

CONTRIBUTIONS
FROM THE
CUSHMAN LABORATORY
FOR
FORAMINIFERAL RESEARCH

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It is proposed to issue these contributions quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

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CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

1. A NEW CRETACEOUS UVIGERINA FROM LOUISIANA

By JOSEPH A. CUSHMAN

Chapman in his work on the Foraminifera published in 1902 gives the geologic range of the genus *Uvigerina* as "Eocene to Recent." There are a few records for the Cretaceous and some even earlier, but the main development of the genus is in the Tertiary. No species of the genus has been recorded from the Cretaceous of America. Mr. A. L. Selig has sent me some specimens of *Uvigerina* obtained from a core taken from basal Arkadelphia Clay at a depth of 1610-1612 feet in a well of the Atlantic Oil Prod. Co., Johnson No. 1, in Bossier Parish, Louisiana. There are a number of specimens which have proved to belong to a new species.

UVIGERINA SELIGI Cushman, n. sp.

Plate 4, figs. 1 a-c

Test minute, less than twice as long as broad; chambers comparatively few, the last three making up the larger part of the test, in end view somewhat angled, basal part of each chamber cut under sharply leaving a somewhat overhanging shoulder; sutures very distinct, depressed; surface minutely roughened, with a few prominent longitudinal costae, those of each chamber independent of adjacent ones; aperture circular with a short, broad, cylindrical neck and slight phialine lip.

Length 0.25 mm.; breadth 0.15 mm.

Type specimens from Upper Cretaceous Arkadelphia Clay, at a depth of 1610-1612 feet in Bossier Parish, Louisiana.

This species resembles slightly the forms found in the Eocene and Oligocene of the Coastal Plain of the United States and Mexico in its small size and angular chambers, and may well be the ancestral form of those species.

2. THREE NEW SPECIES OF SIPHOGENERINA FROM THE MIOCENE OF CALIFORNIA

By JOSEPH A. CUSHMAN

In 1905, Dr. R. M. Bagg, Jr. (Bulletin 268, U. S. Geol. Survey) described and figured some *Siphogenerinas* under the names *Sagrina branneri*, *S. californiensis*, and *S. elongata* Bagg. These were from the Monterey shale of Graves Creek, San Luis Obispo Co., California. It is probable that the latter two names are synonyms of *Siphogenerina branneri* Bagg, this being the microspheric form and the other two the megalospheric form of one species. I have some of the original material collected by Doctor Branner which seems to confirm this.

The Monterey has in it other species of *Siphogenerina* which are very different from those described and figured by Bagg. Of these three are here described and figured:

SIPHOGENERINA COLLOMI Cushman, new species

Plate 4, figure 3

Test large for the genus, fusiform, greatest width above the middle; early chambers irregularly spiral, later ones uniserial, distinct; sutures depressed, strongly curved, extending back on the costae to a considerable distance; test ornamented with very high, plate-like costae, usually ten in number, last-formed chamber smooth; aperture with a very short cylindrical neck and phialine lip.

Length up to 1.60 mm.; breadth 0.65 mm.

Type specimens (Cushman Coll. No. 4325) from Monterey shale, Sect. 24, T.28S., R.14E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This species is nearest related to *Siphogenerina spinosa* Bagg from the Miocene of Maryland and *S. lamellata* Cushman from the Miocene of Florida. The species is named for Roy E. Collom, well known geologist of California.

SIPHOGENERINA REEDI Cushman, new species

Plate 4, figure 4

Test about twice as long as broad, greatest breadth at the apertural end, thence gradually tapering to the initial end; chambers distinct; sutures somewhat depressed, strongly curved; wall ornamented with about fifteen lamellate costae which may continue onto the last-formed chamber; apertural characters obscure.

Length up to 1.10 mm.; breadth 0.50 mm.

Type specimens (Cushman Coll. No. 4326) from Monterey shale, Sect. 24, T.28S., R.14E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This may be distinguished from *S. collomi* by its smaller size and greater number of costae. It is nearest the form I have described from the Panama Canal Zone as *S. raphanus* (Parker and Jones), var. *transversus* Cushman.

It is named for Ralph D. Reed, geologist of California, under whose direction the material was collected.

SIPHOGENERINA KLEINPELLI Cushman, new species

Plate 4, figure 5

Test about twice as long as broad, greatest breadth at the apertural end, thence irregularly tapering to the initial end; chambers distinct; sutures depressed, very slightly if at all curved; wall ornamented with about fifteen very low costae, not at all lamellate, not continuing onto the last-formed chamber; aperture with a very short cylindrical neck and slight phialine lip.

Length up to 1 mm.; breadth 0.50 mm.

Type specimens (Cushman Coll. No. 4327) from Monterey shale, Sect. 24, T.28S., R.14E., San Luis Obispo County, California, collected by W. D. Kleinpell.

This species may be distinguished from *S. reedi* by the much lower and less prominent costae, and the lack of curvature in the sutures.

It is named for W. D. Kleinpell who collected the material.

3. NEW FORAMINIFERA FROM THE UPPER EOCENE
OF MEXICO

By JOSEPH A. CUSHMAN

Plate 1

From material received from the Marland Oil Company of Mexico collected south and southeast of the Panuco River, there were obtained a number of new species representing both the Alazan and the Tantoyuca formations. A number of these are new to science, and are described and figured here. The Alazan species occur with *Hantkenina alabamensis* Cushman and the Tantoyuca species with *Hantkenina brevispina* Cushman. Most of these species are confined, so far as is known, to the Mexican Upper Eocene, but one of them at least, *Bulimina jacksonensis* Cushman, n. sp., is common throughout the Coastal Plain Upper Eocene of the United States. Descriptions of the new species follow:

GENUS ROTALIATINA Cushman, n. gen.

Rotalina REUSS, (in part) Zeitschr, deutsch, geol. Ges., vol. 3, 1851,

p. 77, (not *Rotalina* d'Orbigny).

Test free, trochoid, spiral, composed of about three volutions, the last one composed of numerous chambers, all the chambers exposed from the dorsal side, only those of the last-formed coil visible from the ventral side, umbilicate ventrally; chambers distinct; sutures distinct and usually slightly depressed; wall in the known species smooth; aperture an arched slit between the base of the apertural face and the previous coil. (Type of genus *Rotaliatina mexicana* Cushman, n. sp.)

ROTIATINA MEXICANA Cushman, n. sp.

Plate 1, figs. 1 a, b, c

Test about as broad as long, composed of two or more coils, the earlier coils projecting in a low, rounded spire on the dorsal side, whole test generally tumid; chambers distinct, about seven in the last-formed coil, all visible from the dorsal side, only those of the last-formed coil from the ventral side; sutures dis-

tinct but not depressed unless very slightly so on the ventral side; wall smooth, polished; aperture a rather high, arched slit in the central part of the line between the base of the apertural face of the last-formed chamber and the previous coil.

Length 0.55 mm.; diameter 0.45 mm.

Type specimen (Cushman Coll. No. 4329) from the Upper Eocene, Alazan shale, $2\frac{1}{3}$ km. S. W. of Carrizo on the Rio Tamuin, State of San Luis Potosi, Mexico.

