

CONTRIBUTIONS
FROM THE
CUSHMAN LABORATORY
FOR
FORAMINIFERAL RESEARCH

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These contributions will be issued 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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LABORATORY FOR FORAMINIFERAL RESEARCH

17. THE GENUS CHILOSTOMELLA AND RELATED
GENERA

By JOSEPH A. CUSHMAN

In 1850 Reuss erected the genus *Chilostomella* to include two species, *C. ovoidea* Reuss and *C. czizeki* Reuss, both from the Miocene of Central Europe. The type species, *C. ovoidea* Reuss, was taken up by Brady, and in the *Challenger* Report all the other described species were made synonyms of *C. ovoidea* Reuss. A study of the figures and descriptions together with available recent and fossil specimens has seemed to show that the problem is not such a simple one. Instead of there being but one species involving both fossil and recent forms there are probably two genera with several distinct species. The Cretaceous and some of the Eocene forms are distinguishable from the Recent and most of the Tertiary ones in the apertural characters, and on this basis a new genus has been erected for them. The relationships will be indicated.

GENUS CHILOSTOMELLA Reuss, 1850

Chilostomella REUSS (type *C. ovoidea* REUSS), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 379.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 436.—Chapman, The Foraminifera, 1902, p. 182.—Cushman, Bull. 71, U. S. Nat. Mus., pt. 4, 1914, p. 2; Bull. 104, pt. 5, 1924, p. 1.

Test free, composed of a series of chambers in a coil, each chamber making a half coil of 180° and embracing so that but a small part of the base of the preceding chamber is visible from the exterior; wall smooth, finely perforate, either thin and transparent or thick and opaque; aperture at the inner margin of the ventral face of the chamber, in a semicircle, narrow, often with a slightly upturned lip.

In this genus the aperture is a very narrow, curved slit, at the base of the chamber at the inner margin. In young specimens there is a slight tendency to have a broader aperture correspond-

ing roughly with that in the following genus which is its main characteristic.

CHILOSTOMELLA OVOIDEA Reuss

Plate 11, figs. 1 *a-e*

Chilostomella ovoidea REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, figs. 12 *a-e*.

Test ovoid, circular in transverse section, somewhat tapering at the basal end in front view, two thirds as broad as long, greatest width nearly twice that at the aperture; wall smooth; aperture a narrow slit with a very slight lip.

Reuss' specimens were from the Miocene of Austria. As stated above some authors have referred all specimens of the genus to this species of Reuss. The many recent specimens I have had for study have failed to show anything at all close to this species of Reuss. There are three and perhaps four or more recent forms which have apparently very definite distributions. Of the fossil forms there are several probably distinct species. For this reason it is impossible to correctly place all the references to *C. ovoidea* in their proper place without a study of the specimens involved in each case. In some cases where figures are given this may be done.

CHILOSTOMELLA CZIZEKI Reuss

Plate 11, figs. 2 *a-d*

Chilostomella czizeki REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 380, pl. 48, figs. 13 *a-d*.

This species is figured by Reuss from the same locality as that from which *C. ovoidea* Reuss was described. It is a much more elongate form, and may be a varietal form of *C. ovoidea*. Schwager, Boll. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 70, refers specimens from the Tertiary of Italy to *C. czizeki* Reuss.

CHILOSTOMELLA OOLINA Schwager

Plate 11, figs. 3-10

Chilostomella oolina SCHWAGER, Boll. Com. Geol. Ital., vol. 9, 1878, p. 527, pl. 1, fig. 16.

Chilostomella ovoidea H. B. BRADY (in part) (not Reuss), Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 436.—Egger, Abhandl. kon. Bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 305, pl. 9, figs. 1, 2.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 53, pl. 9, figs. 512-516.—Rhumbler, Nordisches Plankton, pt. 14, Foraminiferen, 1901, p. 11, figs. 1-3, in text.—Cushman, Bull. 104, U. S. Nat. Mus., pt. 5, 1924, p. 2, pl. 1, figs. 8-10.

Test elongate, three time as long as wide, both ends broadly rounded, sides nearly parallel for most of their length, wall thin, distinctly punctate, aperture very narrow, curved.

Length usually less than 1 mm.

The recent specimens from much of the Atlantic region and from some of the Pacific may be referred to this species of Schwager described from the Pliocene of Sicily. It is a much more elongate species than the other recent ones, and has little in common with *C. ovoidea* Reuss, to which it has usually been referred. Probably there are other recent references which should be placed here but owing to lack of figures this is impossible at the present time. It is a pelagic species at least in some stages of its development.

CHILOSTOMELLA GRANDIS Cushman

Plate 11, figs. 12 a-c

Chilostomella grandis CUSHMAN, Proc. U. S. Nat. Mus., vol. 51, 1917, p. 662; Bull. 100, U. S. Nat. Mus., pt. 4, 1921, p. 283, pl. 57, figs. 5 a-c.

Test broadly elliptical in side view, in end view circular; two chambers visible from the exterior; wall thick and opaque, smooth; aperture in end view semicircular with a flangelike truncated lip.

Length up to 4 mm. or more.

This species known from several stations in the Philippine region is the largest and finest of the genus. It has a very heavy test and is evidently a bottom-living species.

In the Australian region there is a large thick-walled *Chilostomella* which in many of its characters resembles *C. grandis* Cushman. It has much more pointed ends, however, and there is not evident the straight sided effect that is so apparent in adult *C. grandis*. The aperture, however, is somewhat similar and especially the thick polished, opaque wall in the adult. I have excellent specimens from off New Zealand, off the Big King in 98 fathoms, and off the Poor Knights, 60 fathoms. This is the form I have recorded as *C. ovoidea*, (Proc. U. S. Nat. Mus., vol. 56, 1919, p. 621). There seem to be both microspheric and megalospheric forms present.

