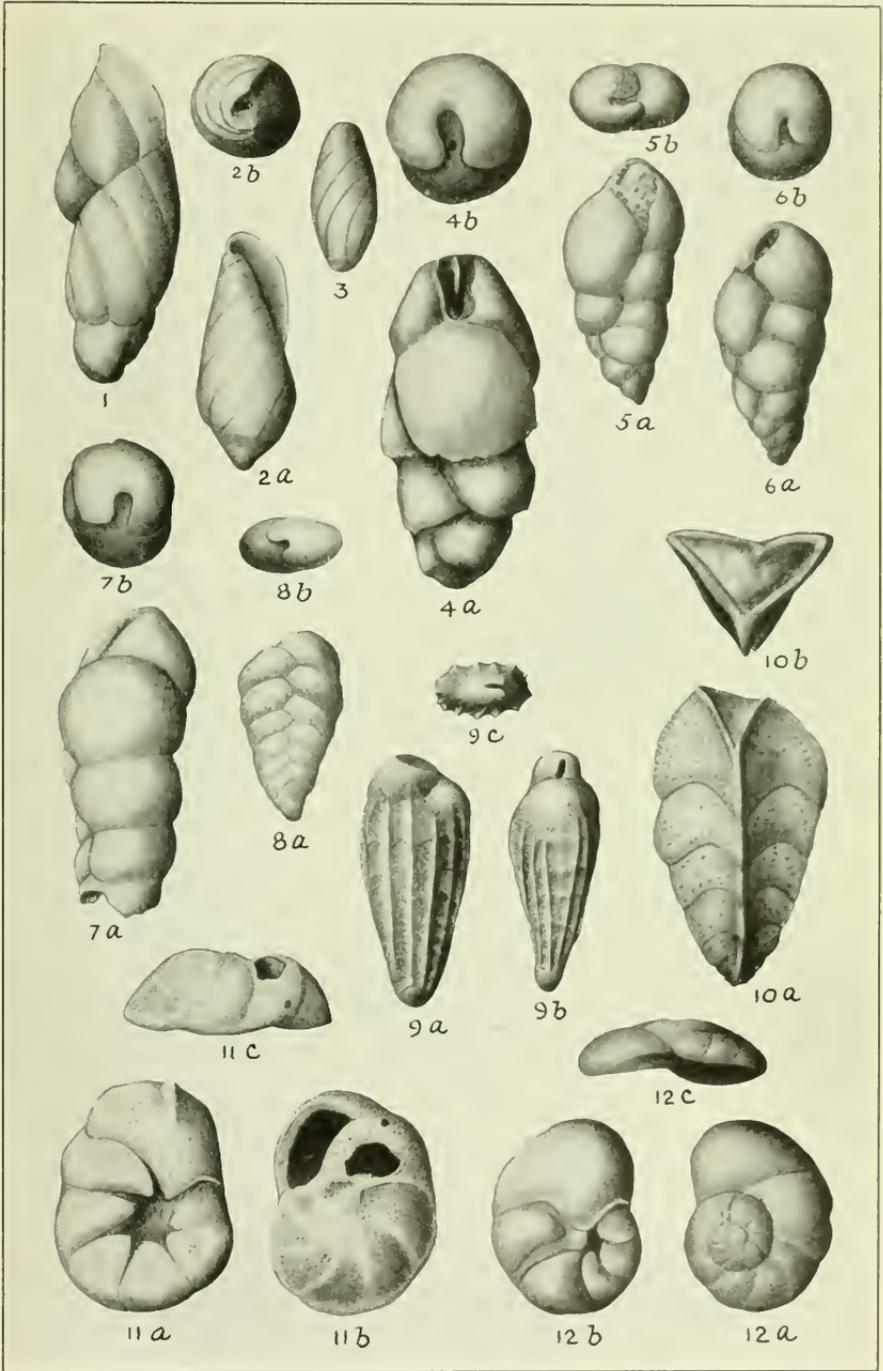
FORAMINIFERA FROM WEST COAST OF SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 15



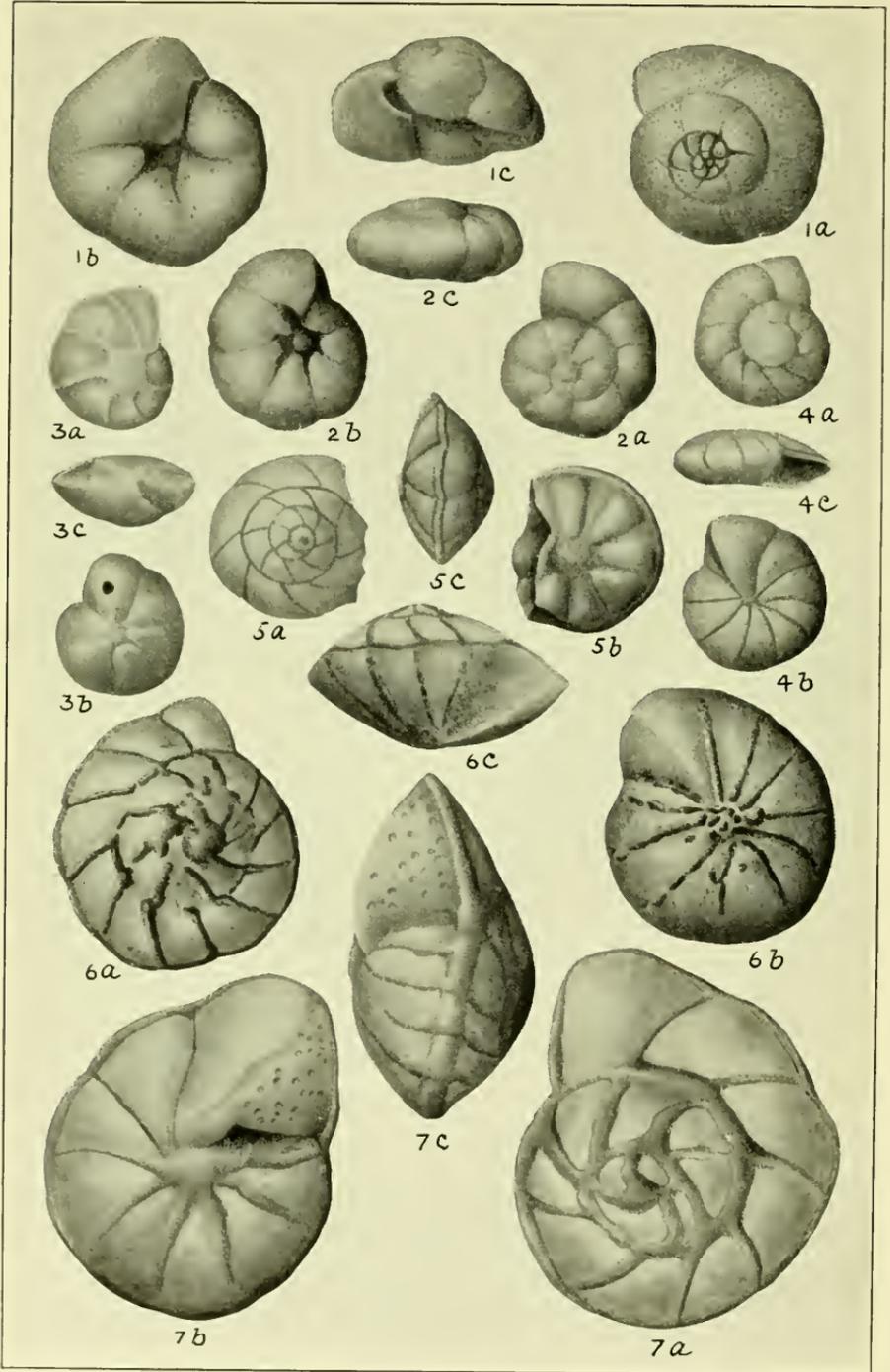
