

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

152. NEW CRETACEOUS TEXTULARIIDAE

By CECIL G. LALICKER

During the past three years the author has been engaged in a monographic study of the family Textulariidae. In the course of this study many species have been found which are apparently new, some of which are here presented in order that they may be of use to others while awaiting publication of a large report on the family now being prepared.

These species have been compared with established species from the Cretaceous of Germany, France, Galicia, Bohemia, England, Mexico, Trinidad, Canada, and the United States, and the similarities noted in detail. Some of them are species which have been misidentified by earlier authors, probably because they did not have topotype material from other countries on hand for comparison. Some of these new species are definitely restricted in their vertical ranges, especially those from the Gault of England, and the Lower Cretaceous of Northern Texas, and in the latter region should make good index fossils.

I am especially indebted to Dr. Joseph A. Cushman for his untiring aid and encouragement in this study, his examination of many types of Textulariidae in various European Museums in the summer of 1932, and having made extensive collections of topotype material available for me. I am also indebted to Margaret S. Moore for the careful drawing of these forms.

SPIROPLECTAMMINA ALEXANDERI Lalicker, n. sp. (Pl. 1, figs. 1 a-c)

Test very small, elongate, gradually increasing in width from rounded initial end, slightly compressed in early portion, periphery rounded, almost circular in top view; chambers numerous, planispiral at initial end, later biserial, wider than high, and increasing in height as added, inflated; sutures dis-

tinct, relatively wide and slightly limbate, straight or very slightly oblique; wall finely arenaceous, but not smooth; aperture, a low broad opening at the base of the last-formed chamber, its breadth being equal to one-half the thickness of the test; color nearly white. Length of holotype 0.34 mm.; width 0.14 mm.; thickness 0.14 mm.

Holotype (Cushman Coll. No. 21601) from the Upper Goodland limestone, "Cragin Knobs," on Stove Foundry Road, 6 miles west of Fort Worth, Texas, where it is very common. Collected by Dr. C. I. Alexander.

This small species seems to be characteristic of the Goodland limestone in northern Texas, having been found only at two stations, one in the upper part, in the "Cragin Knobs," and one in the basal Comanche Peak, both near Fort Worth, Texas. This species is similar in some respects to *Textularia rioensis* Carsey, but is easily distinguished by its small size, nearly parallel sides, and the coiled initial chambers.

This species is named in honor of Dr. C. I. Alexander, who collected the material.

SPIROPLECTAMMINA GOODLANDANA Lalicker, n. sp. (Pl. 1, figs. 2, 3)

Test comparatively small, tapering, somewhat compressed, widest at the apertural end, periphery rounded; chambers numerous, in the early portion coiled, later biserial, relatively low and broad, increasing gradually in height; sutures distinct, slightly limbate, especially in early portion, and depressed in later two-thirds of test, straight or slightly curved, nearly horizontal, in some cases forming an angle of 10° with the horizontal; wall finely arenaceous with considerable proportion of cement, and rather smoothly finished; aperture, a rather high arched opening in a deep reëntrant at the base of the last-formed chamber. Length of holotype 0.54 mm.; width 0.25 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 21605) from the Upper Goodland limestone, $5\frac{1}{2}$ miles west of Sanger, Denton Co., Texas. Collected by Dr. C. I. Alexander.

This small species is very distinctive, and seems to be limited in its vertical range. It is superficially similar to *Spiroplectamina nuda* Lalicker, n. sp., but differs in having higher chambers throughout, more horizontal sutures, depressed sutures and a more highly arched aperture. A detailed comparison of speci-

mens of *S. goodlandana* Lalicker, n. sp., which had been slowly disintegrated with weak acid, causing the sutures to be more limbate than usual, with *S. nuda* Lalicker, n. sp., shows definitely the two species are distinct. I have specimens from the Upper Goodland limestone, 5½ miles west of Sanger, Denton Co., Texas, where it is very common; and from the Goodland-Kiamichi contact, Lake Worth Dam, Fort Worth, Texas.

SPIROPLECTAMMINA LONGA Lalicker, n. sp. (Pl. 1, figs. 4, 5)

Test very elongate, slender, sides nearly parallel for most of the length, somewhat compressed, periphery subacute, greatest width at apertural end; chambers numerous, in the early portion coiled, and for about one-third of the length of the mature form very low, in the remainder of the test higher, averaging over twice the height of the earlier chambers, and more inflated and lobulate; sutures distinct, limbate, more so in early portion, depressed in later portion, oblique, forming an angle of 10-20° with the horizontal, more oblique in early portion; wall distinctly arenaceous with considerable proportion of cement, and rather smoothly finished; aperture, a high arched opening at the base of the last-formed chamber, and in a distinct reëntrant in the apertural face; color grey. Length of holotype 0.65 mm.; width 0.18 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 21603) from the Fort Worth formation, in road cut, north side of state highway, 2 miles northeast of Denison, Grayson Co., Texas. Collected by R. V. Hollingsworth and C. G. Lalicker.

Spiroplectammina mordenensis Wickenden from the Cretaceous of Canada differs from this species by its larger initial end, by a coarsely arenaceous wall, by parallel sides throughout, and a lack of low chambers in the initial one-third of the test. *S. longa* Lalicker, n. sp., is also similar to *S. gaultana* Lalicker, n. sp., from the Gault of Folkestone, England, but differs in having higher chambers in proportion to their width, more inflated chambers, more elongate test, sides more parallel, and in having a more highly arched aperture.

This species appears to be restricted to the upper part of the Lower Cretaceous of northern Texas, ranging from the basal Duck Creek formation to the Grayson formation. I have specimens from the following localities:

Duck Creek, 0.9 miles east of Fink, Texas, in creek bed, left

hand side from Fink; Fort Worth, north side of highway, in road cut, 2 miles northeast of Denison, Grayson Co., Texas; Fort Worth, 1 mile west of Krum, Denton Co., Texas; Fort Worth—Denton contact, 1.5 miles west of Krum, Denton Co., Texas; Denton, 5 miles south of Fort Worth, Texas; Lower Grayson, 1.5 miles northeast of Roanoke, Denton Co., Texas; Grayson, 6 miles north of Roanoke, Denton Co., Texas.