CHILOSTOMELLA MILLETTI Cushman, n. sp.Plate 11, figs. 13 *a-b*

Chilostomella ovoidea MILLET (in part) (not Reuss), Journ. Roy. Micr. Soc., 1901, p. 2, pl. 1, figs. 2 *a-b* (not figs. 3 *a-c*).

Test ovate in outline, broadest below the middle, two thirds as broad as long, only the very base of the penultimate chamber visible, the last-formed chamber nearly completely covering it; wall dense and opaque with a granular surface; aperture nearly at the tip of the test.

Length 0.5 mm.

Millett had this species from the Malay region. Heron-Allen and Earland refer to it some of their Antarctic Expedition material. So far as known this is the only species with any ornamentation, the test in all other species being smooth.

CHILOSTOMELLA CYLINDROIDES ReussPlate 11, figs. 14 *a-c*, 15 *a-d*.

Chilostomella cylindroides REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 80, pl. 6, figs. 43.—Bornemann, l. c., vol. 7, 1855, p. 343, pl. 17, fig. 1.—Hantken, Mitth. Jahrb. ungar. geol. Anstalt., vol. 4, 1875 (1881), p. 63, pl. 7, fig. 7.

Test about twice as long as broad, the sides only slightly convex, ends truncately rounded; wall smooth; aperture narrow, curved.

Reuss described and figured this species from the Oligocene of Hermsdorf near Berlin. Bornemann figures a somewhat stouter form from the same locality under this name. Hantken's specimens from the Upper Eocene of Hungary are about identical with Reuss' original figures. No forms of just this description are known from the later Tertiary.

CHILOSTOMELLA TENUIS BornemannPlate 11, figs. 16 *a-c*

Chilostomella tenuis BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 343, pl. 17, fig. 2 *a-c*.—Reuss, Denkschr. Akad. Wiss. Wien, vol. 25, 1865, p. 156.—Hantken, Mitth. Jahrb. ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 64.

Test small, cylindrical, sides nearly parallel, ends broadly rounded, 3 or 4 times as long as broad, punctate, smooth; aperture narrow.

Bornemann described and figured this slender species from the Oligocene of Hermsdorf near Berlin. Reuss also records it from the Middle Oligocene of Germany and Hantken from the Upper Eocene of Hungary. This is nearest like the Recent and Pliocene *C. oolina* in its narrow form.

GENUS CHILOSTOMELLOIDES Cushman, new genus

Test in general characters similar to *Chilostomella* but the apertural characters distinct. In *Chilostomelloides* the aperture instead of being a long narrow slit is often circular and stands away from the preceding chamber, being entirely closed in by its own chamber wall in some species. In others it is nearly closed except for a narrow segment that is made by the previously formed chamber. Type species *Chilostomelloides oviformis* (Sherborn and Chapman).

The three recorded species which evidently belong to this genus are from the Upper Cretaceous and Eocene of Europe and America.

CHILOSTOMELLOIDES OVIFORMIS (Sherborn and Chapman)

Plate 11, figs. 17 *a-d*, 21 *a-c*

Lagena (Obliquina) oviformis SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 745, pl. 14, figs. 19 *a-d*.

Chilostomella oviformis SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 485, pl. 11, fig. 13.

Test oval in front view, ends broadly rounded; wall smooth; aperture circular or nearly so, standing out at a distinct angle from the general contour of the test, with a thickened lip.

Length up to 1 mm.

The type specimens are from the Eocene (London Clay) of England. There are specimens apparently identical with these from the Alazan Clay of Mexico. The apertural characters and general contour are the same. They are from Rio Buena Vista, State of Vera Cruz, Mexico, collected by T. Wayland Vaughan. With these is a smaller form which probably belongs to true *Chilostomella* but preservation is not sufficiently good for description.

CHILOSTOMELLOIDES EXIMIA (Franzenau)

Plate 11, figs. 18 *a-c*

Chilostomella eximia FRANZENAU, Termesz. Füzetek, vol. 11, 1889, p. 147, 206, woodcut; Math. termesz. ertesito, vol. 7, 1889, p. 248, pl. 4, fig. 3; Math. Nat. Ber. Ungarn, vol. 7, 1889, p. 67, pl. 3, fig. 3 *a-c*.

This species from the Eocene of Central Europe is very close to *C. oviformis*, the apertural end somewhat more tapering and apparently the aperture close to the end of the chamber.

CHILOSTOMELLOIDES EOCENICA Cushman, n. sp.

Plate 11, figs. 20 a-c

Test elongate, about $2\frac{1}{2}$ times as long as broad, ends rounded, sides gently convex, tapering toward either end; wall smooth, very finely punctate; aperture semicircular, standing out at an angle from the contour of the test, with a distinct, slightly thickened lip.

Length 0.5 mm.

Holotype (Cushman Coll. No. 4365) from the Midway, Lower Eocene of the Mexia Oil Field, Texas.

In this species the test is more tapering toward the ends and more elongate than in *C. oviformis*, the wall is thinner, and the aperture not wholly free from the preceding chamber.

CHILOSTOMELLOIDES CYCLOSTOMA (Rzehak)

Plate 11, figs. 19 a-c

Chilostomella cyclostoma RZEHAk, Ann. k. k. Nat. Hofmuseum, vol. 3, 1888, p. 258, pl. 11, figs. 1 a-c.

This species from the Upper Cretaceous of Central Europe is closest to *C. eocenica* Cushman, but it is broader and the ends much more broadly rounded.

Figures are given of the various species adopted from the original figures of the types.

GENUS CHILOSTOMELLINA Cushman, new genus

Test composed of a few inflated chambers, the last-formed one almost completely enveloping the preceding ones, and the chambers rapidly increasing in size as added; wall thin, finely perforate; aperture small, crescentiform with the sides of the chamber with a series of reëntnants at each side.

