CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

123. THE GENUS VULVULINA AND ITS SPECIES

By JOSEPH A. CUSHMAN

In 1826 d'Orbigny erected the genus *Vulvulina* for those species which have a biserial stage at least in the young, and later become uniserial with the test very strongly compressed and wall arenaceous, the aperture in the adult being terminal and elongate. Numerous species have been described under different generic names, and species belonging to this genus range from Eocene to Recent. A study of the material belonging to this genus available in this laboratory together with notes made on other collections has shown that there are several distinct species and varieties which have definite geologic ranges and geographic distributions. Figures and descriptions of these follow.

Genus VULVULINA d'Orbigny, 1826

Genotype, by designation, *Vulvulina capreolus* d'Orbigny

Vulvulina D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 264.—CUSHMAN, Special Publ. No. 1, Cushman Lab. Foram. Res., 1928, p. 118.

Nautilus (part) BATSCH, Conch. Seesandes, 1791, No. 13, pl. 4, figs. 13 *a-d*.

Bigenerina (part) of authors (not D'ORBIGNY).

Schizophora REUSS, Sitz. böhm. Ges. Wiss., vol. 2, 1861, p. 13 (genoholotype, *S. neugeboreni* REUSS).

Grammostomum (part) PARKER and JONES (not EHRENBERG), Ann. Mag. Nat. Hist., ser. 3, vol. 11, 1863, p. 93.

Venilina GÜMBEL, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 10, 1868 (1870), p. 647 (genotype, by designation, *V. nummulina* GÜMBEL).

Textilaria (part) GÜMBEL (not DEFRANCE), l. c., p. 647.

Trigenerina SCHUBERT, Verhandl. k. k. Geol. Reichs., 1902, p. 84 (genotype, *Vulvulina capreolus* D'ORBIGNY).

Test free, much compressed throughout, early stages biserial, or slightly coiled in the microspheric form, later chambers uniserial, simple; wall finely arenaceous with a large proportion of cement; aperture elongate, elliptical, simple, terminal.

Eocene to Recent.

VULVULINA PENNATULA (Batsch) (Pl. 10, figs. 1-5)

"Orthoceratia Pupa" SOLDANI, Test., vol. 1, pt. 2, 1791, p. 99, pl. 108, figs. *D, E, F.*

Nautilus (Orthoceras) pennatula BATSCH, Conch. Seesandes, 1791, No. 13, pl. 4, figs. 13 *a-d.*

Bigenerina pennatula H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 373, pl. 45, figs. 5-8.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 44.—SILVESTRI, Atti Accad. Sci. Acireale, vol. 7, 1896, p. 30.—FLINT, Rep't U. S. Nat. Mus., 1897 (1899), p. 287, pl. 32, fig. 2.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 27, pl. 5, fig. 4.

Vulvulina pennatula FORNASINI, Mem. Accad. Sci. Bologna, ser. 5, vol. 10, 1901, p. 14.—LACROIX, Bull. Instit. Oceanographique, No. 582, 1931, p. 18.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 69, pl. 9, figs. 10-13.

Vulvulina capreolus D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 264, No. 1, pl. 11, figs. 5, 6; Modèles, 1826, No. 59.—LACROIX, Bull. Instit. Oceanographique, No. 582, 1931, p. 18.

Grammostomum capreolus PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 11, 1863, p. 93.

Bigenerina capreolus H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 372, pl. 45, figs. 1-4.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 44.—SILVESTRI, Atti Accad. Sci. Acireale, vol. 7, 1896, p. 30.—FLINT, Rep't U. S. Nat. Mus., 1897 (1899), p. 286, pl. 32, fig. 3.—CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 28, pl. 5, fig. 10.

Vulvulina elegans D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 264, No. 3.

Grammostomum elegans PARKER, JONES and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 170, pl. 11, figs. 121, 123.

Test compressed, longer than broad, the microspheric and megalospheric forms showing a great difference in outline, the former usually tapering gradually from a sharply pointed initial end to the widest portion near the apertural end, the latter broadest toward the base and tapering toward the apertural end; earliest chambers planispiral, later ones biserial, numerous, in the megalospheric form followed by 1—4 uniserial chambers, periphery acute, in the megalospheric form often somewhat spinose, chambers distinct, those of the early portion low, curved, and after the first few, which are spirally coiled, biserial, later ones in the adult uniserial, much compressed, fairly high; sutures of

the biserial portion usually raised and often somewhat rougher than the body of the chamber, later uniserial chambers with the wall smooth, very finely arenaceous, with much cement, and the sutures depressed; aperture of the biserial portion with a low narrow opening at the inner margin of the chamber, and in the uniserial portion the aperture becomes terminal and elongate. Color of the early portion yellowish-brown, later chambers gray. Length up to 2.50 mm.

The types of this species were described by Batsch and probably came from the Adriatic. It is probable that his collections were made, as were so many of the other early collections of this region, from the shore sands of Rimini. His figures are fairly good, and there is no difficulty in recognizing his species in later collections made at Rimini. In 1826, d'Orbigny described *Vulvulina capreolus*, and his material also is from the Adriatic. There seems to be no question from a study of Batsch's figures and d'Orbigny's figures and model but that both of these specific names were applied to one form. In the *Challenger* Report, Brady figures specimens under both names, but most of his specimens came from the West Indies. Specimens from this region are very slightly different from those of the Mediterranean, but the difference does not seem to be of sufficient amount to warrant giving them distinct names.

In the species, the microspheric and megalospheric forms are very different in appearance. The former is usually larger and has the biserial development practically throughout the life history, while the megalospheric form has the biserial portion much reduced, and very quickly reaches its maximum breadth after which it tapers toward the apex, and the uniserial chambers do not increase the width of the test. The raised sutures, particularly in the microspheric form, give a deeply excavated appearance to the chambers in side view. There is a somewhat greater tendency toward spinosity of the periphery in the West Indian forms than in those of the Mediterranean. One or the other of the specific names given by Batsch and d'Orbigny has been applied to most of the fossil material of this genus, and those references will be found under the later species here described. This species also occurs in the Pliocene of Sicily. The specimens are somewhat coarser in their texture, but otherwise seem to be typical.

VULVULINA PENNATULA (Batsch), var. ITALICA Cushman, n. var. (Pl. 10, figs. 6,7)

Bigenerina pennatula FORNASINI (not BATSCH), Foram. Mioc. d. S. Rufillo Presso Bologna, 1889, p. 1, pl. 1, figs. 5, 6.

Variety differing from typical in the much larger size and the greater number of uniserial chambers which are lower than in the typical form.

Holotype of variety (Cushman Coll. No. 12553) from the Miocene of San Rufillo, Rio Savena, near Bologna, Italy.

This is the form figured by Fornasini from this same locality from which I collected excellent material in 1927.

VULVULINA PACIFICA Cushman, n. sp. (Pl. 10, figs. 8, 9)

Bigenerina capreolus CUSHMAN (not D'ORBIGNY), Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 127, pl. 26, figs. 1 *a*, *b*.

Bigenerina pennatula CUSHMAN (not BATSCH), Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 127, pl. 25, figs. 3 *a*, *b*.