SPIROPLECTAMMINA NUDA Lalicker, n. sp. (Pl. 1, figs. 6, 7)

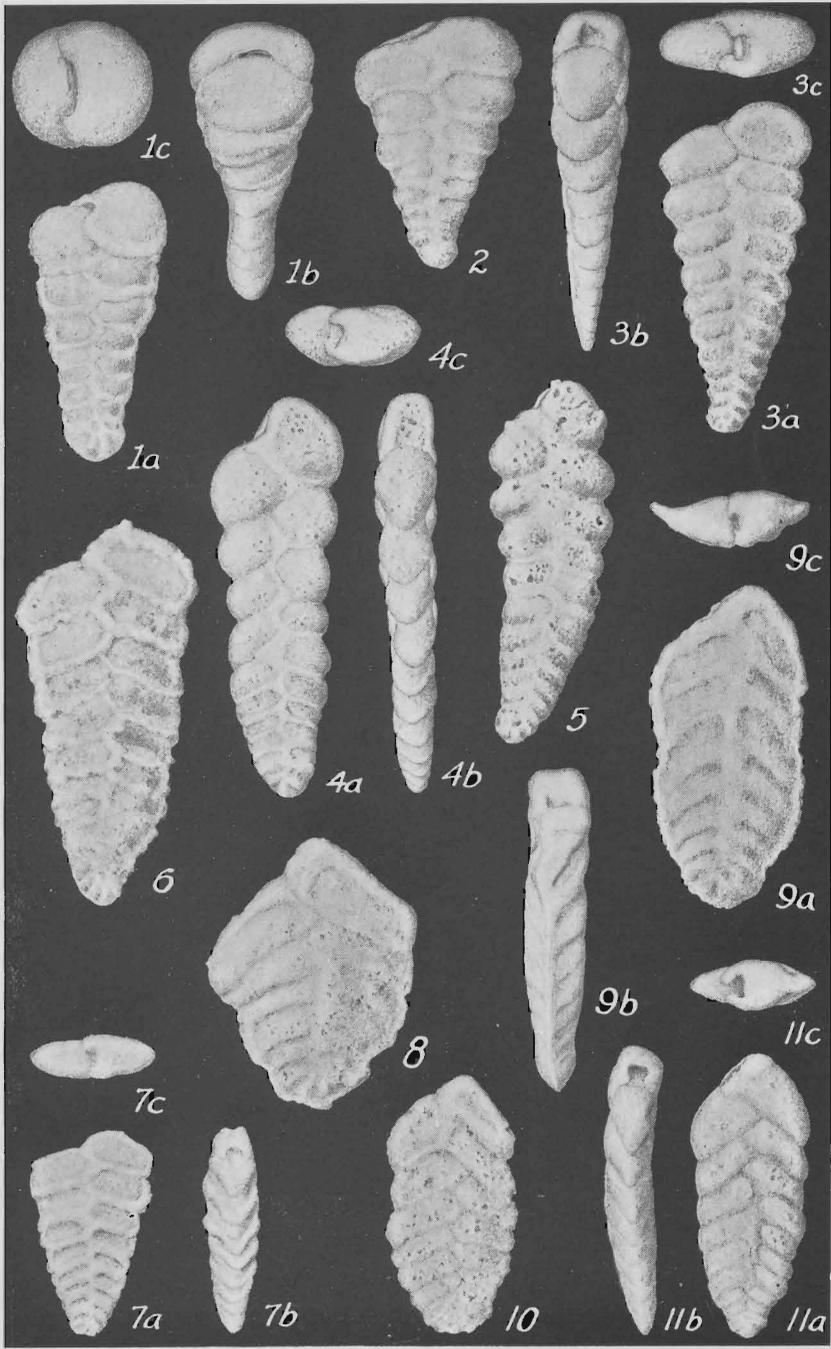
Test small, tapering, gradually expanding from the rounded initial end, somewhat compressed; chambers numerous, in the early portion coiled, depressed, low and broad, gradually increasing in height as added; sutures strongly limbate, straight, forming an angle of 10-15° with the horizontal; wall finely arenaceous, but not smooth; aperture, a low, arched opening at the base of the last-formed chamber. Length of holotype 0.33 mm.; width 0.20 mm.; thickness 0.08 mm.

Holotype (Cushman Coll. No. 21618) from the Middle Fort Worth formation, in road cut, north side of highway, 2 miles northeast of Denison, Grayson Co., Texas. Collected by R. V. Hollingsworth and C. G. Lalicker.

EXPLANATION OF PLATE 1

- FIGS. 1 a-c. *Spiroplectammia alexanderi* Lalicker, n. sp. × 107. Holotype. *a*, front view; *b*, side view; *c*, apertural view. Lower Cretaceous, Texas.
- FIGS. 2, 3. *S. goodlandana* Lalicker, n. sp. × 80. Fig. 2, Paratype. Fig. 3, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Lower Cretaceous, Texas.
- FIGS. 4, 5. *S. longa* Lalicker, n. sp. × 80. Fig. 4, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Fig. 5, Paratype. Lower Cretaceous, Texas.
- FIGS. 6, 7. *S. nuda* Lalicker, n. sp. × 80. Fig. 6, Paratype. Fig. 7, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Lower Cretaceous, Texas.
- FIGS. 8, 9. *S. chicoana* Lalicker, n. sp. × 60. Fig. 8, Paratype. Fig. 9, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Cretaceous, California.
- FIGS. 10, 11. *S. sigmoidina* Lalicker, n. sp. × 60. Fig. 10, Paratype. Fig. 11, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Cretaceous, California.

Figures drawn by Margaret S. Moore.



This species is characterized by its strongly limbate sutures and relatively low chambers. The general outline of this species is similar to *Textularia washitensis* Carsey, but differs in having a coiled initial end, strongly limbate sutures, lower chambers, and straight sutures. In *Spiroplectammīna nuda* Lalicker, n. sp., the zigzag line between chambers is concave upward, while in *Textularia washitensis* Carsey it is convex upward. The similarities between *S. nuda* and *S. goodlandana* Lalicker, n. sp., are discussed above. In addition to the type locality, I have specimens from the Denton formation, 5 miles south of Fort Worth, Texas. It is rare at both localities.