Type species *Chilostomellina fimbriata* Cushman, new species.

This is a peculiar genus in some characters related to *Chilostomella* especially in the apparent alternation of chambers and the embracing character of each newly added chamber.

CHILOSTOMELLINA FIMBRIATA Cushman, n. sp.

Plate 11, figs. 22 a-c

Characters as given for the genus above, the whole test subglobular, slightly larger than broad; the wall very thin, translucent, the sides of the chamber next the aperture markedly fimbriate.

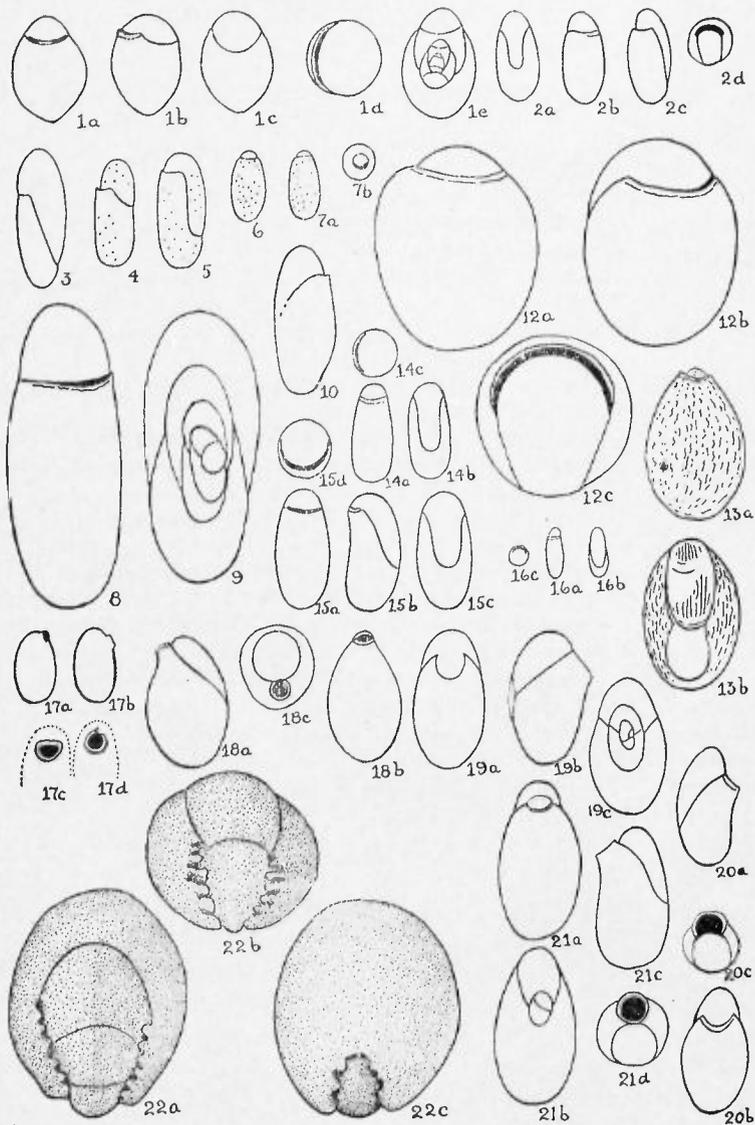
Length 0.45 mm.; breadth 0.35 mm.

Type specimen (U. S. N. M. Coll. No. 20280), from *Albatross* station D3608, in 276 fathoms, Bering Sea.

This is not an abnormal specimen as several others in various stages of development show the same characters.

EXPLANATION OF PLATE 11

- FIGS. 1 *a-c*. *Chilostomella ovoidea* Reuss (After Reuss).
 FIGS. 2 *a-d*. *Chilostomella czizeki* Reuss (After Reuss).
 FIG. 3. *Chilostomella oolina* Schwager (After Schwager).
 FIGS. 4, 5. *Chilostomella oolina* Schwager (*C. ovoidea* Egger) (After Egger).
 FIGS. 6, 7. *Chilostomella oolina* Schwager (*C. ovoidea* Goës) (After Goës).
 FIGS. 8, 9. *Chilostomella oolina* Schwager (*C. ovoidea* Rhumbler) (After Rhumbler).
 FIG. 10. *Chilostomella oolina* Schwager (*C. ovoidea* Cushman) (After Cushman).
 FIGS. 12 *a-c*. *Chilostomella grandis* Cushman (After Cushman).
 FIGS. 13 *a, b*. *Chilostomella milletti* Cushman, n. sp. (*C. ovoidea* Millett) (After Millett).
 FIGS. 14 *a-c*. *Chilostomella cylindroides* Reuss (After Reuss).
 FIGS. 15 *a-d*. *Chilostomella cylindroides* Reuss (After Hantken).
 FIGS. 16 *a-c*. *Chilostomella tenuis* Bornemann (After Bornemann).
 FIGS. 17 *a-d*. *Chilostomelloides oviformis* (Sherborn and Chapman) (*Lagena oviformis* Sherborn and Chapman) (After Sherborn and Chapman).
 FIGS. 18 *a-c*. *Chilostomelloides eximia* (Franzenau) (After Franzenau).
 FIGS. 19 *a-c*. *Chilostomelloides cyclostoma* (Rzehak) (After Rzehak).
 FIGS. 20 *a-c*. *Chilostomelloides eocenica* Cushman, n. sp.
 FIGS. 21 *a-c*. *Chilostomelloides oviformis* (Sherborn and Chapman).
 FIGS. 22 *a-c*. *Chilostomellina fimbriata* Cushman, n. sp.