PLEUROSATOMELLA ALAZANENSIS Cushman, n. sp.

Plate 1, figs. 2 a, b

Test elongate, fusiform, about three times as long as broad, initial end acute, apertural end broadly rounded; chambers few, ornamented, fairly distinct; sutures distinct but not depressed; wall smooth; apertural face of the last-formed chamber truncate, depressed, with a liplike projection above the aperture and below a notched plate.

Length 0.90 mm.

Type specimen (Cushman Coll. No. 4330) from the Upper Eocene, Alazan shale, $2\frac{1}{3}$ km. S. W. of Carrizo on the Rio Tamuin, State of San Luis Potosi, Mexico.

NODOSARIA MEXICANA Cushman, n. sp.

Plate 1, figs. 3, 4

Test elongate, tapering, slightly curved, initial end narrow, rounded; chambers of the early portion rounded or subcylindrical, later ones gradually developing a raised area about the central equatorial region, thence tapering toward either end; sutures distinct, slightly limbate; wall smooth; apertural end slightly produced, conical.

Length 1 mm. or slightly more.

Type specimen (Cushman Coll. No. 4331) from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

UVIGERINA TOPILENSIS Cushman, n. sp.

Plate 1, figs. 5 a, b

Test generally fusiform, broadest in the middle, initial and apertural ends both rounded; chambers irregularly spiral, inflated; sutures distinct, depressed; wall ornamented with a very

few costae, progressively decreasing in height toward the apertural end of the test and usually continuous from one chamber to another, the last-formed chamber usually smooth; wall finely punctate, the costae on the earliest portion sometimes projecting backward into platelike processes; aperture with a very narrow cylindrical neck.

Length 0.70 mm.; breadth 0.30 mm.

Type specimen (Cushman Coll. No. 4332) from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

BULIMINA JACKSONENSIS Cushman, n. sp.

Plate 1, figs. 6, 7

Test elongate, tapering; the initial end acute, broadly rounded at the apertural end and in adults somewhat contracted; chambers numerous, fairly distinct; sutures not depressed; surface ornamented by very prominent longitudinal costae, usually six to eight in number, platelike, much raised above the general surface, continuous from the apical end to the base of the last-formed chamber in adults; the outer margin in well-preserved specimens serrate; aperture elongate, comma-shaped.

Length 1 mm. or more.

Type specimen (Cushman Coll. No. 4333) from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

GLOBIGERINA MEXICANA Cushman, n. sp.

Plate 1, figs. 8 a, b

Test subglobular, early chambers spirally arranged, in the later development the last-formed chamber making up nearly half the surface of the test; chambers distinct, inflated; sutures distinct, somewhat depressed; wall fairly thick, generally reticulate; surface dull; aperture at the inner margin of the chamber with additional small openings at its periphery.

Diameter 0.40—0.60 mm.

Type specimen (Cushman Coll. No. 4334) from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

This species is nearest related to *Globigerina conglobata* H. B. Brady, but is more spherical, the chambers being very different in their arrangement, and the surface much more smooth than in that species.

GLOBIGERINA TOPILENSIS Cushman, n. sp.

Plate 1, figs. 9 a, b, c

Test irregular in form, generally plano-convex, the dorsal side nearly flat, ventral side much inflated, early chambers making a generally spherical test but the last three or four greatly expanded, each chamber being somewhat rectangular in transverse section, the outer face nearly flat; sutures in the last-formed coil very much depressed, whole test deeply umbilicate; wall very strongly reticulate, aperture opening onto the umbilicate area.

Diameter 0.50 mm.; height 0.35 mm.

Type specimen (Cushman Coll. No. 4335) from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

This is a very unusual form of this genus with its generally spherical early development, but very much changed shape in the adult. There are a number of specimens all showing this same character.

HANTKENINA BREVISPINA Cushman

Plate 1, fig. 10

Hantkenina brevispina CUSHMAN, Proc. U. S. Nat. Mus., vol. 66, 1924, p. 2, pl. 2, fig. 3.

The specimen here figured is from the Upper Eocene, Tantoyuca formation, yellow clay from Palacho Hacienda, S. of Panuco-Tampico R. R., State of Vera Cruz, Mexico.

HANTKENINA ALABAMENSIS Cushman

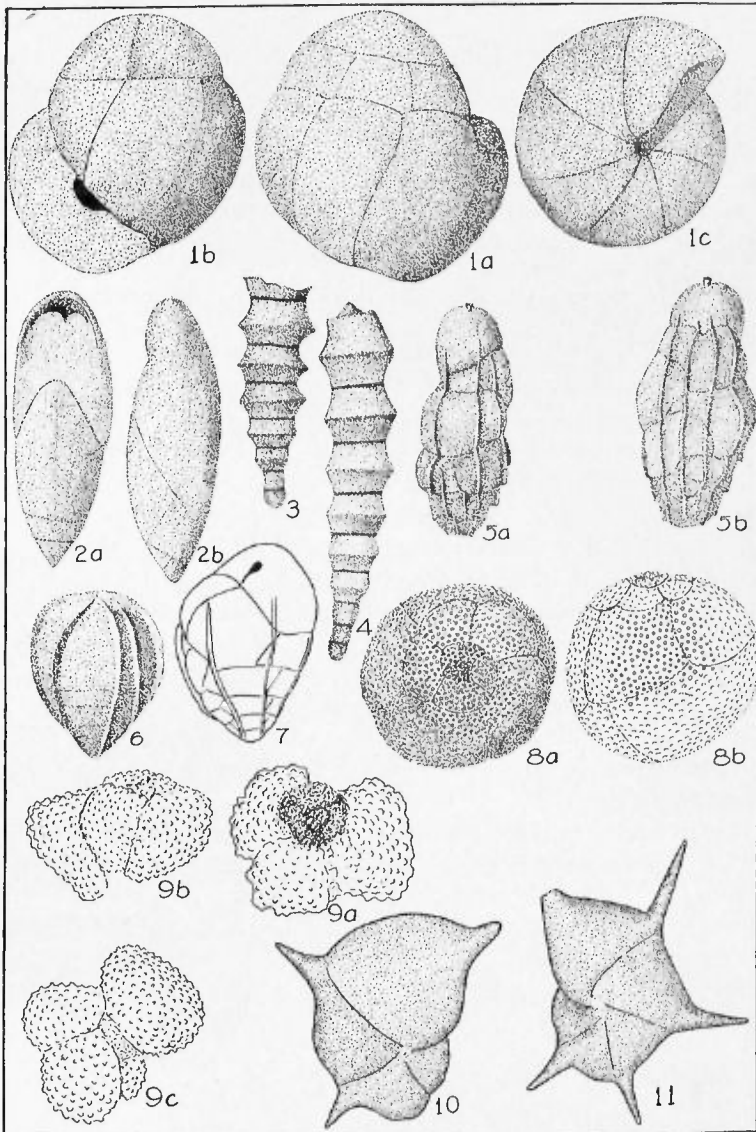
Plate 1, fig. 11

Hantkenina alabamensis CUSHMAN, Proc. U. S. Nat. Mus., vol. 66, 1924, p. 3, pl. 1, figs. 1-6; pl. 2, fig. 5.