SPIROPLECTAMMINA CHICOANA Lalicker, n. sp. (Pl. 1, figs. 8, 9)

Spiroplectammīna anceps CUSHMAN and CHURCH (not REUSS), Proc. Calif. Acad. Sci., 4th ser., vol. 18, 1929, p. 500, pl. 36, figs. 1, 2.

Test much compressed, rapidly increasing in width from the initial end, greatest width near the apertural end, thickest near the median portion of the test, thence thinning toward the periphery; chambers numerous, coiled in the early portion, later becoming biserial, low and broad, depressed; sutures distinct, limbate, especially near the apertural end, straight and somewhat oblique, forming an angle of 25° with the horizontal; wall coarsely arenaceous, but smoothly finished; aperture, a low opening at the base of the inner median margin of the last-formed chamber. Length of holotype 0.70 mm.; width 0.33 mm.; thickness 0.13 mm.

Holotype (Cushman Coll. No. 10043) from well No. 19, California Northern Petroleum Co., sec. 2; T 21 S; R 14 E, near Coalinga, Calif., 1000-1135 feet. Collected by Mr. O. F. Darling.

Spiroplectammīna carinata (d'Orbigny), which is similar to this species in some respects, differs in having a rounded apertural end in side view, more depressed sutures, and a higher aperture in a deeper reëntrant.

SPIROPLECTAMMINA SIGMOIDINA Lalicker, n. sp. (Pl. 1, figs. 10, 11)

Test elongate, somewhat compressed, rapidly increasing in width from the initial end, sides nearly parallel in upper two-thirds of test, periphery subacute; chambers numerous, wider than high, and slightly inflated; sutures depressed, somewhat oblique, and sigmoid, curving upward near the median line and downward near the peripheral margin; wall distinctly arena-

ceous, but smoothly finished; aperture, a rather high arched opening in a deep reëntrant at the base of the inner margin of the last-formed chamber. Length of holotype 0.61 mm.; width 0.25 mm.; thickness 0.11 mm.

Holotype (Cushman Coll. No. 21616) from well No. 19, California Northern Petroleum Co., sec. 2; T 21 S; R 14 E, near Coalinga, Calif., 1000-1135 feet. Collected by Mr. O. F. Darling.

This very distinctive species is characterized by its sigmoid sutures. *Spiroplectamina anceps* (Reuss), from the Cretaceous of Bohemia, resembles this species somewhat in having sigmoid sutures, but in *S. anceps* they are more clear-cut and more highly developed. *S. anceps* is also much thicker, wider, and in general more robust than *S. sigmoidina* Lalicker, n. sp.

SPIROPLECTAMMINA GAULTANA Lalicker, n. sp. (Pl. 2, figs. 1, 2)

Textularia praelonga CHAPMAN (not REUSS), Journ. Roy. Micr. Soc., 1892, p. 329, pl. 6, fig. 23.

Spiroplecta praelonga CHAPMAN (not REUSS), l. c., p. 751, pl. 11, fig. 5.

Spiroplecta biformis BURROWS, SHERBORN, and BAILEY (not PARKER and JONES), l. c., 1890, p. 554, pl. 8, fig. 21.

Test elongate, somewhat compressed, increasing gradually in breadth, widest in the central portion, thence decreasing toward apertural end, periphery subacute, in peripheral view sides parallel; chambers numerous, in the early portion coiled, and for about one-third of the length of the mature form, very low, in the remainder of the test higher, averaging over twice the height of the earlier chambers, and more inflated; sutures wide and distinctly limbate, especially in the early portion, oblique, forming an angle of from 15-20° with the horizontal; wall distinctly arenaceous with considerable proportion of cement, and rather smoothly finished; aperture, a low opening at the base of the last-formed chamber, its breadth being nearly equal to one-half the thickness of the test, and in a distinct reëntrant; color, light grey. Length of holotype 0.68 mm.; width 0.31 mm.; thickness 0.14 mm.

Holotype (Cushman Coll. No. 21612) from bed 11, Gault of Folkestone, England. Collected by Dr. W. A. Macfadyen.

This species has been observed only in the Gault of Folkestone, England, and seems to be restricted to bed 11. It differs from *Spiroplectamina longa* Lalicker, n. sp., in having relatively lower chambers, more depressed chambers, a lower aperture, and a broader test.

SPIROPLECTAMMINA ROEMERI Lalicker, n. sp. (Pl. 2, figs. 5 a-c)

Textularia laevis ROEMER (not EHRENBURG), Verst. norddeutsche Kreide, 1840-41, p. 97, pl. 15, fig. 17.

Spiroplectammina laevis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 87, pl. 11, figs. 2 a, b.

Test subtriangular in outline, strongly tapering, thickest along median line, top view subrhomboidal in outline, periphery acute; chambers numerous, in the early portion coiled, low, and broad, slightly depressed, outer periphery of the chamber along the apertural face with a distinct raised area, particularly when well preserved; sutures distinct, faintly limbate, slightly curved and directed back; wall distinctly arenaceous with a large proportion of cement, and smoothly finished; aperture, a low, broad opening at the base of the inner margin of the last-formed chamber; color nearly white. Length of holotype 0.63 mm.; width 0.56 mm.; thickness 0.26 mm.

Holotype (Cushman Coll. No. 21620) from the Kreide, near Peine, Germany.

This species seems to be restricted to the Kreide of Europe. It is probably an ancestral form of *S. senonana* Lalicker, n. sp., from the Senonian of Bavaria.

SPIROPLECTAMMINA SENONANA Lalicker, n. sp. (Pl. 2, figs. 3, 4)

Test large, triangular in outline, both in front and side views, rhomboidal in end view, thickest along the median line, periphery acute; chambers numerous, coiled in early portion, very low and depressed, with short spines on the ends of some, especially on megalospheric forms; sutures limbate, strongly curved, and united in the center to form a definite high ridge; wall coarsely arenaceous, but rather smoothly finished; aperture, a low, broad opening at the base of the inner margin of the last-formed chamber; color light brown. Length of holotype 1.02 mm.; width 0.98 mm.; thickness 0.64 mm.