18. SOME FOSSIL BOLIVINAS FROM MEXICO

By JOSEPH A. CUSHMAN

In some parts of the Alazan clays of Mexico, especially those of very fine texture there are abundant foraminifera. These wash out with all their details well preserved for study. Among them are several species of *Bolivina* which seem to be different from any described species. These species and varieties have a very definite vertical distribution.

BOLIVINA MEXICANA Cushman, n. sp.

Plate 12, fig. 2

Test much compressed, the early portion with a slight keel, later chambers developing a wider keel; chambers of the early portion low, several times as broad as high, gradually increasing in height as added until in the adult the chambers are only slightly greater in width than in height, inflated slightly in later development; sutures distinct, in the early portion appearing at the surface as a double line between the chambers, in later development less marked and slightly obscured by a slight imbrication of the chambers; wall smooth, finely punctate; aperture elongate with a slight lip.

Length up to 1.2 mm.

Type specimen (Cushman Coll. No. 4366) from clays on Panuco Railroad between kilometer posts 21 and 22, state of Vera Cruz, Mexico.

In some of its characters this species resembles forms referred by various authors to *Bolivina beyrichi* Reuss. A study of European material of *Bolivina beyrichi* Reuss shows that as in the type figure while there are backward projections from the basal angles of each chamber at the periphery the test itself is not truly keeled. A reference to the figures given as *B. beyrichi* from various geologic formations as well as from recent seas will show that many of these have little in common with the typical form described by Reuss.

Bolivina mexicana has a rather wide distribution in the Alazan clays of Mexico, and is often very abundant. There are two varieties which are easily distinguished and which have very definite horizons where they occur in great numbers.

BOLIVINA MEXICANA Cushman, n. sp., var. **ALIFORMIS** Cushman, n. var.
Plate 12, figs. 3, 4 a-b

Test differing from the typical form in the development of a broad transparent keel which extends about the entire test; the sutures are limbate and expanded toward the central portion of the test, the chambers very slightly imbricate in later development.

Type specimen (U. S. N. M. Coll. No. 353838), from Alazan shale, left bank of Tuxpan River, at bluff S. 25° E. about 0.5 km. from Tumbadero Hacienda House, Vera Cruz, Mexico, collected by T. Wayland Vaughan.

At the type horizon the variety is very abundant. In some respects this variety resembles a form referred by Brady to *Bolivina beyrichi*, var. *alata* (Rep. Voy. Challenger, Zoology, vol. 9, 1884, pl. 53, fig. 4.) The Mexican form, however, has very different sutures, in that respect more resembling *Bolivina schwageriana* H. B. Brady.

Both microspheric and megalospheric forms are shown on the plate, the latter form with large proloculum starting off with high chambers, and not developing the more flaring shape of the microspheric form.

BOLIVINA MEXICANA Cushman, n. sp., var. **HORIZONTALIS** Cushman, n. var.
Plate 12, figs. 5 a-b

Variety differing from the typical in the characters of the periphery, each chamber having a definite thin keel with the angle not at the base, and projecting backward but nearer midway of the chamber and pointing in a nearly horizontal direction, the sutures also less oblique than in the typical, and more deeply incised.

Type specimen (U. S. N. M. Coll. No. 353839), from soft grayish clay, southwest slope of Cuesta Blanca, near Zacamixtle, Vera Cruz, Mexico, collected by T. Wayland Vaughan.

This variety is distinct in its peculiar horizontal trend of the sutures and especially the keeled portion. It is common at the above station, and I have also seen it from other localities in Mexico. It is evidently a varietal form of *Bolivina mexicana*.

BOLIVINA ALAZANENSIS Cushman, n. sp.
Plate 12, figs. 1 a-b

Test in transverse section rhomboid, much thicker in the middle thence thinning toward the periphery which has a narrow keel only slightly angled at the chambers; chambers distinct,

curved, and oblique, in later development tending to develop a lobe at the base near the central portion, and slightly imbricate; sutures very distinct, appearing at the surface as a double line in the early portion fused in the middle of the test to form a prominent ridge, slightly broken up near the apertural end; wall smooth, very distinctly punctate; aperture elongate.

Length up to 0.70 mm.

Type specimen (U. S. N. M. Coll. No. 353840), from light gray, soft clay on Tampico-Panuco Railroad, kilometer post 20.15, state of Vera Cruz, Mexico, collected by T. Wayland Vaughan.

I have this species in my own collection from many stations in this same general region. It is widely distributed in the Alazan clays of Mexico. A related form to this is one I have figured from the Red Bluff clay of St. Stephens, Alabama (U. S. Geol. Survey, Prof. Paper 133, 1923, p. 19, pl. 3, fig. 2). The sutures, however, are quite different.

BOLIVINA TECTIFORMIS Cushman, n. sp.

Plate 12, fig. 6 a-b

Test small, compressed, thickest along the median line thence thinning toward the periphery which is rounded; chambers distinct, oblique not curved or only very slightly so; sutures distinct, very much thickened, fusing in the median line to form a thick rounded ridge, the wall over the middle of the chamber thin and nearly transparent, the sutures and median line thick and opaque; wall coarsely punctate, the earlier portion with an ornamentation consisting of slightly oblique longitudinal channels and ridges, most distinct on the thickened sutures becoming obsolete in late chambers; aperture terminal, elliptical, with a thickened lip.

Length up to 0.45 mm.