The specimen here figured is from the Upper Eocene, Alazan shale, $2\frac{1}{3}$ km. S. W. of Carrizo on the Rio Tamuin, State of San Luis Potosi, Mexico.

EXPLANATION OF PLATE 1

- FIGS. 1 *a-c*. *Rotaliatina mexicana* Cushman, n. sp. X 65.
a, side view; *b*, apertural view; *c*, ventral view.
- FIGS. 2 *a, b*. *Pleurostomella alazanensis* Cushman, n. sp. X 40.
a, apertural view; *b*, side view.
- FIGS. 3, 4. *Nodosaria mexicana* Cushman, n. sp. X 40.
- FIGS. 5 *a, b*. *Uvigerina topilensis* Cushman, n. sp. X 45.
Side views.
- FIGS. 6, 7. *Bulimina jacksonensis* Cushman. X 30.
Side views.
- FIGS. 8 *a, b*. *Globigerina mexicana* Cushman, n. sp. X 65.
a, dorsal view; *b*, side view.
- FIGS. 9 *a-c*. *Globigerina topilensis* Cushman, n. sp. X 65.
a, dorsal view; *b*, side view; *c*, ventral view.
- FIG. 10. *Hantkenina brevispina* Cushman. X 50.
- FIG. 11. *Hantkenina alabamensis* Cushman. X 50.



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4. A NEW UVIGERINA FROM THE VIENNA BASIN

By JOSEPH A. CUSHMAN

Species of *Uvigerina* which are truly compressed are very rare. The only published species which shows this character strongly marked is *Uvigerina parkeri* Karrer (Abhandl. Geol. Reichsanstalt, vol. 9, 1877, p. 385, pl. 16b, fig. 5) from Wollersdorf in the Vienna Basin.

In some very excellent foraminiferal material from Perchtoldsdorf in the same Basin I have found another compressed species very different from *U. parkeri*.

UVIGERINA COMPRESSA Cushman, n. sp.

Plate 4, figs. 2 a-c

Test small, slender, elongate, about four times as long as broad, much compressed except in the earliest portion, periphery strongly lobulate; chambers numerous, very distinct, early ones irregularly spiral, later ones from compression tending to become biserial, the earlier end of each chamber strongly overlapping the preceding; sutures depressed, very distinct; surface ornamented throughout by numerous, very distinct but fine costae, in the very earliest chambers produced into short spines; aperture with a very slender, rather short, cylindrical neck and thin phialine lip.

Length 0.65 mm.; breadth 0.15 mm.; thickness 0.08 mm.

Type specimens (Cushman Coll. No. 4328) from "Mediterranean-stüfe" of Perchtoldsdorf, near Vienna.

A comparison of this species with *Uvigerina parkeri* Karrer will show that the two are very distinct, *U. compressa* being a much more ornate species.

5. SOME LATER TERTIARY CASSIDULINAS OF CALIFORNIA

By JOSEPH A. CUSHMAN and DONALD D. HUGHES

Plate 2

A study of some of the later Tertiary Cassidulinas of California and a comparison of them with the original figures and descriptions, as well as a series of both recent and fossil specimens, have given interesting results.

The Pliocene Cassidulinas are very different from most other species of the genus in the literature. Dr. R. M. Bagg, Jr., who worked on some of the material, especially that from Timms Point, San Pedro, has referred the species of that formation to species which will be indicated in the synonymy. His figures, except in one case, were not from California material. In the Timms Point Pliocene which is rich in foraminifera Cassidulinas form about three-quarters of the individuals present. Two species, *C. californica* Cushman and Hughes, n. sp., and *C. limbata* Cushman and Hughes, n. sp., are very abundant.

In the Pleistocene material collected from the Lomita Quarry on the north slope of the Palos Verdes Hills, the relative abundance of *Cassidulina* is much less than in the Pliocene of Timms Point, where it was the dominant genus. In the Lomita Quarry material *Globigerina* becomes the dominant genus. Of the Cassidulinas, which constitute about 5 per cent of the foraminifera of Lomita Quarry, *C. translucens* Cushman and Hughes, n. sp., occurs most abundantly.

In this California Tertiary material there seems to be nothing that can be definitely referred to *Cassidulina laevigata* d'Orbigny. The genotype, *C. laevigata* d'Orbigny, was described from ship's ballast, and therefore has no definite locality. It most resembles cold-water material from the North Atlantic.

Paratypes of the new species here described are deposited in the U. S. National Museum, Leland Stanford, Jr. University, the University of California, and the California Academy of Sciences.

CASSIDULINA CALIFORNICA Cushman and Hughes, n. sp.

Plate 2, figs. 1 a-c

Cassidulina subglobosa BAGG, Bull. 513, U. S. Geol. Surv., 1912, p. 44,
(not *C. subglobosa* H. B. Brady).

Test broadly oval in side view, nearly circular except for the last-formed chamber which slightly projects, periphery very slightly if at all lobulate, in apertural view with the sides parallel and the ends broadly rounded, the sides even tending to become slightly concave in the middle; chambers alternating, five pairs making up the last-formed coil, distinct; sutures very distinct, very slightly limbate but not raised, flush with the surface; wall smooth, matt; aperture in the general axis of the test at one side with a projecting platelike tooth, partially filling the actual opening.

Length 1 mm. or slightly more; thickness 0.50 mm.

Holotype (Cushman Coll. No. 4336) from the Pliocene of Timms Point, San Pedro, California. Specimens are very abundant in this material.

This is evidently the species referred to *Cassidulina subglobosa* by Bagg, as noted above. It differs much from that species in its parallel sides, the length being nearly twice the breadth, and the lack of inflation of the chambers, together with the position and shape of the aperture. It is much thicker than *C. crassa* d'Orbigny. In the young the specimens are more like *C. subglobosa*, and it was probably the young of *C. californica* that was referred by Bagg to *C. calabra*. Fewer specimens of *C. californica* were observed in the Lomita Quarry Pleistocene than in the Pliocene of San Pedro.

CASSIDULINA LIMBATA Cushman and Hughes, n. sp.

Plate 2, figs. 2 a-c

Cassidulina laevigata BAGG, Bull. 513, U. S. Geol. Surv., 1912, p. 43,
(not d'Orbigny).

Test nearly circular in side view, the last-formed chamber slightly projecting, periphery slightly lobulate, carinate; chambers very distinct, six pairs in the last-formed coil, the central portion of each chamber narrowest; sutures very distinct, broadly limbate, central portion with a distinct umbo of clear shell material; aperture narrow, elongate, parallel to the general axis of coiling.

Length 0.75 mm.; thickness 0.45 mm.

Holotype (Cushman Coll. No. 4337) from the Pliocene of Timms Point, San Pedro, California.

Next to *Cassidulina californica* this is the most common species in the Timms Point material. It was apparently referred by Bagg to *C. laevigata* d'Orbigny, but differs from that species in the larger number of chambers, the peculiar narrowing of the middle portion in each, the very distinctly limbate sutures, and prominent umbo. This is somewhat similar to the next species, *C. pulchella* d'Orbigny, but differs from it in the umbonate character and the very prominent limbate sutures, as well as the peculiar shape of the chambers.