Holotype (Cushman Coll. No. 21614) from the Upper Senonian, Gerhartsreuther Graben, near Siegsdorf, Upper Bavaria, Germany. Collected by Dr. J. A. Cushman and Dr. Schnetzer.

This species is characterized by its large size, strongly limbate sutures, and by the short spines on the ends of some chambers, particularly on megalospheric forms. This species differs from *S. roemeri* Lalicker, n. sp., in having strongly limbate and curved

sutures, by its large size, greater thickness in proportion to the width, and the presence of peripheral spines. It differs from *S. dentata* (Alth) in having limbate sutures and a more triangular outline. It is very common at the type locality.

TEXTULARIA ANGLICA Lalicker, n. sp. (Pl. 2, figs. 6, 7)

Textularia gramen BURROWS, SHERBORN, and BAILEY (not D'ORBIGNY),
Journ. Roy. Micr. Soc., 1890, p. 553, pl. 8, figs. 13 a, b.

Test small, broad, subtriangular in outline, suboval in end view, widest at apertural end, periphery rounded throughout; chambers numerous, comparatively high, slightly inflated; sutures depressed, curving backward slightly at peripheral margin; wall finely arenaceous with a large proportion of cement, smoothly finished; aperture, a low opening in a slight reëntrant at the base of the last-formed chamber. Length of holotype 0.32 mm.; width 0.23 mm.; thickness 0.16 mm.

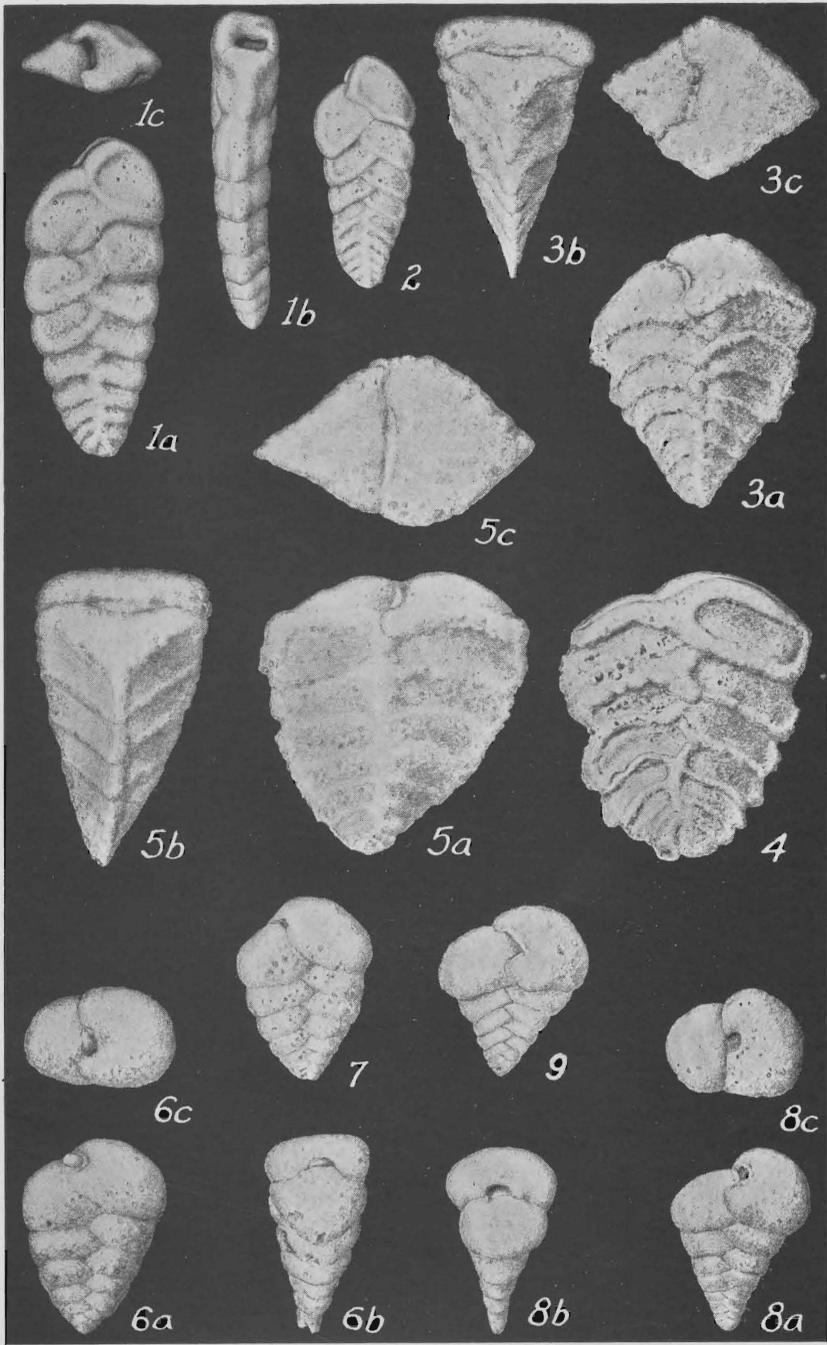
Holotype (Cushman Coll. No. 21608) from bed 13, Gault of Folkestone, England. Collected by Dr. W. A. Macfadyen.

This small species is common in bed 13 of the Gault of Folkestone, England, but has not been observed elsewhere. It differs from *Textularia chapmani* Lalicker, n. sp., in being much wider and thicker in the early portion, in having a lower aperture, and in having less inflated apertural chambers. *T. chapmani* is restricted to bed 11 of the Gault, while *T. anglica* Lalicker, n. sp., is restricted to bed 13.