Test comparatively large especially in the microspheric form, the periphery with numerous, short, spinose projections usually one to each chamber; sutures not as definitely raised as in *V. pennatula* nor are the chambers excavated deeply as in that species. Length up to 2.50 mm.

Holotype (Cat. No. 12984A, U. S. N. M.) from *Albatross* station D5236 in 494 fathoms off Mindanao, Philippine Islands.

This species in its average size is larger than that of the Mediterranean and Atlantic forms, although the maximum size does not exceed them. The periphery is always spinose even in the microspheric form, whereas the same form in *V. pennatula* has usually an entire periphery. There are references from the region of Japan which are not accompanied by figures and which should be checked with this species.

As in the case with other foraminifera occurring in the Recent fauna of the Philippine region, this species is most closely related to the Tertiary of Mexico, and in some respects resembles *Vulvulina spinosa* Cushman described from the Oligocene of Mexico.

Vulvulina nicobarica (Schwager) described by Schwager as *Bigenerina nicobarica* (*Novara*-Exped., Geol. Theil, vol. 2, 1866, p. 196, pl. 4, fig. 7) from the Pliocene of Kar Nicobar seems to be a smoother form than the above species, but no material of Schwager's species is available.

VULVULINA ARENACEA (Bagg) (Pl. 10, fig. 13)

Bigenerina arenacea BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132, pl. 5, figs. 4-6.—CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 29, fig. 50 (in text); Bull. 100, vol. 4, 1921, p. 126.

Test large, much compressed, the sides nearly flat, periphery rounded, earliest chambers spiral, later ones biserial and in the adult uniserial, the early portion rapidly increasing in diameter, later portion with the sides nearly parallel; chambers distinct, the uniserial ones low and broad, increasing slightly in height as added, as many as eight uniserial chambers in some adult specimens; sutures distinct, in the early portion slightly raised, later becoming depressed; wall rather coarsely arenaceous but with a considerable amount of cement, and smoothly finished; aperture in the adult terminal and broadly elliptical, the apertural face slightly projecting in the middle. Length up to 4 mm.

This species was originally described by Bagg from *Albatross* material dredged in the vicinity of the Hawaiian Islands. It occurs in typical form at a *Nero* station in 859 fathoms off Guam, and from the Philippines in 494 fathoms. This is a very distinct species and unlike any of the other fossil or Recent forms of this genus. In some respects, such as the coarsely arenaceous test, flattened sides and rounded aperture, it differs from the typical species of the genus. The developmental stages are similar however.

VULVULINA SPINOSA Cushman (Pl. 10, fig. 15)

Vulvulina spinosa CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 3, 1927, p. 111, pl. 23, fig. 1; Journ. Pal., vol. 1, 1927, p. 149, pl. 28, fig. 4.

Test comparatively large, compressed, the periphery acute and with a spinose process at the basal peripheral angle of each chamber, early portion biserial, later chambers uniserial; sutures depressed, especially those of the later portion; wall finely arenaceous with a large proportion of gray cement, and the whole neatly and smoothly finished; aperture in the early portion a low transverse slit, in the adult terminal, elliptical.

Type specimens were from Alazan clay, Rio Buena Vista, just South of crossing of Alazan to Moyutla Road, Vera Cruz, Mexico.

This species is particularly marked by spinose projections which not only occur on the biserial portion, but also in the later uniserial chambers. In various ways this species resembles the older *V. advena* Cushman from the Upper Eocene, and also the Recent *V. pacifica* as already noted.

VULVULINA SPINOSA Cushman, var. MIOCENICA Cushman, n. var. (Pl. 10, fig. 10)

Vulvulina capreolus CUSHMAN (not D'ORBIGNY), Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 80, pl. 12, fig. 6.

Vulvulina capreolus D'ORBIGNY, var. *spinosa* NUTTALL, Journ. Pal., vol. 6, 1932, p. 6.

Variety differing from the typical in the lesser amount of spinosity, the spines of the biserial portion being fewer and less distinct and usually wanting on the uniserial portion.

Holotype of variety (Cushman Coll. No. 16862) from the Miocene of Buff Bay, Jamaica.

This variety occurs also in the Miocene of Trinidad, Venezuela, and Ecuador.

EXPLANATION OF PLATE 10

FIGS. 1–5. *Vulvulina pennatula* (Batsch). Figs. 1-3 (After Batsch). 1, Longitudinal section. 2, Exterior. 3, Section showing coiled young stage. Figs. 4 *a-c*, (After d'Orbigny). *a*, front view; *b*, apertural view; *c*, side view. Fig. 5, Recent specimen from the Western Atlantic. × 20.

FIGS. 6, 7. *V. pennatula* (Batsch), var. *italica* Cushman, n. var. × 17. Fig. 6, Megalospheric form, paratype. Fig. 7, Microspheric form, holotype. From Miocene, near Bologna, Italy.

FIGS. 8, 9. *V. pacifica* Cushman, n. sp. × 20. Fig. 8, Microspheric form, holotype. Fig. 9, Megalospheric form, paratype. Recent, Philippines.

FIG. 10. *V. spinosa* Cushman, var. *miocenica* Cushman, n. var. × 20. Miocene of Jamaica. Holotype.

FIG. 12. *V. pectinata* Hantken. × 25. Lower Oligocene, near Budapest, Hungary.

FIG. 13. *V. arenacea* (Bagg). × 18. Off Hawaiian Islands.

FIG. 14. *V. advena* Cushman. × 32. Eocene, Alabama.

FIG. 15. *V. spinosa* Cushman. × 20. Lower Oligocene, Vera Cruz, Mexico.

FIG. 16. *V. nummulina* (Gümbel). × 25. Lower Oligocene, near Budapest, Hungary.