There is a tendency in some specimens for the carina to be less developed and the sutures less limbate than in the typical form, but even in such specimens the "pinched-in" character of the middle portion of the chambers will distinguish the species.

In the Lomita Quarry material *Cassidulina limbata* is quite common, but does not develop the limbate character to such a marked extent as in the Pliocene, but the peculiar form of the chambers in this species serves at once to distinguish it.

CASSIDULINA PULCHELLA D'Orbigny

Plate 2, figs. 6 a, b

Cassidulina pulchella D'ORBIGNY, Voy. Amér. MÉR., 1839, "Foraminifères" p. 57, pl. 8, figs. 1-3.

Test compressed, nearly circular in side view, last-formed chamber projecting, periphery slightly angled, in apertural view the sides nearly parallel; chambers distinct, six or seven pairs in the last formed coil, rather broad and not greatly curved; sutures fairly distinct, slightly depressed, not limbate; surface smooth; aperture elongate at one side, and nearly parallel to the axis of coiling, the outer end of the aperture slightly broader than the inner end.

Length up to 0.75 mm.; thickness 0.25 mm.

Specimens were rare in the Timms Point material. D'Orbigny's original description of this species was based on material from the Coast of Peru. It was not observed in the Pleistocene of Lomita Quarry.

CASSIDULINA TORTUOSA Cushman and Hughes, n. sp.

Plate 2, figs. 4 a-c

Test broadly ovate in side view, somewhat irregular, central portion very thick, often equalling half the length, periphery subacute; chambers distinct, six or seven pairs in the last-formed coil, each chamber much curved forming a distinct angle at the central portion; sutures distinct, slightly limbate, with prominent angles; central region with an umbo of clear shell material; aperture elongate, the outer end rounded, tapering to a point at the base, parallel to the axis of coiling.

Length usually not more than 0.05 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 4338) from the Pliocene of Timms Point, San Pedro, California, where it is abundant. It occurs in fewer numbers in the Pleistocene of Lomita Quarry.

This differs from the other known species of *Cassidulina* in the very much angled chambers, producing a very peculiar arrangement of the sutures, often much more marked than in the figure given. There is also in side view a decidedly spiral twist given to the chambers which is more prominent in this species than any others of the Californian material studied. In the young especially the whole test has an irregular polygonal form.

CASSIDULINA COREYI Cushman and Hughes, n. sp.

Plate 2, figs. 3 a, b

Test oval, about one and a half times as long as broad, the periphery strongly serrate, central portion slightly umbilicate, periphery acute, six or seven pairs of chambers in the last-formed coil; chambers angled at the periphery; sutures fairly straight, slightly depressed, not limbate; wall smooth; aperture elongate in the axis of coiling, narrow.

Length 0.50 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 4339) from half a mile north of the Southern Pacific R. R. and a half mile west of Ventura River, Ventura County, California.

This species was collected by Grant W. Corby.

This very distinct species resembles *Cassidulina elegans* Sidebottom, described from the Southwest Pacific, more than any other of the known species of this genus. It may be easily distinguished from other species by the very strongly serrate periphery and the peculiar shape of the chambers. The last-formed chamber has an obliquely truncate border.

CASSIDULINA TRANSLUCENS Cushman and Hughes, n. sp.

Plate 2, figs. 5 a-c

Test nearly circular in side view with a very distinct, broad, thin carina independent of the individual chambers, in apertural view broadly oval, six or seven pairs of chambers making up the last-formed coil, only slightly overlapping, the chambers themselves rhomboid, the long sides nearly parallel, broadest at the outer end, central portion of the test translucent, showing the earlier chambers even to the proloculum; sutures fairly distinct but not marked at the surface; aperture elongate in the axis of coiling, with a very long, narrow, thin tooth on the inner side; wall smooth, polished.

Length 0.60 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 4340) Pleistocene, Lomita Quarry, Palos Verdes Hills, Los Angeles County, California. This species is also found less commonly in the Upper Pliocene of California.

It may be distinguished from the other Californian species by its broad, thin, transparent carina, and by the peculiar translucent appearance of the test, the central portion of which is clear and transparent, through which the earlier chambers may be seen.

CASSIDULINA SUBGLOBOSA H. B. Brady, Var. **QUADRATA** Cushman and Hughes, n. var.

Plate 2, figs. 7 a-c

Test in side view nearly circular, the periphery very slightly if at all lobulate, in apertural view roughly quadrangular, length and thickness about equal, the thickness often being slightly greater than the length; chambers fairly distinct but not usually projecting much, if any, above the general outline, five or six pairs in the last-formed coil; sutures distinct, slightly limbate, very little if at all depressed, wall smooth, matt; aperture somewhat rounded, nearly in the axis of coiling, usually with a triangular or flattened tooth projecting into the aperture.

Length up to 1 mm.

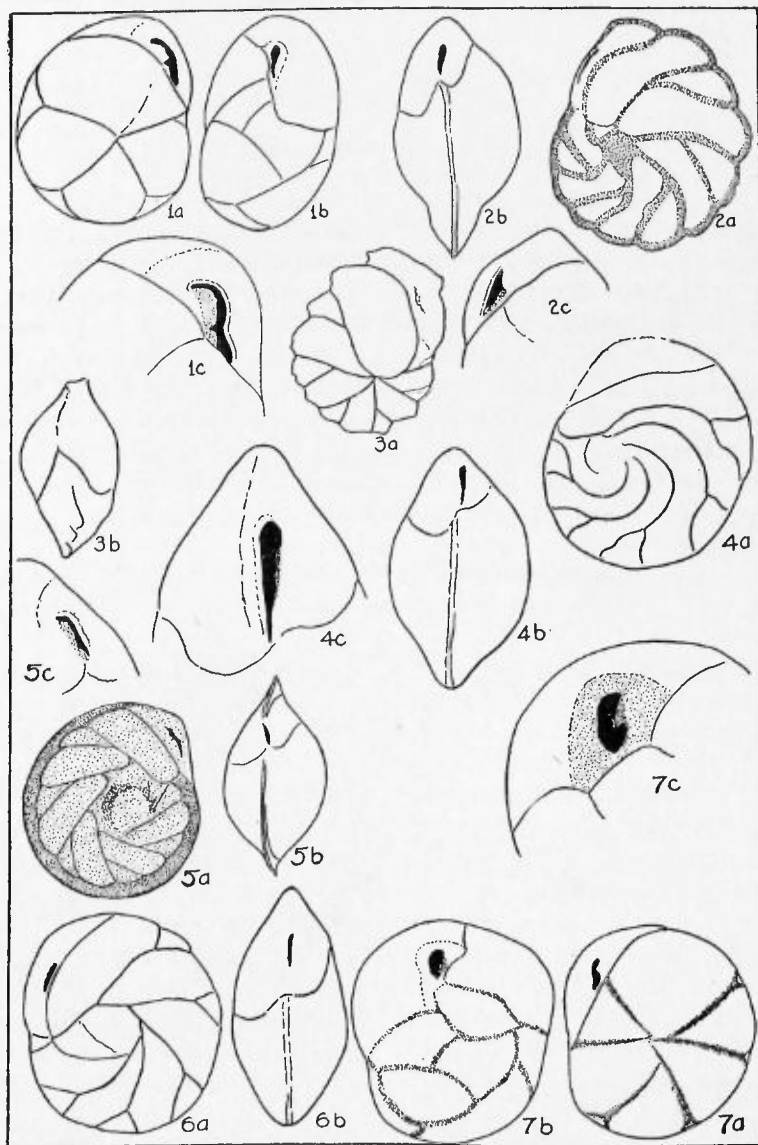
Holotype (Cushman Coll. No. 4341) Pleistocene, Lomita Quarry, Palos Verdes Hills, Los Angeles County, California.