EXPLANATION OF PLATE 2

- FIGS. 1, 2. *Spiroplectammina gaultana* Lalicker, n. sp. × 60. Fig. 1, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Fig. 2, Paratype. Lower Cretaceous, Folkestone, England.
- FIGS. 3, 4. *S. senoniana* Lalicker, n. sp. × 33. Fig. 3, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Fig. 4, Paratype. Cretaceous, Siegsdorf, Germany.
- FIGS. 5 a-c. *S. roemeri* Lalicker, n. sp. × 60. Holotype. *a*, front view; *b*, side view; *c*, apertural view. Cretaceous, Peine, Germany.
- FIGS. 6, 7. *Textularia anglica* Lalicker, n. sp. × 80. Fig. 6, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Fig. 7, Paratype. Lower Cretaceous, Folkestone, England.
- FIGS. 8, 9. *T. chapmani* Lalicker, n. sp. × 60. Fig. 8, Holotype. *a*, front view; *b*, side view; *c*, apertural view. Fig. 9, Paratype. Lower Cretaceous, Folkestone, England.

Figures drawn by Margaret S. Moore.



TEXTULARIA CHAPMANI Lalicker, n. sp. (Pl. 2, figs. 8, 9)

Textularia conica CHAPMAN (not D'ORBIGNY), Journ. Roy. Micr. Soc., 1892, p. 329, pl. 6, fig. 20.

Test small, roughly triangular in front and side views, early portion distinctly compressed, widest and thickest at the apertural end, in end view subcircular, periphery broadly rounded near the apertural end, becoming slightly angular near the base; chambers numerous, comparatively low, much wider than high; sutures depressed, straight or slightly curved upward near the periphery; wall finely arenaceous, only slightly roughened; aperture, a small semicircular opening at the base of the last-formed chamber. Length of holotype 0.40 mm.; width 0.30 mm.; thickness 0.23 mm.

Holotype (Cushman Coll. No. 21610) from bed 11, Gault of Folkestone, England. Collected by Dr. W. A. Macfadyen.

This is a very distinctive species, and seems to be restricted to bed 11 of the Gault of Folkestone, England. I have compared a series of these forms with a large series of *Textularia conica* d'Orbigny from Cuba. This species is much thinner in the lower one-half than is *T. conica*, and the angle of the sutures is different, those of *T. chapmani* Lalicker, n. sp., sloping backward at a steeper angle. This species is wider and thicker in the end chambers than *T. conica*. *T. conica* expands gradually, while *T. chapmani* expands rapidly.

153. A NEW GENUS OF FORAMINIFERA FROM THE MIOCENE OF VENEZUELA

By JOSEPH A. CUSHMAN and HOLLIS D. HEDBERG

The following new genus and species from Venezuela is interesting in its resemblance to other genera of the Rotaliidae as well as in its peculiar structures.

Genus EPONIDELLA Cushman and Hedberg, n. gen.

Genotype, *Eponidella libertadensis* Cushman and Hedberg, n. sp.

Test trochoid, chambers all visible from the dorsal side, only those of the last-formed whorl visible from the ventral side;

chambers of the ventral side of the test in two series, a small supplementary chamber being added over the umbilical portion of each main chamber; wall calcareous, coarsely perforate, that of the main portion very thick, in the supplementary ventral portion much thinner, entire test with a very thin but distinct chitinous inner wall a light yellowish-brown in color; aperture in the earlier stages running in from the ventral side, later becoming semicircular, oval, or nearly circular, in the middle of the apertural face, and sometimes divided by a very thin horizontal partition.

As yet this genus is only known from the type species from the Miocene of Venezuela.

The relationships of this genus seem to be with the members of the Rotaliidae such as *Gyroidina*, *Eponides*, etc. In some respects it resembles *Epistomina* and *Epistomaria*, but there is no indication of a definite series of supplementary apertures. The thin inner chitinous wall is very similar to that seen in some species of *Discorbis*, and related forms, undoubtedly representing the early primitive test from which many of these calcareous forms have apparently developed.

EPONIDELLA LIBERTADENSIS Cushman and Hedberg, n. sp. (Pl. 3, figs. 1-4)

Test small, low, trochoid, usually consisting of 2 to 2½ whorls, biconvex, the dorsal side slightly more convex than the ventral, periphery broad, rounded, ventral side with the umbilicus filled; chambers distinct, numerous, usually 10 to 11 in the last-formed whorl, of rather uniform shape, increasing very slightly in size as added, early chambers visible from the dorsal side, only those of the last whorl from the ventral side where in the umbilical end of each chamber is a smaller supplementary chamber, generally triangular in shape; sutures distinct, very slightly if at all depressed, very strongly limbate, on the dorsal side slightly curved, on the ventral side nearly straight and radial; wall composed of two layers, an outer, thick, coarsely perforate, calcareous layer, and an inner, thin, yellowish-brown, chitinous one, wall of the supplementary ventral chambers thinner than that of the remainder of the test, the junction between the main chamber and the smaller ventral one extending a slight distance into the cavity of the test, but not completely dividing the interior; aperture in the early stages at the ventral margin, extending gradually into the apertural face, often with definite

lobes and projections, in the adult becoming separated from the base, and appearing either semicircular or irregularly oval or nearly circular in the middle of the apertural face, sometimes divided by a very thin partition into two nearly equal parts. Average length 0.21 mm.; breadth 0.18 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 21598) from Miocene shales near San Mateo, District of Libertad, State of Anzoategui, Venezuela.

This species is an interesting one, showing the peculiar features of this genus, and also showing rather unusual characters of the wall. The main wall of the test is very thick and very coarsely perforate as seen in our sections, the supplementary chambers having much thinner walls, and at the junction of the two the resulting division wall is continued into the cavity of the test for a slight distance, but does not completely divide it. The entire test has an inner chitinous wall, very thin, but filling the entire test. This is demonstrated in our preparation made by dissolving the exterior calcareous wall with weak acid, leaving a complete inner wall and the connecting portions. One of these specimens is here drawn. The genus is related to *Eponides* in the general characters of the test and the aperture in the early stages. The umbilicus is filled, otherwise it somewhat resembles some of the more compressed forms of *Gyroidina*. The aperture is very variable in its developmental characters, so that specimens in different stages of development show widely differing shapes at the apertural opening. In the specimens which seem to be complete adults, it is a rounded opening in the middle of the apertural face.

A specialized genus of this sort should be rather limited in its distribution, and should make an excellent index fossil. It will be interesting to have reports of its distribution from other localities in the Miocene, unless it is a species of very restricted geographical distribution.