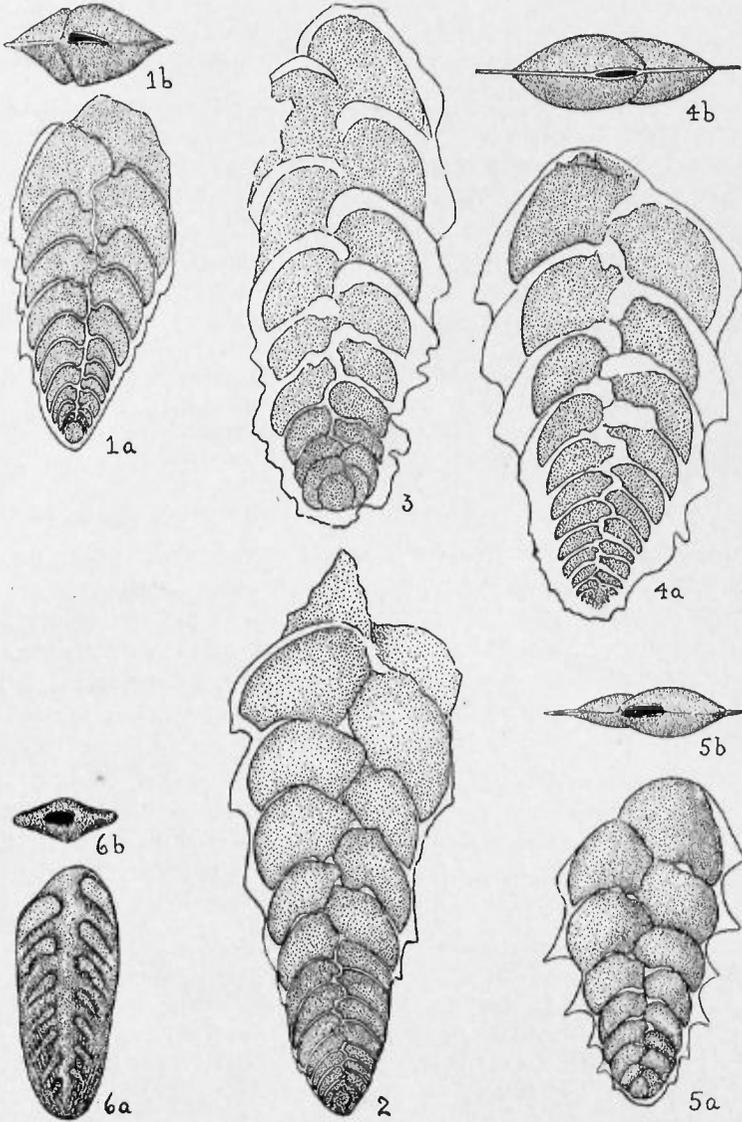
Type specimen (U. S. N. M. Coll. No. 353841), from Alazan clays, bluff on Rio Buena Vista, 2 kms. in a straight line above its confluence with Rio Tuxpan, state of Vera Cruz, Mexico, collected by T. Wayland Vaughan.

This is a peculiar little species which is very distinctive in some parts of the Alazan where it often occurs in great numbers.

It is distinct in its thickenings of the sutures and median line, the coarse punctations and unusual fine ornamentation of the early chambers. The blocklike form with the broadly rounded initial end, the truncate apertural end, and the nearly parallel sides are distinctive.

EXPLANATION OF PLATE 12

- FIGS. 1 *a, b.* *Bolivina alazanensis* Cushman, n. sp. X 75.
a, front view; *b*, apertural view.
- FIG. 2. *Bolivina mexicana* Cushman, n. sp. X 75.
- FIGS. 3, 4 *a, b.* *Bolivina mexicana* Cushman, n. sp., var. *aliformis* Cushman, n. var.
3, front view of megalospheric specimen; 4 *a*, front view of microspheric specimen; 4 *b*, apertural view.
- FIGS. 5 *a, b.* *Bolivina mexicana* Cushman, n. sp., var. *horizontalis* Cushman, n. var.
a, front view; *b*, apertural view.
- FIGS. 6 *a, b.* *Bolivina tectiformis* Cushman, n. sp. X 75.
a, front view; *b*, apertural view.



19. TRIFARINA IN THE AMERICAN EOCENE AND ELSEWHERE

By JOSEPH A. CUSHMAN

A study of Jackson Upper Eocene material from Jackson, Mississippi, has revealed a species of *Trifarina* present there. It is a minute form and might be easily overlooked. A comparison with other Upper Eocene material from the Coastal Plain and recent material from the Atlantic and Pacific shows that it may be distinguished from either, yet is clearly related to both recent forms. The form occurs at other localities in the Upper Eocene of the Coastal Plain of the United States.

GENUS TRIFARINA Cushman, 1923

Rhabdogonium H. B. BRADY (not Reuss), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 524 (and subsequent authors).

Triplasia CUSHMAN (not Reuss), Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 62.

Trifarina CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 99.

Test elongate, triangular in transverse section; the early chambers in an irregular spiral, later ones very loosely so or uniserial; wall thin, translucent, finely punctate; aperture terminal, not radiate, at the end of a short, often phialine lip.

In the strict sense in which this genus is used the most definite forms have been known from the present oceans. There is a larger stouter species known from the Pacific, *T. reussi* Cushman, and a much smaller, more slender one from the Atlantic, *T. bradyi* Cushman. In the Pacific this last species is represented by a distinguishable variety noted below, and in the American Upper Eocene is another variety as later recorded in this paper.

TRIFARINA BRADYI Cushman

Rhabdogonium tricarinatum H. B. BRADY (not *Vaginulina tricarinata* D'ORBIGNY), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 525, in part.—H. B. Brady, Parker and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 223, pl. 45, fig. 3.—Cushman, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 99, pl. 22, figs. 5-7, 9 (3, 4, 8?).

The Atlantic form has a slightly larger test than the Pacific one, has the sides more concave especially in later growth, and the carinae at the angles higher and more prominent, the wall thinner, less distinctly punctate. Plate 67, fig. 3, of the

Challenger Report is from a specimen dredged at *Challenger* station 192, off the Ki Islands according to notes furnished me by Capt. F. A. Potts. The source of figs. 1 and 2 is not determined.