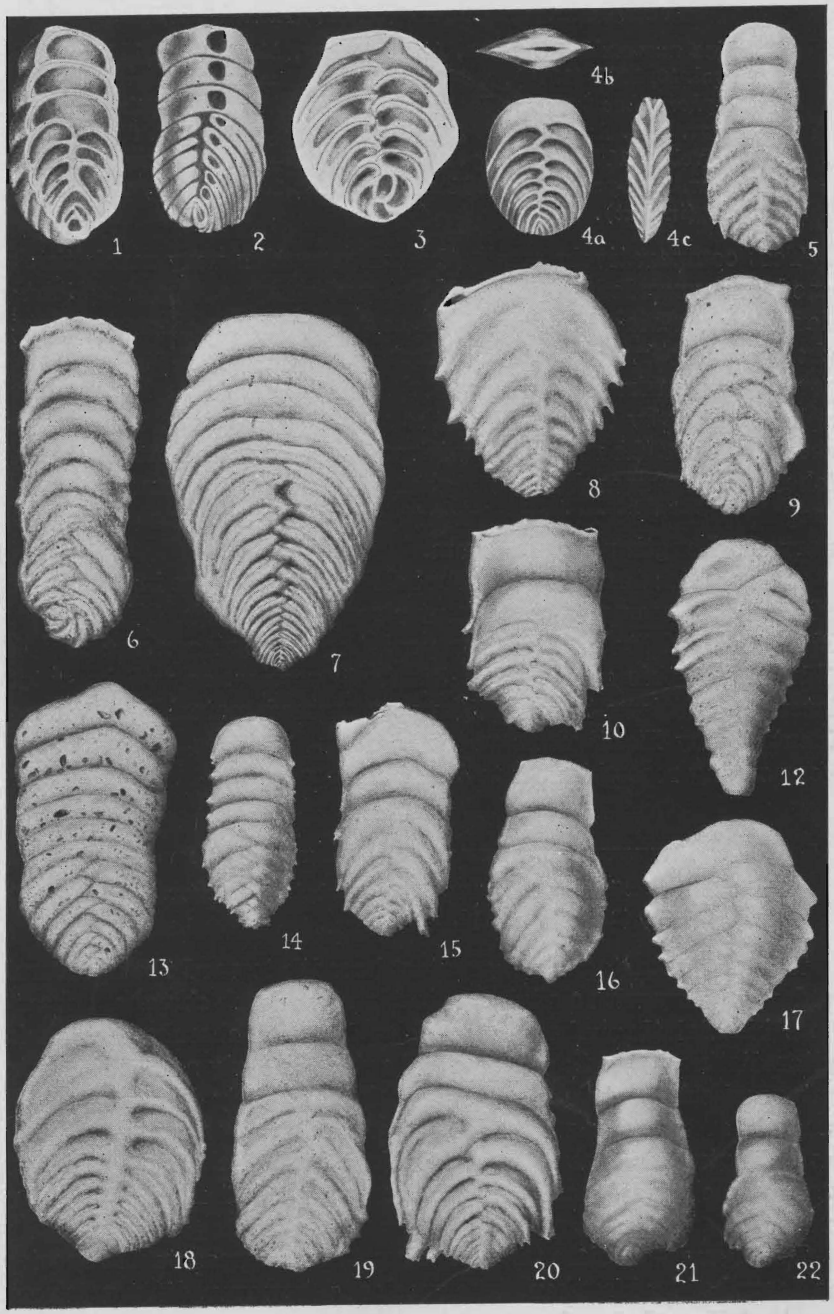
FIG. 17. *V. pectinata* Hantken, var. *mexicana* Nuttall. × 25. Oligocene, Mexico.

FIGS. 18, 19. *V. flabelliformis* (Gümbel). × 20. Fig. 18, Microspheric form. Fig. 19, Megalospheric form. Eocene, Rollgraben, near Kressenberg, Germany.

FIG. 20. *V. jarvisi* Cushman, n. sp. × 17. Eocene, Trinidad, holotype.

FIGS. 21, 22. *V. colei* Cushman, n. sp. × 20. Eocene, Mexico. Fig. 21, Holotype.

Figures drawn by Margaret S. Moore.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VULVULINA NUMMULINA (Gümbel) (Pl. 10, fig. 16)

Venilina nummulina GÜMBEL, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 10, 1868 (1870), p. 648, pl. 2, figs. 84 *a*, *b*.

Schizophora haeringensis HANTKEN (not GÜMBEL), Mitth. Jahrb. k. Ungar. geol. Anstalt, vol. 1, 1871 (1872), p. 136, pl. 2, figs. 17 *a*, *b*; l. c., vol. 4, 1875 (1881), p. 68, pl. 7, fig. 3.—GRZYBOWSKI, Rozprawy Spraw. mat.-przyr. uhad. Krakow., vol. 9, 1894, p. 187, pl. 2, fig. 6; fig. 1 (in text).

Test comparatively small, the early portion very much thickened and rounded in the middle, periphery entire or slightly dentate, uniserial chambers 1—3, compressed, periphery lobulate; chambers distinct; sutures distinct, very slightly raised in the biserial portion in the microspheric form, less so in the megalospheric, slightly depressed in the uniserial portion; wall arenaceous, but for the most part with much cement and smoothly finished, the sutures being roughened in some specimens in the megalospheric form; aperture in the adult terminal, elongate, narrow. Length up to 1.50 mm.

This species described by Gümbel from the Eocene in the region of Hammer seems to be present also in the Lower Oligocene of Hungary and Italy. Hantken used the name "*haeringensis*" of Gümbel for this species, but Gümbel's species, as will be noted later, is a different form. I have examined material in Vienna identified by Hantken from his various localities, and it shows very strong resemblances to Gümbel's species.

VULVULINA PECTINATA Hantken (Pl. 10, fig. 12)

Vulvulina pectinata HANTKEN, Mitth. Jahrb. k. Ungar. geol. Anstalt, vol. 4, 1875 (1881), p. 68, pl. 7, fig. 10.

Test elongate, tapering, greatest breadth toward the apertural end, periphery with a slight projection from each chamber; chambers biserial throughout except for the last chamber which is often distinct from the others, and extends nearly across the test; sutures distinct, oblique, nearly straight, slightly depressed; wall smooth, arenaceous, with a large proportion of cement; aperture as in *Textularia* except that of the last-formed chamber which is terminal, elongate, and narrow. Length up to 1 mm. or slightly more.

The figured specimen is a topotype, and represents the species as described by Hantken. The species is, however, different from most of those belonging to this genus in the angle and lack of

curvature of the sutures, and the development of but a single uniserial chamber. The aperture, however, is characteristic. There are in the collection in Vienna named by Hantken specimens called by this name, but they seem to belong to the previous species. Topotypes, however, are not uncommon showing exactly the characters of the specimens figured and described by Hantken.

VULVULINA PECTINATA Hantken, var. MEXICANA Nuttall (Pl. 10, fig. 17)

Vulvulina pectinata HANTKEN, var. *mexicana* NUTTALL, Journ. Pal., vol. 4, 1930, p. 280, pl. 23, fig. 7.

This variety described by Nuttall from the Eocene, Aragon formation, of Mexico has the periphery with a slight flange, which in the microspheric form is sometimes slightly spinose at the periphery, the terminal chamber in the microspheric form becoming uniserial. Sutures are more curved than in the typical, and the form is much more typically a *Vulvulina* than is Hantken's species.

VULVULINA FLABELLIFORMIS (Gümbel) (Pl. 10, figs. 18, 19)

Textilaria flabelliformis GÜMBEL, Abhandl. bay. Akad. Wiss. München, Cl. II, vol. 10, 1868 (1870), p. 647, pl. 2, figs. 83 *a*, *b*.
Venilina haeringensis GÜMBEL, l. c., p. 649, pl. 2, figs. 84 bis *a*, *b*.

Test with the early chambers rapidly increasing in breadth, later portion of the test gradually reduced in breadth toward the apertural end both in the microspheric and megalospheric forms, periphery subacute in the microspheric form, and in the megalospheric with a slight keel, particularly on the uniserial chambers; chambers distinct, low in the biserial portion, very strongly curved backward, those of the uniserial portion high; sutures distinct, very strongly raised, and roughened in both forms except between the uniserial chambers where they are slightly depressed; wall distinctly arenaceous, smoothly finished in the uniserial chambers; aperture in the adult terminal, elongate, narrow. Length up to nearly 2 mm.

The forms figured by Gümbel under these two names are identical, the former representing the microspheric form, and the latter the megalospheric. According to the rules the earlier name should be used. This is a rather coarse, distinct species in the Eocene of southern Europe. The figured specimens are from the Eocene of Rollgraben, near Hammer, Germany.