The development of supplementary chambers on the ventral side of the test in this genus is another example of the development of such structures which are now known in a number of different groups. The best known of these perhaps are the supplementary chambers developed on the ventral side of *Hastigerina* and *Amphistegina*. In these two genera, the smaller, ventral, supplementary chambers alternate with the larger ones. In *Epistomaria*, the supplementary chambers on the ventral side,

as in the new genus here described, correspond to the larger chambers, and do not alternate with them. In other groups, such supplementary chambers are seen in the Buliminidae where *Robertina* develops a double set of chambers, and in the Cassidulinidae in the recently erected genus *Pseudobulimina* Earland. It would be an interesting problem to work out in section the developmental stages of the origin of these various supplementary chambers.

154. NEW LATE TERTIARY BOLIVINAS FROM CALIFORNIA

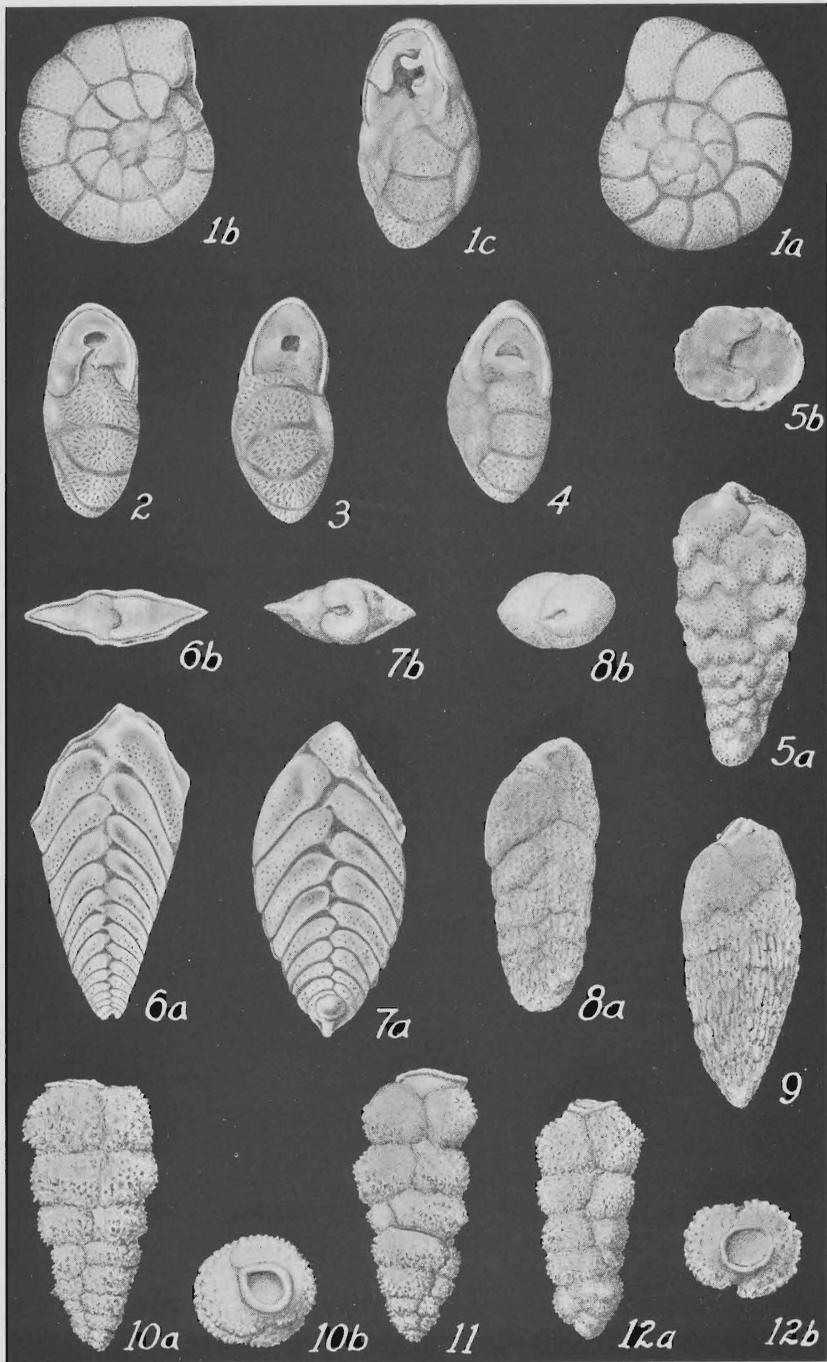
By JOSEPH A. CUSHMAN and BRADFORD C. ADAMS

It seems well to place on record the few forms here described, that they may be included in the large work on this group by the senior author now nearing completion. The forms are of especial interest to workers on the late Tertiary sediments of California.

EXPLANATION OF PLATE 3

- FIGS. 1-4. *Eponidella libertadensis* Cushman and Hedberg, n. gen. and n. sp. $\times 100$. Fig. 1, Holotype. *a*, dorsal view; *b*, ventral view; *c*, apertural view. Figs. 2-4, Paratypes. Showing development of the aperture from that which is connected with the base to those which are entirely cut off in the middle of the apertural face. Miocene, District of Libertad, State of Anzoategui.
- FIGS. 5 *a*, *b*. *Bolivina sinuata* Galloway and Wissler, var. *alisoensis* Cushman and Adams, n. var. $\times 60$. *a*, front view; *b*, apertural view.
- FIGS. 6, 7. *Bolivina cochei* Cushman and Adams, n. sp. $\times 100$. Fig. 6, Holotype. Microspheric form. Fig. 7, Paratype. Megalospheric form. *a*, *a*, front views; *b*, *b*, apertural views.
- FIGS. 8, 9. *Bolivina subadvena* Cushman, var. *sulphurensis* Cushman and Adams, n. var. $\times 60$. Fig. 8, Paratype. Megalospheric form. *a*, front view; *b*, apertural view. Fig. 9, Holotype. Microspheric form.
- FIGS. 10-12. *Bitubulogenerina howei* Cushman, n. sp. $\times 100$. Fig. 10, Holotype. *a*, front view; *b*, apertural view. Figs. 11, 12, Paratypes. 12 *a*, front view; 12 *b*, apertural view.