I have examined numerous specimens from various parts of the Pacific, and in general they seem to keep to the slightly smaller size, less prominent carinae, and more distinctly punctate test.

Specimens from the Filter Quarries of Batesford, Victoria, Australia, seem to be somewhat larger than the general run of recent Pacific specimens, and are certainly more like the recent Pacific form than that of the Atlantic. Heron-Allen and Earland refer it to *Rhabdogonium tricarinatum*. A further study of d'Orbigny's original model of *Vaginulina tricarinata* shows it to be uniserial throughout, the aperture at one angle and removes it from any relation to the genus under consideration.

TRIFARINA REUSSI Cushman

Rhabdogonium minutum H. B. BRADY (not *R. minutum* REUSS), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 526, pl. 67, figs. 4-6.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 145.—Chapman, Journ. Linn. Soc. London, Zool., vol. 30, 1910, p. 412 [?].

Triplasia reussi CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 3, 1913, p. 63, pl. 39, fig. 3.

Trifarina reussi CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 4, 1923, p. 99.

Test thick and short, triangular in transverse section, chambers few, somewhat carinate; walls roughish, thick; apertural end with a short, fairly large neck, often with a fringelike border about the aperture itself.

TRIFARINA BRADYI Cushman, var. ADVENA Cushman, n. var.

Variety differing from the typical in the smaller size, more distinctly punctate, thicker wall; sides hardly concave.

Length 0.30 mm.

The type specimen (U. S. N. M. Coll. No. 353843), from the Upper Jackson at Jackson, Mississippi. It is found at other stations in the Upper Eocene of the Coastal Plain.

From what may be seen from a study of these three forms, the Upper Eocene one is more like the recent Pacific than like the recent Atlantic form. It is smaller, thicker, and more punctate than either.

Length 0.80 mm.

This species is known only from the tropical Pacific, and as

has been stated in the above references, is distinct from Reuss' fossil species from Galicia.

There are a few other fossil forms that may possibly belong in this genus, but they are not sufficiently well characterized to place them without reference to original material.

20. A PECULIAR FRONDICULARIA FROM MEXICO AND TRINIDAD

By JOSEPH A. CUSHMAN

In the Alazan clays of the Coastal Plain of Mexico there is a peculiar, elongate species of *Frondicularia*. It occurs at several stations, and is very constant in its characters. The same species has been found to occur at Brasso, Trinidad, B. W. I.

The relationships of this species are very interesting. A description follows:

FRONDICULARIA MEXICANA Cushman, n. sp.

Plate 13, figs. 5 a-c

Test somewhat compressed, very elongate, narrow, the peripheral portion with three sharp, platelike carinae, one in the middle line, the other two lateral; the sides except for the initial end parallel, initial end rounded, slightly tapering, the early portion of the test convex, ornamented by a few longitudinal raised costae, the later portion concave, smooth; chambers rather indistinct; sutures hardly if at all depressed, aperture terminal, central, radiate.

Length up to nearly 1 mm.

Type specimen (U. S. N. M. Coll. No. 353842), from dark gray Alazan clay, Rio La Puerta, Soledad Crossing, Vera Cruz, Mexico, collected by T. Wayland Vaughan. There are also specimens in the U. S. National Museum collections from the Alazan of Mexico collected by Doctor Vaughan from Arroyo Camalla, Tepitzintla-El Humo Road, 4 kms. E. of El Humo; from Rio Buena Vista, 2 kms. in a straight line above its confluence with Rio Tuxpan, Vera Cruz; and from the type locality of the Alazan shale at Rio Buena Vista, just south of crossing of the Alazan to Moyutla road, Vera Cruz.

At its type locality *Fronidicularia mexicana* occurs with a species of *Orthophragmina*.

The specimens from Brasso, Trinidad, are very similar.

In its relationships this species is Indo-Pacific. One of the most closely related species is *Fronidicularia australis* Heron-Allen and Earland, described from the Miocene, "Filter Quarry," of Victoria, Australia (Journ. Roy. Micr. Soc., 1924, p. 157, pl. 10, figs. 56-58). It also resembles more remotely *F. bicostata* Karrer from the Tertiary of Luzon, Philippines (in von Drasche, Frag. Geol. Insel Luzon, 1878, p. 91, pl. 5, fig. 13). Its relationship to the recent form figured by Sidebottom from 465 fathoms off the East Coast of Australia and referred to *F. tenera* (Bornemann) should also be noted.

Many of the species of the Alazan clays of Mexico show this East Indian relationship as has been noted in an earlier paper on *Tritaxilina*.

There is a species in the Pliocene of the American West Coast which also forms a link in this series and probably shows that a similar species occurred on the West Coast of America after *Fronidicularia mexicana* became extinct on the eastern side.

21. MIOCENE SPECIES OF NONIONINA FROM CALIFORNIA

By JOSEPH A. CUSHMAN

There are in the Monterey Shale in certain portions enormous numbers of several species of Nonionina. Three of these are closely allied species, but they have distinctive characters and very definite stratigraphic ranges. The fourth species is here referred to the Recent *Nonionina auris* d'Orbigny, and has a somewhat wider range. The figures are intended to bring out these specific characters so that the species may be distinguished from one another.

NONIONINA MEDIO-COSTATA Cushman, n. sp.

Plate 13, fig. 1 *a-c*

Test slightly longer than broad, periphery rounded, composed of numerous chambers, 15 or more in the last-formed coil; slight-

ly umbilicate; sutures distinct, slightly depressed, gently curved, forming nearly a right angle with the periphery, the area between the sutures raised and the inner end with a definite costa rounded toward the umbilicus; in apertural view the apertural face gently convex, definitely higher than broad, the aperture an arched opening at the base of the apertural face between it and the preceding coil.