VULVULINA ADVENA Cushman (Pl. 10, fig. 14)

Vulvulina advena CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 2, 1926, p. 32, pl. 4, figs. 9 *a*, *b*.

Test small, thin, much compressed, periphery acute but not keeled, early chambers alternating, later ones (as many as five) uniserial; chambers rather high, gently sloping; sutures of the biserial portion flush with the surface, the whole early portion smooth, in the later portion the sutures slightly depressed; wall smoothly finished, each angle of the chambers with a short spinose projection, even those of the uniserial portion; aperture elongate, terminal. Length up to 1.25 mm.

This species was described from the Upper Eocene from 3½ miles Southeast of Cullomburg, Alabama. It is not common in the Coastal Plain region, but is very distinct, with a smooth shining test, material being very fine grained but distinctly arenaceous.

VULVULINA COLEI Cushman, n. sp. (Pl. 10, figs. 21, 22)

Vulvulina advena COLE (not CUSHMAN), Bull. Amer. Pal., vol. 14, No. 53, 1928, p. 206(6), pl. 1, fig. 24; pl. 3, fig. 17.

Test small, elongate, usually reaching the maximum width very early in development and thence with the sides either parallel or narrowing toward the apertural end; earliest chambers spiral and projecting downward below the remainder of the test, the lower angles of the test sometimes slightly projecting or even spinose, later chambers high; sutures distinct but not raised, those of the uniserial portion slightly depressed; wall very finely arenaceous, smoothly finished, somewhat polished; aperture in the adult terminal, elongate, narrow. Length up to 1 mm.

Holotype (Cushman Coll. No. 16865) from the Eocene, Chapapote formation, Chapapote, Mexico.

This is a small but distinctive species showing its primitive character in having the spiral portion not included in the following biserial one, and with a very smooth polished test.

VULVULINA JARVISI Cushman, n. sp. (Pl. 10, fig. 20)

Test fairly large, periphery subacute or even slightly keeled, broadest toward the base, thence decreasing in breadth toward the apertural end; chambers distinct, the early ones low, much curved, later ones uniserial, depressed; sutures distinct, in the biserial portion very strongly raised, in the uniserial portion

slightly depressed; wall distinctly arenaceous, slightly roughened on the sutures, otherwise smoothly finished; aperture in the adult terminal, narrowly elliptical. Length up to 2.25 mm.

Holotype (Cushman Coll. No. 16864) from the Eocene of Hospital Hill, Trinidad, B. W. I.

This species, collected by Mr. P. W. Jarvis, is in its general character somewhat like the preceding species from Mexico, but the entire test is larger, more coarsely formed, and the periphery is decidedly spinose, in the type specimen with some of the spines at the basal angles flat with several small teeth.

There are certain other species not included in our collections. One of these is the species described by Liebus as *Trigenerina folium* (Nat. Zeitschr. Lotus, vol. 72, 1924, pp. 112-113) and later refigured (Journ. Pal., vol. 6, 1932, pp. 208-210, figs. 1-8 [in text]). This has more numerous uniserial chambers than typical *V. pennatula,* and they are not reduced in width. The sutures of the biserial portion also appear not to be as distinctly curved as in that species. Evidently the species should be a valid one and known as *Vulvulina folia* (Liebus). It is possible that the two forms from Moravia and Albania are not one species.

Vulvulina varanica Martinotti (Atti Soc. Ital. Sci. Nat., vol. 62, 1923, p. 324, pl. 7, fig. 7; fig. 3 [in text]) from the Mollassa of Varano, Italy, has the angles of the broad base somewhat spinose. I have no topotype material of this species, but material from the Eocene of Siegsdorf, Bavaria in our collection has much the same appearance.

Schizophora neugeboreni Reuss from the Miocene of the Vienna Basin, the basis of one of Reuss' models and later figured by Karrer and others, is a form needing more study.

Vulvulina alata Seguenza and *V. gramen* d'Orbigny are probably Bolivinas. *V. oolithica* Deecke from the Cretaceous of Alsace evidently does not belong to this genus nor do the species described from the Jurassic by Schwager and by Zwingli and Kübler. Certain other poorly characterized species described under *Vulvulina* probably do not belong to this genus.

124. TEXTULARIA AND RELATED FORMS FROM THE CRETACEOUS

By JOSEPH A. CUSHMAN

A study in Europe the past summer of Cretaceous types and other collections of foraminifera has revealed many interesting facts. It confirmed the opinion already held that many of our American species of Cretaceous foraminifera are identical with those of Europe. Also it has shown that many of the earlier species of Cretaceous foraminifera of Europe were so poorly figured and inadequately described that they have not been placed in their proper position generically nor have later identifications often been correct. This is particularly true of work of American authors including my own. It was only by a study of these type specimens and a series of topotypes that the correct understanding of many of the earlier species was possible. The following notes are given so that the nomenclature of this particular group of Cretaceous foraminifera may be placed on a firmer footing than it now is, and figures are given of many of these forms so that other workers may have before them the data for determining their own material. It is hoped that other groups may be rather rapidly published that the data for them also may be available. My thanks are due for grants from the Milton Fund of Harvard University and the Permanent Science Fund of the American Academy of Arts and Sciences for help in these studies, and also to many European workers and institutions for opportunity of studying collections.

The species which have been assigned to *Textularia* will be taken up in the order of their original publication, and notes will follow with figures of the more important of these. The American forms will be more fully illustrated in a forthcoming large report on the American Cretaceous foraminifera now being completed for the U. S. Geological Survey.

"*Textularia trochus* d'Orbigny" (Mém. Soc. Géol. France, sér. 1, vol. 4, 1840, p. 45, pl. 4, figs. 25, 26). Material studied in Europe together with type specimens from the Craie Blanche of the Paris Basin shows that this species is related to *Gaudryina*, and it will be

taken up in another paper which will give the results of a study of that genus.

"*Textularia turris* d'Orbigny" (Mém. Soc. Géol. France, sér. 1, vol. 4, 1840, p. 46, pl. 4, figs. 27, 28). As in the case of the preceding species this has proven to be related to *Gaudryina* and will be discussed at a later time.

"*Textularia baudouiniana* d'Orbigny" (Mém. Soc. Géol. France, sér. 1, vol. 4, 1840, p. 46, pl. 4, figs. 29, 30)=*Spiroplectammina baudouiniana* (d'Orbigny) (Pl. 11, figs. 1 *a*, *b*). This is a large species, with the early chambers frequently missing, but fairly large series from the Craie Blanche of the Paris Basin, one of which is figured, show it to be a *Spiroplectammina*. The central portion is much raised, and the peripheral part rather sharply angled. The sutures are slightly curved, but are only slightly directed back at the periphery. The original figures given by d'Orbigny are somewhat conventionalized, but on the whole show the character of the species fairly well. This large form is fairly common in Europe in the White Chalk of the Paris Basin and in other regions of similar age. It occurs in rather typical form in the Cretaceous of Trinidad.

"*Textularia ehrenbergii* Roemer" (Verst. norddeutsch. Kreide, 1840-41, p. 97, pl. 15, fig. 16). No specimens of this species were seen, and nothing referable to it has been obtained from topotype material.