Figures drawn by Margaret S. Moore.



BOLIVINA COCHEI Cushman and Adams, n. sp. (Pl. 3, figs. 6, 7)

Test much compressed, gradually increasing in width from the acute initial end to the greatest width formed by the last-formed pair of chambers, periphery acute, slightly carinate, occasionally somewhat serrate, initial end sharply acute in the microspheric, rounded in the megalospheric form, often with a slight apical spine slightly at one side of the longitudinal axis of the test; chambers distinct, 12 or more pairs, low and broad, increasing gradually in height toward the apertural end; sutures distinct, somewhat limbate, forming an angle of about 45° with the vertical axis; wall finely perforate, either smooth or ornamented with a series of irregular, slightly developed costae. Length 0.40 mm.; breadth 0.20 mm.; thickness 0.06-0.08 mm.

Holotype (Cushman Coll. No. 21621) from Canada de Aliso, Ventura Co., California, 2½ mi. N., 75° E. of La Crosse Junction, in brown siltstone 260 ft. above the base of the first Pico sandstone (after Cartwright).

This species shows considerable variation. The sutures of the early portion are often very thick and raised, and in the later portion in large specimens may be depressed. The narrow keel is fairly constant, but elsewhere as in the Repetto Hills, Los Angeles, California, it becomes wider and more serrate. This latter phase is identified by some authors as *Bolivina pisciformis* Galloway and Morrey, but that species is larger and more robust, and usually smooth.

BOLIVINA SINUATA Galloway and Wissler, var. **ALISOENSIS** Cushman and Adams, n. var. (Pl. 3, figs. 5 a, b)

Variety differing from the typical in the much less prominent ornamentation, which forms four longitudinal rows of weak nodular projections on the later portion of the test, and a tendency for the test to become somewhat twisted about the longitudinal axis. Length 0.50-0.60 mm.; breadth 0.25-0.30 mm.; thickness 0.18-0.20 mm.

Holotype of variety (Cushman Coll. No. 21623) from Canada de Aliso, Ventura Co., California, 2½ mi. N., 72° E. of La Crosse Junction, and on the north side of the Sulphur Mountain divide line at the head of Canada de Aliso, in brown earthy shale, 31 ft. below the conspicuous, finely laminated, gray "paper shale" member of the Modelo formation.

This is one of the forms usually referred to *Bolivina floridana*

Cushman by authors, but this particular form seems to be a variety, as noted above.

BOLIVINA SUBADVENA Cushman, var. **SULPHURENSIS** Cushman and Adams, n. var.
(Pl. 3, figs. 8, 9)

Variety differing from the typical in the surface characters of the test which in the typical form has a tendency to have the median line of the broad face of the test raised into a more or less pronounced ridge, especially in the microspheric form, which is lacking in the variety; while in the megalospheric form, it has the chambers less strongly lobed than in the typical form, the inner end of the sutures is thinner, and the lower end of the test is ornamented with matte processes. Length 0.45-0.60 mm.; breadth 0.20-0.22 mm.; thickness 0.15 mm.

Holotype of variety (Cushman Coll. No. 21624) from Canada de Aliso, Ventura Co., California, 2 $\frac{1}{5}$ mi. N., 75° E. of La Crosse Junction, in brown siltstone 250 ft. above the base of the first Pico sandstone (after Cartwright). The varietal name is for Sulphur Mountain where the variety is well developed.

155. BITUBULOGENERINA HOWEI, A NEW SPECIES FROM THE LOWER OLIGOCENE

By JOSEPH A. CUSHMAN

In his recent paper in the Journal of Paleontology, Dr. Henry V. Howe has erected the new genus *Bitubulogenerina*, and described several species. He has given a copy of the figure of a species I had earlier referred to from the Mint Spring marl. This species should have a specific name, that it may be more easily referred to and find its place in relation to the other species already described.

BITUBULOGENERINA HOWEI Cushman, n. sp. (Pl. 3, figs. 10-12)

Gaudryina sp. CUSHMAN, Prof. Paper 129-F, U. S. Geol. Survey, 1922, p. 127, pl. 29, fig. 6.

Bitubulogenerina sp. HOWE, Journ. Pal., vol. 8, 1934, pl. 51, fig. 4.

Test elongate, early portion tapering, triserial, later adult portion biserial, with the sides nearly parallel, very slightly compressed, periphery rounded, lobulate; chambers distinct, some-

what inflated, the earlier triserial ones increasing gradually in size, later ones very slightly increasing as added; sutures distinct, strongly depressed; wall calcareous, finely perforate, exterior, covered with numerous small, bluntly spinose projections; aperture in the adult terminal, occupying a median position, large and rounded, with a distinct, raised lip. Length 0.28-0.33 mm.; breadth 0.12-0.15 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 21627) from the Lower Oligocene, Red Bluff clay of Red Bluff, Hiwannee, Mississippi.

It also occurs in the Mint Spring marl, at foot of high waterfall, Mint Spring Bayou, Vicksburg, Miss. It probably has a fairly wide distribution in the Lower Oligocene of the Gulf Coastal Plain of the United States.

In this connection, it may be noted that the type species of the genus *Tubulogenerina*, *T. tubulifera* (Parker and Jones), was very peculiarly figured by the original authors. Their figure shows rather long, tubular projections from the surface with the outer end somewhat expanded. I have numerous specimens of this species from the type locality, and they show a rather uniform character indicating that the species is a very definite one in this French material. They show nothing of any such extravagant tubular structures as the type figures would indicate. The species, *Tubulogenerina ferox* Heron-Allen and Earland, from the Miocene of Australia has very peculiar structures, consisting of somewhat conical projections which are hollow and tubular. The aperture of these in the adult consists of a series of coarse perforations, the terminal face being a cribrate plate. This species is evidently more accelerated than the earlier fossil ones, both in the character of the aperture and in the early stages which the authors give as biserial.

It is very definitely shown in the early stages of the Eocene species that the earliest development is triserial, followed by a biserial one, and in the adult uniserial. The characters seem to indicate that these triserial early stages are very similar to those of *Bulimina*, and some of the more rounded, primitive forms of *Virgulina*. It would seem from a study of the various species that they are closely allied to these genera, and should belong in the Buliminidae. There seems to be a very definite development through such forms as *Bitubulogenerina* to these uniserial forms with a cribrate aperture and tubular projections on the exterior.