Length up to 0.65 mm.; breadth 0.40 mm.; thickness 0.22 mm.

Type specimen (Cushman Coll. No. 4367) from Miocene, Monterey shale, Sect. 24, T.28,R.14, San Luis Obispo Co., California.

The distinguishing characters are especially the narrow apertural face and test with the raised costae between the sutures.

NONIONINA COSTIFERA Cushman, n. sp.

Plate 13, figs. 2 a-c

Test longer than broad, periphery acute, almost keeled, composed of numerous chambers, as many as 20 in the last-formed coil, umbilicate; sutures distinct, limbate, slightly raised above the general surface, increasing in thickness and height toward the umbilicus, forming an acute angle with the periphery; in apertural view, the apertural face heart-shaped or broadly triangular, flattened or slightly concave, the aperture a very small semi-circular opening at the base of the apertural face, between it and the preceding coil.

Length up to 1 mm.; breadth 0.60 mm.; thickness 0.35-0.40 mm.

Type specimen (Cushman Coll. No. 4368) from Miocene, Monterey shale, Sect. 24, T.28,R.14, San Luis Obispo Co., California.

The distinguishing characters are especially the limbate and costate sutures and the very broad triangular apertural face.

NONIONINA INCISA Cushman, n. sp.

Plate 13, figs. 3 a-c

Test longer than broad, periphery acute, composed of numerous chambers, about 15 in the last-formed coil, slightly umbilicate; sutures distinct, deeply incised, curved, forming an acute angle with the periphery; wall smooth; in apertural view the apertural face broad, slightly convex, the aperture an elongate narrow arched opening at the base of the apertural face between it and the preceding coil.

Length up to 0.60 mm.; breadth 0.40 mm.; thickness 0.25–0.30 mm.

Type specimen (Cushman Coll. No. 4369), from Miocene, Monterey shale, Sect. 24, T.28,R.14, San Luis Obispo Co., California.

This species may be distinguished from the two preceding by the lack of definite costae and the broad apertural face. The sutures are sometimes very deeply incised, and the chambers between correspondingly convex.

NONIONINA AURIS (d'Orbigny)

Plate 13, figs. 4 *a-c*

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

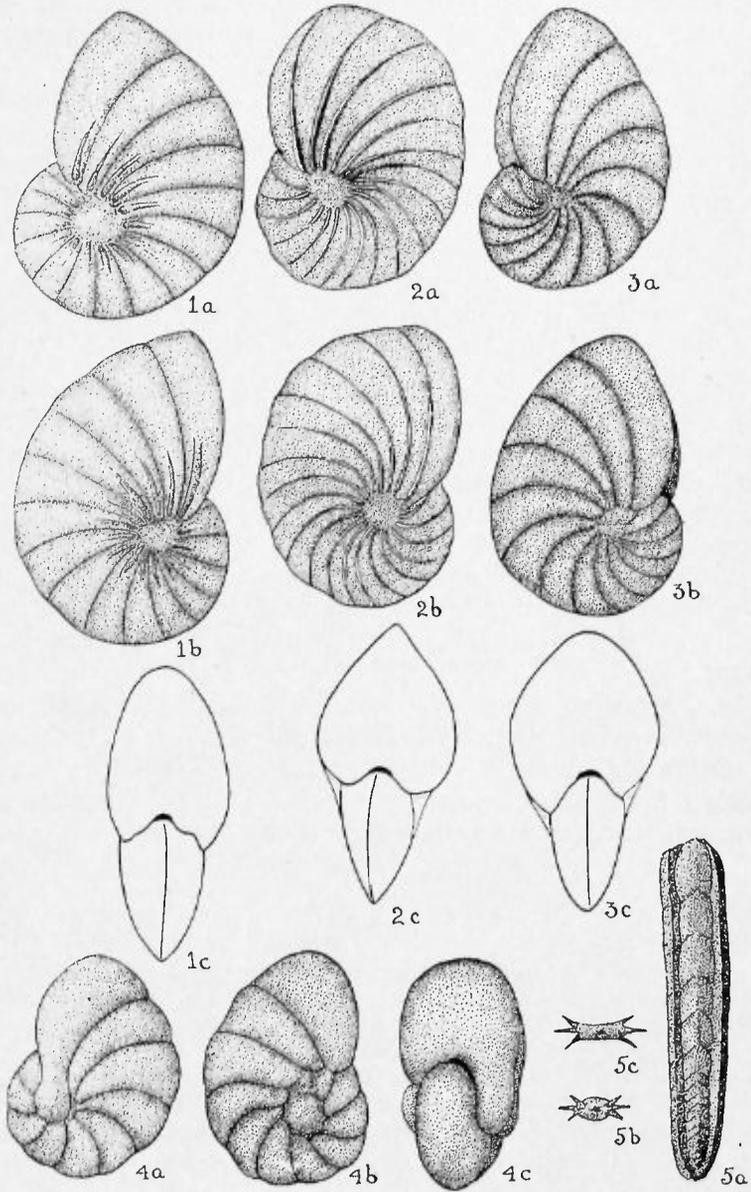
There is figured a specimen of *Nonionina* which is very close to *N. auris* (d'Orbigny) described by d'Orbigny from the West Coast of South America. I have figured a form (Contrib. Cushman Lab. Foram. Res., vol. 1, pt. 2, 1925, p. 44, pl. 7, figs. 3 *a-c*) from Queen Charlotte Sound, which is similar to that figured by d'Orbigny but having a broader stouter form with fewer chambers. The Miocene specimen figured above which is typical of those found in the Monterey has more chambers and is closer in this respect to d'Orbigny's type figure, but is somewhat stouter.