"*Textularia laevis* Roemer" (Verst. norddeutsch. Kreide, 1840-41, p. 97, pl. 15, fig. 17)=*Spiroplectammina laevis* (Roemer) (Pl. 11, figs. 2 *a*, *b*). A topotype of this species from the Cretaceous of Peine, Germany, is figured. This shows that this species is a *Spiroplectammina*, that the sutures are slightly curved and directed back as in the type figure, the test strongly tapering and the outer periphery of the chamber along the apertural face with a distinct raised area particularly when well preserved. In end view the test is seen to be very thick at the central line and tapers very sharply to the periphery. The typical form of the species apparently does not occur in the Upper Cretaceous of America, but the following variety occurs.

Spiroplectammina laevis (Roemer), var. *cretosa* Cushman, n. var. (Pl. 11, figs. 3 *a*, *b*). Test tapering, usually somewhat longer than broad, the greatest breadth toward the apertural end, periphery subacute, apertural end only slightly rounded, broad in end view, tapering rapidly to the subacute periphery; chambers with

the early portion coiled, later biserial, distinct, the margin of the apertural face distinctly raised, giving a series of raised ridges at the suture lines and forming a raised zigzag line along the center of the test; wall finely arenaceous, stout, not usually collapsed; aperture a low opening on the inner margin of the apertural face with the peripheral portion of the face extending forward so that the aperture itself is in a reëntrant. Length up to 0.65 mm.; breadth 0.45 mm.; thickness 0.25 mm.

Holotype of variety is from the Cretaceous, Upper Taylor, from 5.1 miles from Josephine, along highway to Nevada, Collins County, Texas.

This variety with its many chambers, which are low and broad and only slightly curved, is a characteristic one of the Upper Taylor and apparently also in the Navarro at Jones Crossing on Onion Creek, near Austin, Texas. The specimen figured by Mrs. Plummer as *Spiroplectammina semicomplanata* (Carsey) (Bull. 3101, Univ. Texas, 1931, pl. 8, fig. 8) should probably be assigned to this variety. Mrs. Plummer has kindly sent me material from this locality collected by Miss Gene Ross, and this thicker form with its narrower chambers the walls of which are not collapsed, seems to occur in the same section as *Spiroplectammina semicomplanata* (Carsey) (l. c., pl. 8, fig. 7). It is apparently very rare here, however, and it is only to be found common in the Taylor and its equivalents over a wide area.

"*Textularia obtusangula* Roemer" (Verst. norddeutsch. Kreide, 1840-41, p. 97, pl. 15, fig. 18)=*Spiroplectammina obtusangula* (Roemer). This species described by Roemer from Peine, Germany is illustrated here by a figure of a topotype specimen (Pl. 11, figs. 4 *a*, *b*). The test is somewhat contracted at the periphery, the sutures strongly curved backward, and the periphery is rounded. I have not found specimens from our American Upper Cretaceous that can be definitely assigned to this species.

Under *Textularia* Reuss in 1845-6 (Verstein. böhm. Kreide) described numerous species from the Upper Cretaceous of Bohemia. The original type material illustrated in his paper has apparently been lost, but fortunately there are three collections determined by Reuss at the time of the writing of his paper which are still in existence accompanied by letters of transmittal in his own handwriting. One of these collections belongs to the Museum of Comparative Zoology in Cambridge, another is in the paleontological collections at Dresden, and the third in Vienna. These

three collections have been studied during this last year, and the species have been drawn and notes made for publication on the foraminifera of this entire work of Reuss. At this time, only those species which are assigned to *Textularia* will be noted.

"*Textularia conulus* Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 38, pl. 8, fig. 59; pl. 13, fig. 75)=*Dorothia conulus* (Reuss). Specimens of this species selected and named by Reuss from the type locality are in all three of the Reuss collections mentioned. I have numerous topotype specimens of this species, and it will be considered when the genus *Dorothia* is later taken up.

"*Textularia tricarinata* Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 8, fig. 60)=*Tritaxia tricarinata* (Reuss). Reuss himself later placed this species in the genus *Tritaxia*, and a study of specimens in the various Reuss collections as well as abundant topotype material shows that this disposition of the species is correct. This species was described but not figured by Reuss in 1844.

"*Textularia triquetra* Reuss" (not von Münster) (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 13, fig. 77). This species was originally described by von Münster from the Oligocene, and although Reuss identified his Cretaceous material with it in 1845 he later changed this to *Verneuilina münsteri* Reuss.

"*Textularia anceps* Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 8, fig. 79; pl. 13, fig. 78)=*Spiroplectammina anceps* (Reuss) (Pl. 11, fig. 5 *a*, *b*). There has been much difficulty in the determination of this species due to the fact that the figures given by Reuss were inadequate to give the full characters of the species. Fortunately in all three of the Reuss collections studied this species is represented, and I have numerous topotype specimens from Luschitz, Bohemia. Figures of two of the specimens in the Cambridge Reuss collection are here given. The species is a very definite one with a peculiar projecting apertural end and sigmoid sutures. The wall is very smooth and the end view is shown in our figure. While this species is common in some parts of the Cretaceous of Europe, particularly in Bohemia, it occurs elsewhere and I have collected it in the Upper Cretaceous in the chalks of England. Typically it does not seem to occur in the American Cretaceous although many specimens have been referred to it. Most of these references for American forms should be placed under *Spiroplectammina semicomplanata* (Carsey).

"Textularia praelonga Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 12, fig. 14)=*Spiroplectammina anceps* (Reuss) (Pl. 11, fig. 6). The figures given by Reuss of this species are not well drawn, but specimens are in all three of the Reuss collections already mentioned. One of the specimens from the Cambridge collection is here figured. This agrees with specimens in the other two collections and with a series of topotypes which I have from Luschitz, the type locality. Reuss gave this name to the adult form of his *"Textularia anceps"*. The chambers are often somewhat collapsed in the later portion, and the raised ridges resulting often give somewhat the effect produced in Reuss' original figures.

"Textularia obsoleta Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 13, fig. 79). This species described by Reuss from Bohemia and noted as very rare does not occur in any of the Reuss collections. He notes that it is close to *"Textularia laevis* Roemer", but nothing further can be said in regard to it. I did not find the species in type material from Luschitz.

"Textularia partschii Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 13, fig. 80)=*Spiroplectammina baudouiniana* (d'Orbigny). Reuss in his original reference mentioned the fact that this species was very close to that of d'Orbigny, and in his later work definitely placed it there.

"Textularia globulosa Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 1, p. 39, pl. 12, fig. 23)=*Gümbelina globulosa* (Reuss). This species occurs in all three of the Reuss collections studied, and is definitely a *Gümbelina*. This species was later called *"Textularia globifera* Reuss".

"Textularia concinna Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 2, p. 109, pl. 24, fig. 54)=*Gaudryina concinna* (Reuss). There are four specimens in the Reuss collection in Vienna which show that this species is definitely a *Gaudryina*. It occurs commonly in the Cretaceous of Bohemia and Saxony and will be considered later in a paper on *Gaudryina*.