RECENT LITERATURE ON THE FORAMINIFERA

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

- Rutsch, R.** Beiträge zur Kenntnis tropisch-amerikamischer Tertiär molusken. II. Pteropoden und Heteropoden aus dem Miocaen von Trinidad (Brit. Westindien).—*Eclogae geologicae Helvetiae*, vol. 27, No. 2, 1934, pp. 299-326, pl. VIII, map.—Lists numerous genera of foraminifera.
- Colom, G.** Estudios sobre las Calpionelas.—*Bol. Soc. Española Hist. Nat.*, Tom. XXXIV, 1934, pp. 379-388, pls. XXX-XXXII, text figs. 1, 2.—Numerous species of this peculiar genus described and figured, one new, *Calpionella darderi*.
- Contribucion al Conocimiento de las Facies Lito-paleontologicas del Cretacico de la Baleares.—*Geol. des Pays Catalans*, vol. III, No. 2, (Pt. V), April 2, 1934, pp. 1-11, pl. I, 2 text figs.—Several species figured, mostly very small, none new.
- Thalmann, Hans E.** Die Regional-stratigraphische Verbreitung der oberkretazischen Foraminiferen—Gattung Globotruncana Cushman, 1927.—*Eclogae geologicae Helvetiae*, Bd. 27, No. 2, 1934, pp. 413-428, 1 text fig.—Gives numerous notes on the world distribution of the species of this widely distributed Cretaceous genus.
- Mitteilungen über Foraminiferen I.—l. c., pp. 428-440, 1 plate, 5 text figs.—Notes on several species including two new, *Rotalia catilliformis* and *R. alveiformis* from the Pliocene of Java. Notes also on a card index of the Foraminifera.
- Lepidocyclina canellei* Lemoine & R. Douvillé im Oligocän von Tabasco (Mexiko).—*Centralblatt für Min., Geol., und Pal.*, Jahrg. 1934, Abt. B, No. 10, 1934, pp. 446-448.—Notes on numerous species, none new.
- Mitteloligozän in der Umgebung von Tampico (Mexiko).—*Geologischen Rundschau*, Bd. XXV, 1934, pp. 325-329.—Notes and lists of numerous species of foraminifera and other fossils, none new.
- Hecht, Franz.** Einfache Geräte zum Fotografieren von Mikrofossilien insbesondere Foraminiferen.—“*Senckenbergiana*,” Bd. 16, 1934, pp. 65-77, text figs. 1-11.—Gives details of a camera for microphotography with several illustrations of excellent photographs of foraminifera.
- Eine neue Verteilungszelle zum Aufbewahren von Mikrofossilien, vornehmlich Foraminiferen.—l. c., pp. 152-155, 2 text figs.—Gives some new methods of handling and mounting foraminifera.
- Gubler, J.** Structure et Sécrétion du Test des Fusulinidés.—*Annales de Protistologie*, vol. IV, October, 1934, separate, pp. 1-24, 15 text figs.—Gives detailed discussion with numerous figures of the structure and development of the test in this important Palaeozoic group.
- Le Calvez, Jean.** Embryons a cinq loges de *Planorbulina mediterraneis* (d'Orb.) et trimorphisme de cette espèce.—*Bull. Soc. Zool. France*, vol. LIX, 1934, pp. 284-290, 4 text figs.—Gives interesting data in the life history of this species.

- Bonte, A.** Observations sur le Foraminifères du Tuffean landénien de Lille (Port de Gand).—Ann. Soc. Géol. du Nord, vol. LIX, 1934, pp. 67-82, pl. III, text figs. 1-8.—Several Eocene species figured, one new, *Cristellaria landinensis*.
- Earland, Arthur.** Foraminifera Part III. The Falklands Sector of the Antarctic (excluding South Georgia).—*Discovery Reports*, vol. X, 1934, pp. 1-208, pls. I-X.—Notes 529 species and varieties. The following new genera are erected: *Recurvoides*, *Placopsilinella*, *Ammoflintina*, *Ammocibicides*, *Spirolocammina*, *Spiroplectella*, *Pseudobulimina*. There are 69 new species and varieties described. The large plates carry excellent figures of many of the species. Of particular interest to American workers is the new genus and species, *Ammocibicides pontoni*, from the Wilcox Eocene of Ozark, Ala.
- Howe, Henry V.** *Bitubulogenerina*, a Tertiary new Genus of Foraminifera.—*Journ. Pal.*, vol. 8, No. 4, December, 1934, pp. 417-421, pl. 51, 1 text fig.—The following species are described as new: *Tubulogenerina jacksonensis*, *Bitubulogenerina vicksburgensis*, *B. mauricensis*, *B. montgomeryensis*, and *B. hiwanneensis*.
- Newell, Norman D.** Some Mid-Pennsylvanian Invertebrates from Kansas and Oklahoma: I. Fusulinidae, Brachiopoda.—l. c., pp. 422-432, pls. 52-55.—The following new foraminifera are described and figured: *Triticites neglectus*, *T. osagensis*, *T. secalinus*, v. *oryziformis*.
- Liebus, Adalbert.** Neue Foraminiferen-Funde aus dem Wienerwald-Flysch.—*Verhandl. Geol. Bundesanstalt*, 1934, pp. 65-70, 6 text figs.—Several species noted and figured, none new.
- Ellisor, Alva C. and John Teagle.** Correlation of Pecan Gap Chalk in Texas.—*Bull. Amer. Assoc. Petr. Geol.*, vol. 18, No. 11, November, 1934, pp. 1506-1536, 4 text figs.—Numerous lists of Cretaceous foraminifera are given, and charts showing their distribution.
- Henbest, Lloyd G.** *Nanicella*, a new genus of Devonian Foraminifera.—*Journ. Washington Acad. Sci.*, vol. 25, No. 1, Jan. 15, 1935, pp. 34, 35.—The genotype is "*Endothyra gallowayi* Thomas."

J. A. C.