This variety seems to be confined in the California material to the Pleistocene. It differs from typical *Cassidulina subglobosa* H. B. Brady in the less inflated chambers, the quadrangular form, and in the aperture, which in typical *C. subglobosa* is placed in a very distinct angle with the axis of coiling in each

newly added chamber, whereas in the variety it is very close to the axis of coiling. This variety does not show the radiating ridges about the aperture that are a characteristic of typical *C. subglobosa* in recent material.

PLATE 2

- FIGS. 1 *a-c.* *Cassidulina californica* Cushman and Hughes, n. sp.
a, side view; *b*, peripheral view. X 30.
c, details of aperture more enlarged. X 50.
- FIGS. 2 *a-c.* *Cassidulina limbata* Cushman and Hughes, n. sp.
a, side view; *b*, peripheral view. X 40.
c, details of aperture more enlarged. X 75.
- FIGS. 3 *a, b.* *Cassidulina corbyi* Cushman and Hughes, n. sp.
a, side view; *b*, peripheral view. X 50.
- FIGS. 4 *a-c.* *Cassidulina tortuosa* Cushman and Hughes, n. sp.
a, side view; *b*, peripheral view. X 60.
c, details of aperture more enlarged. X 125.
- FIGS. 5 *a-c.* *Cassidulina translucens* Cushman and Hughes, n. sp.
a, side view; *b*, peripheral view. X 50.
c, details of aperture more enlarged. X 100.
- FIGS. 6 *a, b.* *Cassidulina pulchella* d'Orbigny.
a, side view; *b*, peripheral view. X 45.
- FIGS. 7 *a-c.* *Cassidulina subglobosa* H. B. Brady, var. *quadrata* Cushman
and Hughes, n. var.
a, side view; *b*, peripheral view. X 40.
c, details of aperture more enlarged. X 100.



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6. SOME NEW FORAMINIFERA FROM THE VELASCO
SHALE OF MEXICO

By JOSEPH A. CUSHMAN

Plate 3

In the Velasco shale, which is the uppermost portion of the Upper Cretaceous in the Panuco Section of Mexico, there is a very rich fauna of foraminifera. Many of these species are very close to or identical with species described from the uppermost Cretaceous of Europe. There are, however, a number of species which on close comparison with the European forms appear to be distinct. Some of these more striking ones are described in this paper. They are mostly from the Forns Lease of the Marland Oil Company of Mexico, and to that Company my thanks are due for the privilege of publishing these new forms.

TEXTULARIA VELASCOENSIS Cushman, n. sp.

Plate 3, figs. 1 a-c

Test in front view oval, the initial end pointed, remainder of the test rather broadly oval, widest near the middle, in end view elliptical with the ends somewhat truncate; chambers comparatively few in number, fairly distinct except in the earlier portion; sutures distinct and limbate, raised; surface ornamented by the limbate sutures between which are raised projections extending back from the sutures themselves onto the lateral surfaces of the chambers with other irregular, raised areas, the sides of the test less ornamented but in some specimens with a continuation of the same irregular, raised surface ornamentation; aperture elongate, low.

Length up to 0.75 mm.; breadth 0.55 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 4343) from the Velasco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This is a very distinct species, and the type of ornamentation is a very rare one for this genus.

PULVINULINA VELASCOENSIS Cushman, n. sp.

Plate 3, figs. 5 a-c

Test plano-convex, the dorsal side flat or even slightly concave, ventral side very much produced, periphery carinate, subacute, ventral side with the chambers very much prolonged into a distinct projecting mass, the series of which surround a depressed umbilical area; about seven chambers in the last-formed coil, distinct; sutures distinct, on the dorsal side curved, marked by a series of small, beadlike processes, the periphery of each with a slightly raised carina which marks also the line of coiling in the central portion, ventral side with the sutures nearly radiate, straight, much depressed, surface roughened with very minute, low spinose processes which rather uniformly cover the entire test; aperture elongate, narrow, on the ventral side the last-formed chamber extending from near the periphery almost to the umbilical area.

Diameter 0.65 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 4347) from the Velasco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This is a very abundant species in the Velasco shale of this region, appearing in several forms, some of which may be worthy of distinction. It is distinguished by the very finely spinose surface, especially by the ring of projecting masses surrounding the umbilical area on the ventral side, and the ornamentation a solid, raised carina and beaded sutures.

GLOBIGERINA VELASCOENSIS Cushman, n. sp.

Plate 3, figs. 6 a-c

Test much compressed, the dorsal side with all the chambers visible, ventral side only those of the last-formed coil, sides nearly parallel, periphery broadly rounded; chambers distinct, three or four making up the last-formed coil, early chambers subglobular, later ones becoming more compressed, and the inner margin fairly straight; wall finely and evenly reticulate; aperture on the ventral side, elongate.

Diameter 0.45 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 4348) from the Velasco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This is a peculiar species in its very much compressed form, the nearly straight inner margin of the chambers, and the much finer reticulate surface than usually occurs in this genus.

GAUDRYINA VELASCOENSIS Cushman, n. sp.Plate 3, figs. 7 *a, b*

Test elongate, about twice as long as broad, the early half generally triangular in transverse section, the later half quadrangular, the angles of the early portion very broadly rounded; chambers in the earlier triserial portion indistinct, in the later biserial portion somewhat more distinct; sutures indistinct except between the last three or four chambers, where they are slightly depressed; wall in the early triserial portion with numerous fine, longitudinal striations, the later portion smooth and rather coarsely punctate; aperture very elongate, low.

Length 0.70 mm.; breadth 0.40 mm.

Holotype (Cushman Coll. No. 4349) from the Valesco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This species is very distinct in the Velasco shale, characterized by its coarsely punctate wall, finely striate early portion with very rounded angles, and the later portion quadrangular.

TRUNCATULINA VELASCOENSIS Cushman, n. sp.Plate 3, figs. 2 *a-c*

Test nearly bilaterally symmetrical with a very thin, broad keel, chambers all visible from the dorsal side, only those in the last-formed coil from the ventral side, about ten chambers in the last-formed coil, fewer in the earlier ones; chambers distinct, especially from the ventral side; sutures on the dorsal side raised and confluent, on the ventral side slightly depressed, curved; wall smooth on the ventral side, the dorsal side with an excavated area over each chamber; aperture elongate, narrow, on the ventral side of the last-formed chamber nearly in the axis of coiling.