"Textularia foeda Reuss" (Verstein. böhm. Kreide, 1845-6, pt. 2, p. 109, pl. 43, figs. 12, 13)=*Gaudryina foeda* (Reuss). There are no specimens of this species in the collections, but specimens referred to this species were studied in other collections of Europe and many similar specimens were found in our topotype material from Luschitz. They show that the early chambers are triserial and that the species should be referred to the genus *Gaudryina*.

The test is very easily distorted as is shown in Reuss' original figure 3 and in many of our specimens. However, notes will be given of its occurrence in America when the genus *Gaudryina* is taken up.

"*Textularia dentata* Alth" (Haidinger's Naturw., vol. 3, pt. 2, 1850, p. 262, pl. 13, fig. 13)=*Spiroplectammina dentata* (Alth) (Pl. 11, figs. 7 *a*, *b*). Topotype material from Lemberg has given us specimens of this species, one of which is here figured. It is a *Spiroplectammina*, and has already been noted from the Cretaceous of Trinidad (Cushman and Jarvis, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 14, pl. 3, fig. 7). It may be noted here that the specimens from the Upper Cretaceous of Bavaria referred to this species by Egger are not the same.

"*Textularia articulata* Reuss" (in Haidinger's Naturw., vol. 3, pt. 2, 1850, p. 45, pl. 4, fig. 14)=*Spiroplectoides flexuosa* (Reuss). This species name had already been used by d'Orbigny and was later changed to "*Textularia flexuosa* Reuss".

"*Textularia pupa* Reuss" (Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 232, pl. 13, figs. 4, 5)=*Dorothia pupa* (Reuss). Topotypes of this species show that it is a *Dorothia*, at least so far as figure 4 is concerned which should be taken as the type. Figure 5 is a *Gümbelina*.

"*Textularia globifera* Reuss" (Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 232, pl. 13, figs. 7, 8)=*Gümbelina globifera* (Reuss). Reuss originally called this species "*Textularia globulosa*", but as the species name had already been used by Ehrenberg, the new name *globifera* was proposed for it.

"*Textularia flexuosa* Reuss" (Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 235)=*Spiroplectoides flexuosa* (Reuss). A study of topotype material shows this to be a *Spiroplectoides*, but not the same as *S. rosula* (Ehrenberg).

Reuss in his 1860 paper describes other species of *Textularia* not recorded here which are from the Gault but not recorded from the Upper Cretaceous.

"*Textularia faujasi* Reuss" (Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 320, pl. 3, figs. 9 *a*, *b*)=*Gaudryina faujasi* (Reuss). Topotype specimens of this species show that it is triserial at the base and belongs to the genus *Gaudryina*.

"*Textularia serrata* Chapman" (Quart. Journ. Geol. Soc., London, vol. 48, 1892, p. 515, pl. 15, fig. 7). This species seems to belong to the genus *Eouvigerina*.

"Textularia decurrens Chapman" (Quart. Journ. Geol. Soc., London, vol. 48, 1892, p. 515, pl. 15, fig. 6). This species is a *Ventilabrella.*

"Textularia brevicona Perner" (Foram. Ceske Cenomann, 1892, p. 54, pl. 9, figs. 12 *a, b*). This is a *Gümbelina.*

EXPLANATION OF PLATE 11

FIGS. 1 *a, b.* *Spiroplectammina baudouiniana* (d'Orbigny). × 16. *a,* front view; *b,* apertural view. From Craie Blanche, Bougival, France.

FIGS. 2 *a, b.* *S. laevis* (Roemer). × 35. *a,* front view; *b,* apertural view. Cretaceous, Peine, Germany.

FIGS. 3 *a, b.* *S. laevis* (Roemer), var. *cretosa* Cushman, n. var. × 35. Holotype. *a,* front view; *b,* apertural view. Cretaceous, Texas.

FIGS. 4 *a, b.* *S. obtusangula* (Roemer). × 35. *a,* front view; *b,* apertural view. Cretaceous, Peine, Germany.

FIGS. 5, 6. *S. anceps* (Reuss). × 16. Fig. 5 *a,* front view; *b,* apertural view. Fig. 6, Adult form named by Reuss *"Textularia praelonga".* Cretaceous, Luschitz, Bohemia.

FIGS. 7 *a, b.* *S. dentata* (Alth). × 16. *a,* front view; *b,* apertural view. Cretaceous, Lemberg, Galicia.

FIGS. 8, 9. *S. semicomplanata* (Carsey). × 45. *a, a,* front views; *b, b,* apertural views. Upper Cretaceous, Texas.

FIGS. 10 *a, b.* *S. semicomplanata* (Carsey), var. *juncea* Cushman, n. var. × 25. *a,* front view; *b,* apertural view. Cretaceous, Saratoga chalk, Arkansas.

FIGS. 11 *a, b.* *Textularia subconica* Franke. × 30. *a,* front view; *b,* apertural view. Cretaceous, Texas.

FIGS. 12, 13. *T. ripleyensis* W. Berry. Fig. 12, × 25. Holotype redrawn. Fig. 13, × 35. Cretaceous, Texas. *a, a,* front views; *b, b,* apertural views.

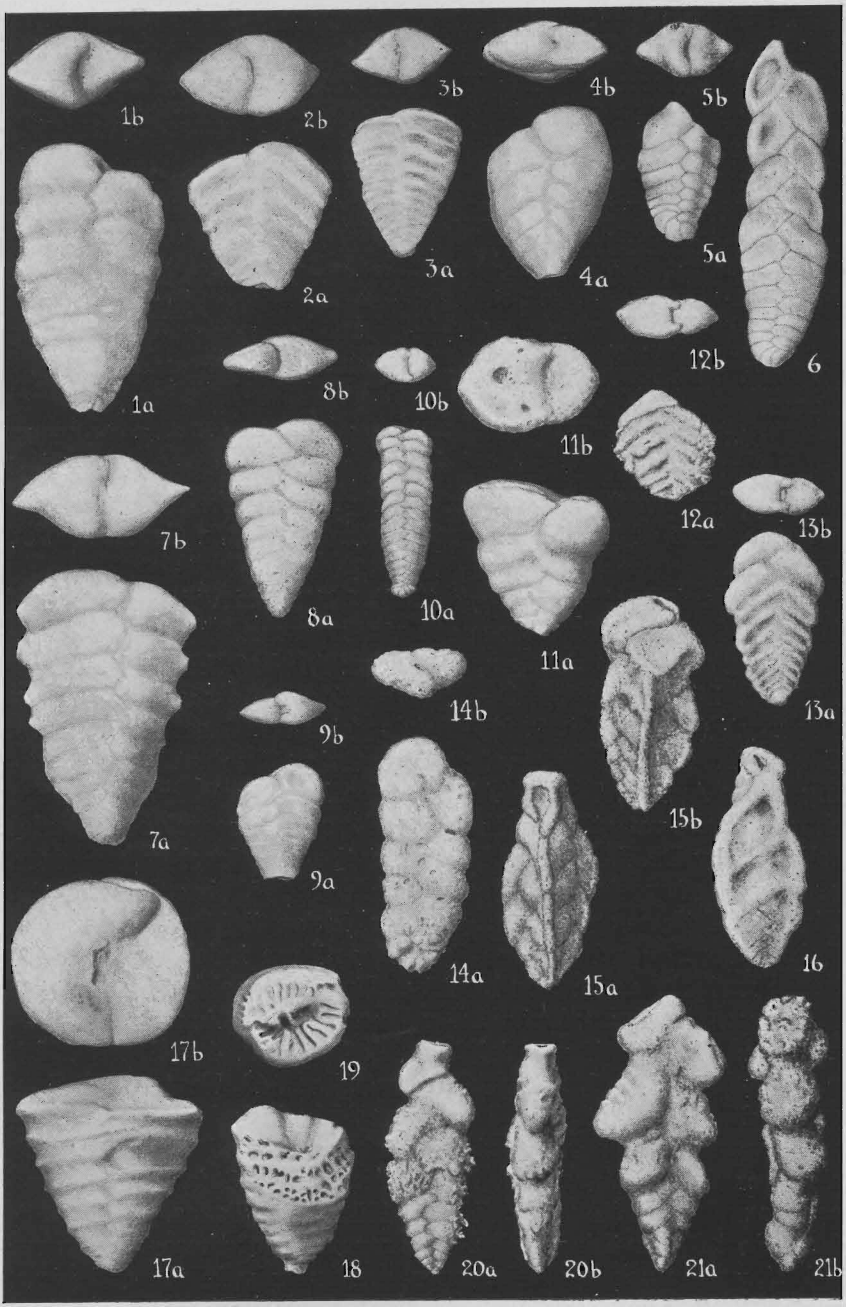
FIGS. 14 *a, b.* *Spiroplectammina navarroana* Cushman, n. sp. × 60. *a,* front view; *b,* apertural view. Cretaceous, Texas.