The figured specimen (Cushman Coll. No. 4370) is from Miocene, Monterey shale, Sect. 24, T.28,R.14, San Luis Obispo Co., California.

This species never seems to be abundant in the material examined, but is very constant in its characters.

EXPLANATION OF PLATE 13

- FIGS. 1 *a-c*. *Nonionina medio-costata* Cushman, n. sp. X 75.
a, b, opposite sides; *c*, apertural view.
- FIGS. 2 *a-c*. *Nonionina costifera* Cushman, n. sp. X 45.
a, b, opposite sides; *c*, apertural view.
- FIGS. 3 *a-c*. *Nonionina incisa* Cushman, n. sp. X 75.
a, b, opposite sides; *c*, apertural view.
- FIGS. 4 *a-c*. *Nonionina auris* (d'Orbigny). X 75.
a, b, opposite sides; *c*, apertural view.
- FIGS. 5 *a-c*. *Frondicularia mexicana* Cushman, n. sp. X 50.
a, front view; *b*, section of young portion; *c*, section of adult with flatter or even concave faces.



RECENT LITERATURE ON THE FORAMINIFERA

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

Lange, E.

Eine mittelpermische Fauna von Guguk Bulat. (Padanger Oberland, Sumatra).

(Verhandl. Geol.-Mijn. Gen. Ned. Kol. Geol. Ser., vol. 7, 1925, pp. 213-295, pls. 1-5, 10 text figs.) *The Hague.*

Pages 217-272 are given to the foraminifera with many photographic sections in the first four plates. In all, 79 species of foraminifera are dealt with of which 57 are described as new as well as 2 new genera, *Padangia* and *Pachyphloia*.

Silvestri, A.

Sur quelques foraminifères et pseudo-foraminifères de Sumatra.

(Verhandl. Geol.-Mijn. Gen. Ned. Kol. Geol. Ser., vol. 8, 1925, pp. 449-460, pls. 1-3.) *The Hague.*

Notes are given on a number of species of foraminifera from Sumatra. Twelve sections are given from photographs including new species of *Lacazina* and *Choffatella*.

Tobler, A.

Mesozoikum und Tertiär des Gumai-gebirges.

(Verhandl. Geol.-Mijn. Gen. Ned. Kol. Geol. Ser., vol. 8, 1925, pp. 521-535.) *The Hague.*

Notes are given on the occurrence of various foraminifera characteristic of different horizons in Sumatra.

Van der Vlerk, J. M.

Lepidocyclina medicolumnata nov. spec. de Pasir (SE-Borneo).

(Compte-Rendu quatrieme assemblee generale de la Soc. pal. suisse. *Eclogae geologicae Helvetiae*, vol. 19, No. 1, 1925, pp. 267-269, pl. 7. *Basle.*

This new species from Borneo is described in detail. Excellent figures are given of this and of *L. formosa* Schlumberger.

Van der Vlerk, J. M.

De Verspreiding van het Foraminiferan-Geslacht *Lepidocyclina* en Haar Beteekenis Voor de Palaeogeographie.

(Handel. Derde Nederl. Indisch Nat. Congres., 1924 (1925),
9 pages. *Buitenzorg.*

Many general notes are given on the occurrence of *Lepidocyclina* and related forms in relation both to time and horizontal distribution. World distribution is summarized.

Nuttall, W. L. F.

The Stratigraphy of the Laki Series (Lower Eocene) of parts of Sind and Baluchistan (India); with a Description of the Larger Foraminifera contained in those Beds.

(Quart. Journ. Geol. Soc., vol. 81, 1925, pp. 417-453, pls. 23-27, 5 text figures.) *London.*

A short outline of the geological history of the region is followed by descriptions of some of the foraminifera as well as a comparison of the Indian fauna with that of southern Europe. Fourteen species are given in detail. Two new species and a new variety are described, as well as a new genus *Opertorbitolites*. The plates are made up from excellent photographs of sections and exteriors.

Martinotti, A.

Osservazioni sulla *Nodosaria annulata* Rs. e sulla *Nodosaria paronai* Derv.

(Riv. Sci. Nat. "Natura," vol. 16, 1925, pp. 79-83, 6 figures in text.) *Pavia.*

Excellent figures are given with sections of these two species from the Pliocene and Miocene of Italy.

Chapman, F.

Foraminifera and Oil.

(The Melbourne [Australia] "Argus," Sept. 19, 1925.)

This newspaper article connects very definitely the occurrence of foraminifera and oil in many parts of the world giving examples where the tests of fossil foraminifera as far back as the Carboniferous are lined with such material.

Nuttall, W. L. G.

Two Species of Eocene Foraminifera from India, *Alveolina elliptica* and *Dictyoconoides cooki*.

(Ann. Mag. Nat. Hist., ser. 9, vol. 16, Oct. 1925, pp. 378-388, pls. 20, 21.) *London.*

Very full descriptions and excellent figures are given of these forms from the Eocene.

Beede, J. W. and Kniker, H. T.

Species of the Genus Schwagerina and Their Stratigraphic Significance.

(Bull. 2433, Univ. Texas., Sept. 1, 1924, pp. 1-98, pls. 1-9, with map.) *Austin.*

This paper is a monographic treatment of all the previously known species of the genus and some new ones with their detailed descriptions, illustrated by figures of the exteriors as well as various sections. Much interesting information is included on the structure, evolution of the group, and the world distribution.

Ozawa, Y.

A brief Critical Revision of the Fusulina—Species Recently Described, with Additional Studies of Japanese Fusulinae.

(Journ. Geol. Soc. Tokyo, vol. 32, May, 1925, pp. 19-27, pls. 9, 10.) *Tokyo.*

This paper is as its title indicates a revision of recently described species from the Orient. Two plates from photographed sections are included.

J. A. C.