FORAMINIFERA FROM WEST COAST OF SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 16



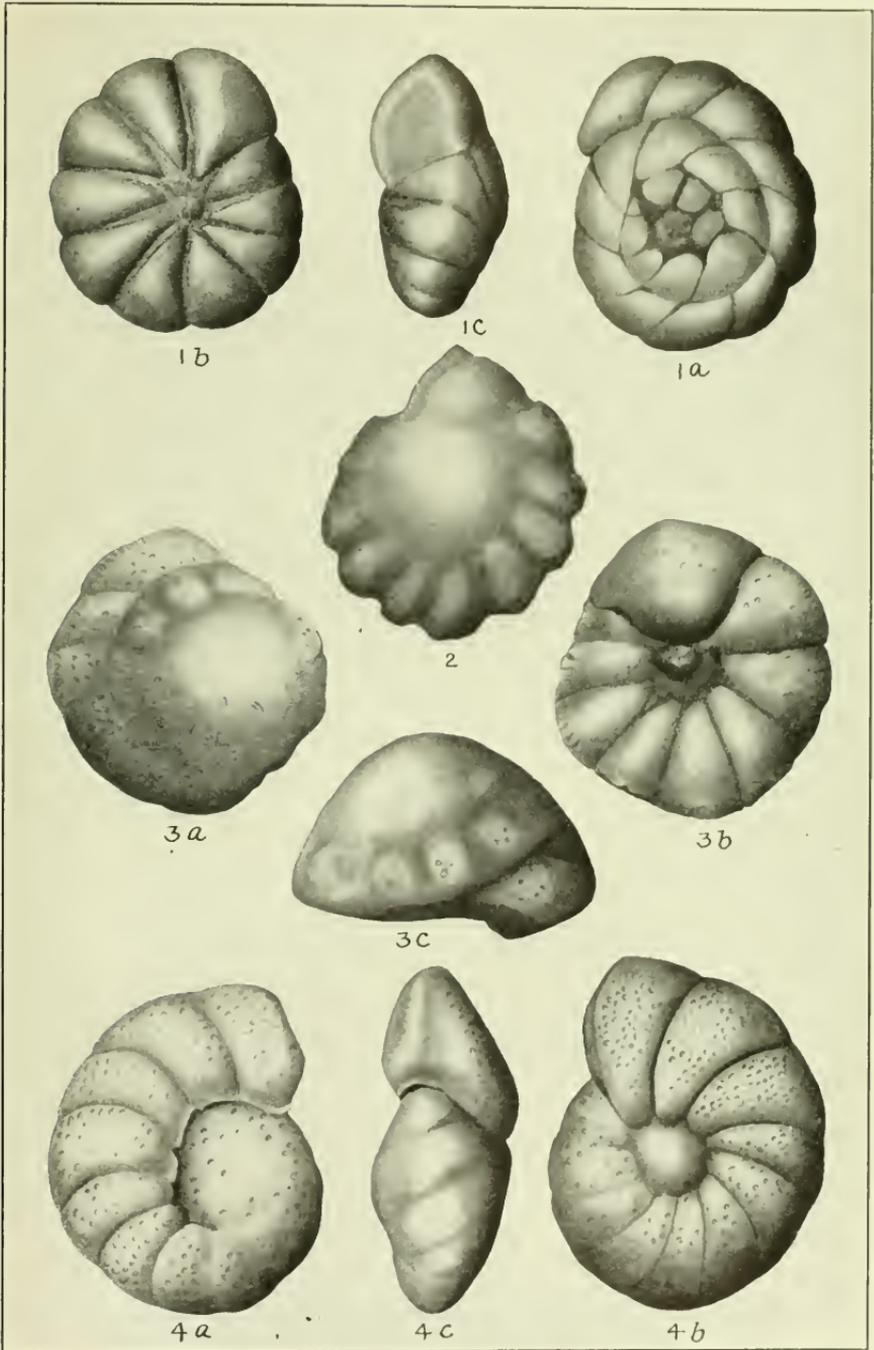
FORAMINIFERA FROM WEST COAST OF SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 18



FORAMINIFERA FROM WEST COAST OF SOUTH AMERICA

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FORAMINIFERA FROM WEST COAST OF SOUTH AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 16