FIGS. 15, 16. *Gaudryina navarroana* Cushman, n. sp. × 35. Fig. 15, Holotype. *a,* side view; *b,* front view.

FIGS. 17–19. *Textulariella cretosa* Cushman, n. sp. × 15. Fig. 17, Holotype. *a,* front view; *b,* apertural view. Figs. 18, 19, Eroded specimens showing chamberlets. Cretaceous, Charing, England.

FIGS. 20, 21. *Gaudryinella pseudoserrata* Cushman, n. sp. × 35. Fig. 20, Holotype. *a, a,* front views; *b, b,* side views. Cretaceous, Texas.

Figures drawn by Margaret S. Moore.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"*Textularia parallela* Perner" (Foram. Ceske Cenomann, 1892, p. 54, pl. 9, fig. 13). The type of this species was seen at the Narodni Museum at Prag. It is really a *Bolivina*, but the name cannot be used in that genus as it has already been preoccupied by Reuss.

'*Textularia velascoensis* Cushman" (Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 18, pl. 3, fig. 1)=*Bolivinoides velascoensis* (Cushman).

"*Textularia subglabra* Cushman" (Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 584, pl. 15, figs. 7 *a-c*). This species originally described from the Velasco shale of Mexico is represented by somewhat similar specimens in the Taylor marl of Texas.

"*Textularia excolata* Cushman" (Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 585, pl. 15, figs. 9 *a, b*)=*Spiroplectammina excolata* (Cushman). This species originally described from the Velasco shale of Mexico also occurs in the Upper Cretaceous of Trinidad.

"*Textularia costata* Carsey" (Bull. 2612, Univ. Texas, 1926, p. 26, pl. 1, fig. 4)=*Gümbelina excolata* Cushman.

"*Textularia semicomplanata* Carsey" (Bull. 2612, Univ. Texas, 1926, p. 25, pl. 3, fig. 4)=*Spiroplectammina semicomplanata* (Carsey) (Pl. 11, figs. 8, 9). This species was described by Mrs. Carsey from the Navarro outcrops on Onion Creek at Jones Crossing, near Austin, Texas. At the type locality the walls of the chambers are very thin and easily collapsed. A search of material collected by Dr. L. W. Stephenson at the type locality has given us a series of specimens, some of which are in their original state. Figures of these are given. To Mrs. Helen J. Plummer, to Dr. Robert Cuyler, and to Miss Gene Ross I am indebted for additional material from this locality. Unquestionably some of the references to *Spiroplectammina anceps* from America: Cushman and Church, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 500, pl. 36, figs. 1, 2; and Cushman, Bull. 41, Tenn. Geol. Survey, 1931, p. 18, pl. 1, figs. 5 *a, b;* should be included under *Spiroplectammina semicomplanata.* As already noted the thin, high chambered form figured by Mrs. Plummer as *Spiroplectammina semicomplanata* (Carsey) (Bull. 3101, Univ. Texas, 1931, pl. 8, fig. 7 [not 8]) is this species. A comparison of these two figures will show the specific differences, particularly in the end view, which in *S. semicomplanata* is much more narrow, with sides

straight or becoming concave toward the periphery and the aperture in a deep indentation of the inner margin; whereas in *S. laevis*, var. *cretosa* the end view is very broad, sides usually convex and the aperture with only a slight reëntrant in the line of the apertural face.

This species seems to be widely distributed in the Cretaceous of America in the Navarro and in parts of the Taylor as well as in the Selma Chalk and other equivalents. The form called by Berry and Kelley "*Textularia sagittula* Defrance, var. *coonensis* W. Berry" from the Coon Creek of Tennessee is probably this species although the type is badly broken and shows only a portion of the middle of the test.

Spiroplectammina semicomplanata (Carsey), var. *juncea* Cushman, n. var. (Pl. 11, figs. 10 *a*, *b*). Variety with test very elongate, sides nearly parallel for most of their length, with many chambers, the early ones decidedly spiral.

Holotype of variety (Cushman Coll. No. 15593) from the Saratoga Chalk, near Saratoga, Arkansas.

This form has already been figured as *Spiroplectammina anceps* Cushman (not Reuss) (Journ. Pal., vol. 5, 1931, p. 299, pl. 34, figs. 2 *a*, *b*). This variety which is referred to Mrs. Carsey's species has occurred at several stations in the Saratoga Chalk of Arkansas and in other samples from that same region which have been referred to the Lower Navarro. So far as I have seen, this particular variety is confined to the Saratoga Chalk and its equivalents of Arkansas.

There are in the Lower Taylor specimens which are very close to *S. semicomplanata* (Carsey), but which are somewhat more elongate and tend to have the sutures nearly straight instead of curved as in the typical species. A study of more material may show this to be distinct.

There are other species of *Textularia* described in Mrs. Carsey's paper from the Lower Cretaceous of Texas, but these are not included here.

"*Textularia trochus* d'Orbigny, var. *subconica* Franke" (Abhandl. Preuss. Geol. Landes, new series, vol. 3, 1928, p. 131, pl. 12, fig. 1)=*T. subconica* Franke. Material of this form was studied in Europe, and the early chambers seem to show that this should be a distinct species and not related to d'Orbigny's species. Forms similar to that described by Dr. Franke occur in the Taylor marl of Texas and its equivalents such as the Middle Annona

Chalk and parts of the Selma Chalk. A figure of one of these is given here (Pl. 11, figs. 11 *a*, *b*).