Length slightly more than 0.05 mm.; breadth about the same; thickness 0.30 mm.

Holotype (Cushman Coll. No. 4344) from the Velasco shale, 5 km. S. W. of La Bolsa, on W. side of the Moctezuma River, Hacienda Santa Ines, State of San Luis Potosi, Mexico.

This species is very distinctive in the Velasco shale by the thickened limbate sutures, which become confluent on the dorsal side, leaving well-marked, depressed areas over the chambers, and by the very broad, thin keel surrounding the periphery of the test.

ANOMALINA VELASCOENSIS Cushman, n. sp.

Plate 3, figs. 3 a-c

Test plano-convex, the dorsal side nearly flat, ventral side very broadly rounded. periphery broadly rounded; chambers fairly distinct, eight or nine in the last-formed coil, on the dorsal side there is a depressed area coinciding with the line of coiling, the central portion raised in a spiral, later chambers with a slightly depressed area over each chamber, the sutures being somewhat limbate and raised, on the ventral side sutures limbate but not raised above the general surface, curved, in the edge view the thickenings of the dorsal side often stand up slightly above the general surface; wall generally smooth and finely punctate.

Length about 0.50 mm.; breadth 0.45 mm.; and thickness 0.35 mm.

Holotype (Cushman Coll. No. 4345) from the Velasco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This is a widely distributed species throughout most of the Velasco formation, and may be distinguished by the very different characters of the dorsal and ventral surfaces, the peculiar spiral thickening of the dorsal side being especially marked.

NODOSARIA LIMONENSIS Cushman, n. sp.

Plate 3, figs. 4 a, b

Test elongate, subconical, widest near the base, circular in transverse section; chambers indistinct from the surface; sutures indistinct; wall ornamented by a series of eight broad, prominent, longitudinal costae, which toward the base become bifurcate, between these above the early portion, are very thin, delicate, longitudinal costae, alternating with the thick ones; aperture somewhat projecting, radiate.

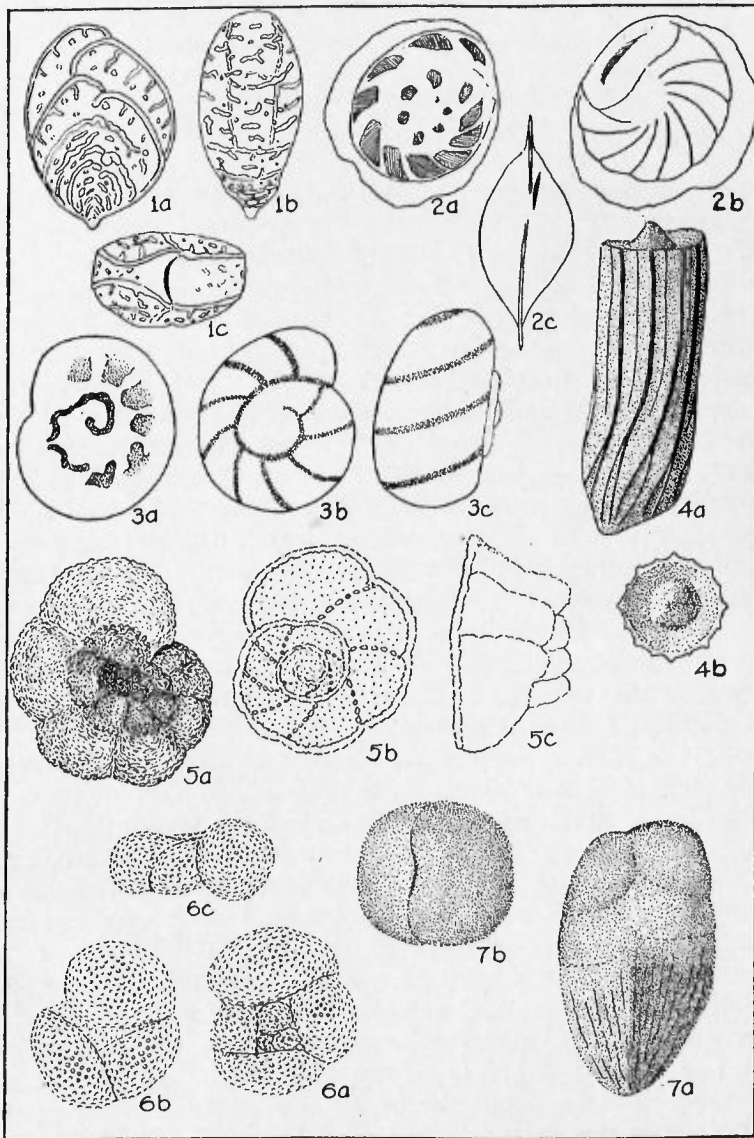
Length of type specimen, which is evidently incomplete, 0.85 mm.; breadth at base 0.25 mm.

Holotype (Cushman Coll. No. 4346) from the Velasco shale, Tamalte Arroyo, Hacienda El Limon, State of San Luis Potosi, Mexico.

This is a very unusual ornamentation and is a very marked character in this species, the early portion with the bifurcate sutures, which coalesce into one stronger, broader costa, and alternating thin, delicate ones will serve to distinguish this from any of the other species of the Mexican Cretaceous.

PLATE 3

- FIGS. 1 *a-c.* *Textularia velascoensis* Cushman, n. sp. X 35.
a, front view; *b*, side view; *c*, apertural view.
- FIGS. 2 *a-c.* *Truncatulina velascoensis* Cushman, n. sp. X 50.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 3 *a-c.* *Anomalina velascoensis* Cushman, n. sp. X 50.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 4 *a, b.* *Nodosaria limonensis* Cushman, n. sp. X 50.
a, front view; *b*, apertural view.
- FIGS. 5 *a-c.* *Pulvulinina velascoensis* Cushman, n. sp. X 50.
a, ventral view; *b*, dorsal view; *c*, peripheral view.
- FIGS. 6 *a-c.* *Globigerina velascoensis* Cushman, n. sp. X 50.
a, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIGS. 7 *a, b.* *Gaudryina velascoensis* Cushman, n. sp. X 50.
a, front view; *b*, apertural view.



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7. APERTURAL CHARACTERS IN CRISTELLARIA WITH DESCRIPTIONS OF A NEW SPECIES

By JOSEPH A. CUSHMAN

In the Miocene Monterey shales of California there is a large, very fine species of *Cristellaria*, the apertural characters of which are particularly interesting, from the bearing they have on other species of the genus. It is a close-coiled form in its young, later developing an uncoiled portion, consisting of three or four chambers in the adult. The apertural end projects somewhat above the general outline of the chamber. Viewed from without, this is a radiate aperture, but when the last-formed chamber is broken the interior characters are very interesting. Plate 4, fig. 12 shows the characters of the outer wall of the last-formed chamber viewed from within. Instead of the outer, radiate aperture being seen there is a rounded opening into a secondary chamber, which will here be termed the apertural chamberlet. About this circular aperture is a thin, circular or oval plate, much thinner than the wall of the test itself. Beyond it as shown diagrammatically in figure 13 is a small chamberlet connecting this rounded opening with the outside radiate aperture characteristic of this genus. A number of other specimens showed this same character, so it is not in any way abnormal. Other species of *Cristellaria* were broken in a similar manner, and revealed characters not unlike those figured here.

A further examination of the early chambers of *Cristellaria* has shown that some of them at least do not keep this chamberlet as growth progresses. The use of such a structure as this may become apparent from a study of the life history of the foraminifera. It is known that in the microspheric form the contained protoplasm breaks up into a great many small portions, each with its individual nucleus. These, then, break out from the parent test and form new individuals. In some cases, the early one or two chambers of the new are formed before the young leaves the parent test. In such cases as in *Orbitolites* the outer wall becomes thin and breaks down, allowing the escape of the contained young. Also as an individual foraminifer adds new chambers the single nucleus works its way through to later chambers. This process might be rather difficult where

very small apertures between chambers exist. Apparently in some species at least of *Cristellaria* this outer radiate aperture becomes enlarged by resorption of the wall, and the inner rounded aperture becomes the connection between adjacent chambers. The thin, circular plate about this inner aperture might very easily be a provision for a greater enlargement of the inner aperture by resorption without weakening the general wall of the test. A similar apertural chamberlet should be looked for in other groups of the Lagenidae, where radiate apertures are the rule. The species may be described as follows:

CRISTELLARIA BEALI Cushman, n. sp.

Plate 4, figs. 6-13

Test large, in the early portion close coiled and with a sub-acute periphery in the adult, uncoiled with three or four inflated chambers, the last-formed one broadly triangular in transverse section, with broadly rounded angles; chambers distinct; sutures distinct, with a very decided angle toward the periphery, more marked in the adult portion where they are somewhat depressed, those of the early coiled portion distinct but not depressed; wall smooth and shining; aperture radiate with an internal apertural chamberlet, the inner wall of which has a circular opening about which is a thin plate.

Length 1.05 mm. or slightly more; thickness 0.30 mm.

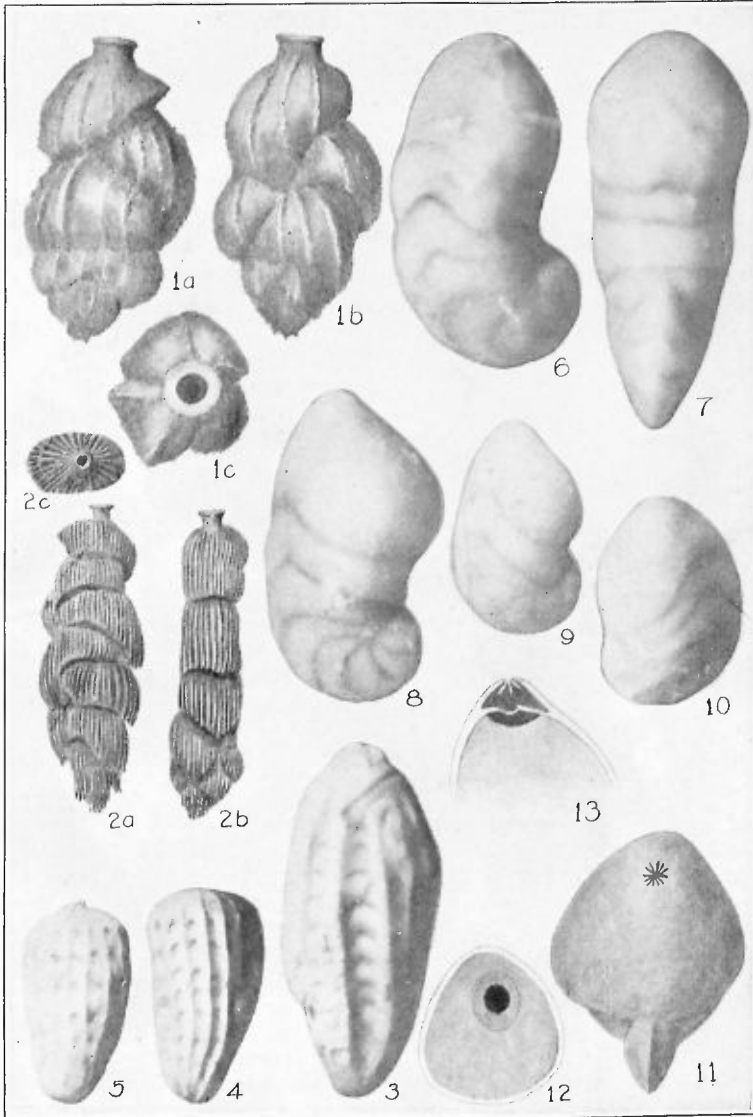
Holotype (Cushman Coll. No. 4342) from Monterey shale, Sect. 24, T.28S., R.14E., San Luis Obispo County, California, collected by W. D. Kleinpell.

The species is named for Carl Beal, geologist of California.

In some respects *Cristellaria beali* resembles *C. arcuata* d'Orbigny but is a larger, stouter species, and the peculiar angled character of the sutures of the California species will easily distinguish it.

PLATE 4

- FIGS. 1 a-c. *Uvigerina seligi* Cushman, n. sp.
a, b, side views; c, apertural view. X 150.
- FIGS. 2 a-c. *Uvigerina compressa* Cushman, n. sp.
a, front view; b, side view; c, apertural view. X 65.
- FIG. 3. *Siphogenerina collomi* Cushman, n. sp. X 35.
- FIG. 4. *Siphogenerina reedi* Cushman, n. sp. X 35.
- FIG. 5. *Siphogenerina kleinpelli* Cushman, n. sp. X 35.
- FIGS. 6-13. *Cristellaria beali* Cushman, n. sp. X 35.
6, 8, 9, 10, side views; 7, front view; 11, apertural view; 12,
interior of the last-formed chamber; 13, ideal section of
the last-formed chamber showing the thin plate about
the inner aperture, the apertural chamberlet outside
with the radiate aperture.



RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand.

Silvestri, A.

Fauna paleogenica di Vasciano presso Todi.

(Boll. Soc. Geol. Ital., vol. 42, 1923 (1924), pp. 7-29, pl. 1, text figs. A, B.)

Fifteen species and varieties are recorded with notes, with a double plate from micro-photographs, from the lower Tertiary of Central Italy.

Dollfus, R. P.

Contribution à la faune des Invertébrés du banc de Rockall.

(Bull. Institut. Oceanographique, No. 438, January 1924, pp. 1-28.)

A list of species, identified by Heron-Allen and Earland from the Rockall Bank, is given on pp. 5-9 with a few notes.

Heron-Allen, E. and Earland, A.

The Foraminifera of Lord Howe Island, South Pacific.

(Journ. Linn. Soc., Zoology, vol. 35, April 1924, pp. 599-647, pls. 35-37.)

One hundred ninety nine species are noted from shallow-water material of this South Pacific island. Two new genera are described, *Diffusilina* and *Craterites*. Seven new species and varieties are described.

Paalzow, R.

Foraminiferen aus den Cerithiensanden von Offenbach a. M.

(Bericht Offenbacher Vereins für Naturkunde, 1924, pp. 7-28, pls. 1, 2.)

Twenty-three species are noted from this Oligocene material from Germany. Two new species are described.

Van der Vlerk, I. M.

Foraminiferen uit het Tertiair van Java.

(Wetenschappelijke Mededeelingen, No. 1, 1924, 19 pages, pls. 3-5.)

Fifteen species and varieties are noted and most of them figured from photomicrographs. Seven new species and varieties are described from this later Tertiary of Java.

Van der Vlerk, I. M.

Miogypsina Dehaartii, nov. spec., de Larat (Moluques).

(*Eclogae geologicae Helvetiae*, vol. 18, No. 3, 1924, pp. 429-432, 3 text figs.)

This short paper describes and figures a new species of *Miogypsina* found in the late Tertiary at Larat, an island off the southeast coast of Dutch New Guinea.

Cushman, J. A.

The Foraminifera of the Atlantic Ocean, Pt. V, Chilostomelidae and Globigerinidae.

(Bull. 104, U. S. Nat. Mus., pt. 5, 1924, pp. 1-55, pls. 1-8.)

Heron-Allen, E. and Earland, A.

The Miocene Foraminifera of the "Filter Quarry," Moorabool River, Victoria, Australia.

(Journ. Roy. Micr. Soc., June 1924, pp. 121-186, pls. 7-14.)

Two hundred and seventy species and varieties are noted from this Australian lower Tertiary. There are twenty new species and varieties described.

Hanna, G. D. and Hanna, M. A.

Foraminifera from the Eocene of Cowlitz River, Lewis County, Washington.

(Univ. Washington Publ. in Geol., vol. 1, No. 4, Oct. 1924, pp. 57-62, pl. 13.)

Ten species are described and figured of which five are described as new.

Cushman, J. A.

Samoan Foraminifera.

(Carnegie Institution of Washington, Publ. 342, Oct. (Nov.) 1924, pp. 1-75, pls. 1-25.)

This paper records one hundred fifty five species and varieties of recent foraminifera from Pago Pago Harbor, Samoa. A table of distribution is given showing some of the Indo-Pacific distribution of the species. One new genus *Rotaliammima* is described and twenty four new species and varieties.

Cushman, J. A.

A New Genus of Eocene Foraminifera.

(Proc. U. S. Nat. Mus., vol. 66, 1924, pp. 1-4, pls. 1, 2; 1 text fig.)

A new genus *Hantkenina* is described with several new species from the Upper Eocene of Mexico and the United States.

SCIENTIFIC INTELLIGENCE.

CHEMISTRY AND PHYSICS.

Quantitative Organic Microanalysis; by FRITZ PREGL. Translated by Ernest Fyleman, Phila., 1924 (Blakiston's Son & Co. Price \$4.00).—This is a translation of Professor Pregl's well-known book, giving the methods of microanalysis which have been so largely developed by the author.

H. W. FOOTE.

Chemistry and Atomic Structure; by J. D. MAIN SMITH. Pp. 221. N. Y. 1924 (VanNostrand Co. Price \$3.75).—The first third of this book is an account, largely historical, of some of the older ideas of physical chemistry regarding atoms, molecules, valency and electrochemistry. This is followed by a very full description of Werner's Co-ordination Theory, and the rest of the book is devoted chiefly to the structure of the atom. To the reviewer, it seems as if the book were made up of several somewhat unrelated topics in Physical Chemistry, but the views of the writer on each are well presented, and the book makes very interesting reading.

H. W. FOOTE.

The Specific Heats of Gases; by J. R. PARTINGTON and W. G. SHILLING. Pp. 252. N. Y. 1924 (Van Nostrand Co. Price \$8.00).—This is an excellent monograph on the subject, including experimental methods and data. Most of the "equations of state"—some fifty-six in all—have also been given, though there is no mention of the recent important work of Keyes. The many very complicated equations and expressions used throughout the book add materially to its cost and probably account for its high price.

H. W. FOOTE.

GEOLOGY.

Contributions from the Cushman Laboratory for Foraminiferal Research, Vol. I, No. 1, April, 1925.—This new quarterly, published at Sharon, Massachusetts, by Joseph A. Cushman, will, as the name indicates, concern itself with spreading the technical knowledge of the Foraminifera, from which there is endless information to be had out of the fossil past and the living present. The subscription price is \$2.50 per year.

C. S.

Notes on American Paleozoic Cephalopods; by AUG. F. FOERSTE. Denison Univ. Bull., Jour. Sci. Lab., Vol. 20, pp. 193-267, pls. 21-42, 1924.—Here the author gives us another valuable installment of his studies on the early Paleozoic cephalopods. Twenty-one old genera and nineteen old species are reworked, and eight new forms and nine new genera are described. All are well illustrated with half-tones that bring out the generic and specific

characteristics. One of the major conclusions is that the cephalopods older than the middle Ordovician differ strikingly from the others in being largely holochoanitic, a fact that also has far-reaching stratigraphic importance.

Upper Ordovician Faunas of Ontario and Quebec; by A. F. FOERSTE. Geol. Survey, Canada, Mem. 138, 255 pages, 46 plates, 14 text figs., 1924.—In this monograph—and a most valuable one it is—are defined and illustrated 317 forms, of which all but ten are specifically named. Of these, 70 are new, and there are in addition 4 new genera. E. O. Ulrich revises the Heterocrinidæ and describes 8 new genera.

Under Upper Ordovician the author includes the Cincinnati (Eden, Maysville, and Oswego) and Richmond (among regular formations also Queenston, Meaford, and Juniata) series. The monograph is one of the most significant contributions to North American stratigraphy and paleontology in recent years, and the author and the Geological Survey of Canada are to be congratulated upon its publication.

The Contribution of South Africa to the Principles of Geology; by A. L. DU TOIT. South African Jour. Sci., Vol. 21, pp. 52-78, 1924.—Attention is directed to this excellent presidential address, given before Section B of the South African Association for the Advancement of Science, which all geologists should read and make a part of themselves. By so doing they would, as the author hopes, “encourage the small band of workers in this Continent [no longer the Dark one] to further and more energetic research notwithstanding the disadvantages under which they are labouring.”

Among the great geologic phenomena that are best seen in Africa are (1) the four periods of glaciation, of which the Permian is the most striking anywhere, (2) continental fragmentation, (3) the extraordinary eruptive masses and their magmatic differentiation, (4) Gondwana land with its significant Gangamopteris flora, and the great array of Karroo stegocephalian and reptilian evolution pointing the way to the mammals, (5) the amazing occurrence of diamonds, culminating in the great Cullinan stone that weighed in the rough one pound and six ounces avoirdupois, and (6) the world's greatest production of the abrasive corundum. The reviewer thinks that Africa may also be the continent in which the flowering plants arose, and that they should be looked for in the floras of the Karroo series.

C. S.

MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

Biology and Human Life; by BENJAMIN C. GRUENBERG. Pp. XIV, 592, with 243 textfigures. Boston, New York, etc., 1925 (Ginn and Company).—A textbook for pupils in the secondary