"*Textularia ripleyensis* W. Berry" (in W. Berry and Kelley, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 4, pl. 2, fig. 2). The type of this species was not well figured but has been redrawn, and is given here together with other figures of this same species (Pl. 11, figs. 12, 13). It is a very common species in the Taylor marl and its equivalents of Texas and other portions of the Gulf Coastal Plain region of the United States. The test is much compressed and the apertural end contracted in the middle line, then convex so that the greatest width of each chamber is somewhat to the outside of the middle line. There is much variation in the character of the wall, the raised areas being typically very much roughened, but these are often comparatively smooth in some specimens although all gradations exist between the two extremes. The end view is very characteristic as the aperture is along a nearly straight line at the middle of the base of the apertural face, while the two sides are extended out into two narrow elongate processes.

"*Textularia sagittula* Defrance, var. *coonensis* W. Berry" (in W. Berry and Kelley, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 3; pl. 2, fig. 3). The type specimen of this form is a fragment with both ends missing as has been previously noted, and it probably should be placed under *Spiroplectammina semicomplanata* (Carsey).

"*Textularia nacataensis* White" (Journ. Pal., vol. 3, 1929, p. 31, pl. 4, fig. 2). This species and its variety *cyclostoma* White (l. c., p. 31, pl. 4, fig. 3) from the Velasco shale of Mexico are not true Textularias, and further study of this form is necessary to place it definitely.

There are other species of *Textularia* described from the Lower Cretaceous, but most of them do not enter into a discussion of the Upper Cretaceous species.

The following forms of American Cretaceous should be noted in connection with the other forms of *Textularia*.

Spiroplectammina bentonensis Carman (Journ. Pal., vol. 3, 1929, p. 311, pl. 34, figs. 8, 9)=*Gaudryina bentonensis* (Carman). This small species described from the Cretaceous of Wyoming also occurs particularly in the Bonham clay of Texas.

Spiroplectammina navarroana Cushman, n. sp. (Pl. 11, figs. 14 *a*, *b*). Test elongate, very slightly if at all tapering in the adult

portion; chambers nearly as high as broad, rounded at the periphery, somewhat inflated; sutures distinct, slightly depressed, nearly at right angles to the periphery; wall rather coarsely arenaceous with large fragments but fairly smoothly finished; aperture somewhat oblique, consisting of a narrow arched opening at the inner margin of the apertural face. Length 0.75 mm.; breadth 0.20 mm.; thickness 0.10 mm.

The type of this species is from the upper clay member of the Navarro, 6 miles East of Corsicana, Navarro County, Texas. It is a very coarsely arenaceous species, and seems to be limited to this portion of the section.

There are a few other forms related to *Textularia* in the American Upper Cretaceous, but up to this time they have been represented by material which is either too poor or of insufficient quantity to warrant giving descriptions of them.

125. THE RELATIONSHIPS OF TEXTULARIELLA AND DESCRIPTION OF A NEW SPECIES

By JOSEPH A. CUSHMAN

The genus *Textulariella* was erected for the species "*Textularia barrettii*" known from the Recent and Miocene of the West Indian Region. The main body of the test is composed of biserial chambers, which have labyrinthic interiors. The Cretaceous species described below has these same characters, but the early stages are triserial at least. A re-examination of a suite of Recent specimens of *Textularia barrettii* has shown that the early stages of that species are also triserial, and that the genus should for the present be placed in the Verneuilinidae.

TEXTULARIELLA CRETOSA Cushman, n. sp. (Pl. 11, figs. 17-19)

Test in the early stages triserial, later biserial, circular in transverse section, rapidly increasing in diameter toward the apertural end which is somewhat concave; chambers numerous, adult ones low and broad, interior labyrinthic, sometimes with two tiers of chamberlets in a single chamber; sutures distinct,

raised slightly above the surface, nearly at right angles to the axis of the test; wall very finely arenaceous, smoothly finished; aperture a low opening at the middle of the base of inner margin of the chamber. Length up to 1.75 mm.; diameter 1.75 mm.

Holotype (Cushman Coll. No. 17624) from Cretaceous, Chalk detritus, Charing, England. This species is apparently abundant in parts of the chalk of England, but I have not seen it in our American Cretaceous. It is related to the gaudryine forms of the Upper Cretaceous, "*G. oxycona*" etc., but these have simple chambers in their typical form.

126. TWO NEW NAVARRO FORAMINIFERA FROM TEXAS

By JOSEPH A. CUSHMAN

The two species described here are excellent markers for the Upper Navarro, and are apparently not previously described.

GAUDRYINA NAVARROANA Cushman, n. sp. (Pl. 11, figs. 15, 16)

Test elongate, early portion triserial and sharply triangular, the edges bluntly angled, fusiform in front view; chambers of the later portion biserial and somewhat compressed, lobed; sutures fairly distinct in the early portion, distinct and depressed later; wall rather coarsely arenaceous but fairly smoothly finished; aperture a deep reëntrant in the inner margin of the chamber with raised, rounded margins. Length up to 1 mm.; breadth 0.50 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 17623) from the Cretaceous, Upper Navarro of the Mexia Oil Field at 121 feet on the upthrow side of the fault. It is abundant in the cores from this depth to 376 feet, corresponding to the upper clay member of the Navarro. It occurs also in material kindly sent me by Mrs. Helen Jeanne Plummer from just below the Midway, three-quarters of a mile S., 45° W. of Peerless, Hopkins County, Texas. I have it also from the uppermost Cretaceous of Arkansas. It makes an excellent index fossil for this upper part of the Navarro in contact with the Midway.

GAUDRYINELLA PSEUDOSERRATA Cushman, n. sp. (Pl. 11, figs. 20, 21)

Test elongate, early portion triserial, soon becoming biserial and somewhat compressed, in the adult tending to become uniserial; chambers distinct, later ones inflated and lobulate; sutures distinct, later ones deeply depressed; wall rather coarsely arenaceous, later portion often roughly finished; aperture in the adult rounded and subterminal. Length 1 mm. or more; diameter 0.50 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 17621) from Upper Cretaceous, Navarro, chalky marl member, 5 miles SW. of Gruntan, Hunt County, Texas. This species is very abundant and widely distributed in this portion of the Navarro above the Nacatoch sand. It is an excellent marker for this zone. It tends strongly toward a uniserial condition in the adult.

In the same core mentioned above, this species starts in typical form at about 412 feet, and continues downward to 475 feet. It has various interesting varietal developments in the American Upper Cretaceous.

RECENT LITERATURE ON THE FORAMINIFERA

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

Hofker, J.

Notizen ueber die Foraminiferen des Golfes von Neapel. III. Die Foraminiferenfauna der Ammontatura.

(Pubbl. Sta. Zool. Napoli, vol. XII, fasc. 1, 1932, pp. 61-144, figs. 1-45 [in text].) *Napoli.*

Describes and figures numerous species and varieties, 4 new.

White, Maynard P.

Some Texas Fusulinidae.

(Univ. Texas Bull. 3211, 1932, pp. 1-104, pls. 1-10, figs. 1-3 [in text].) *Austin.*

Describes and figures numerous forms, 5 new.

Wickenden, R. T. D.

A Useful Foraminifera Horizon in the Alberta Shale of Southern Alberta.

(Journ. Pal., vol. 6, No. 2, June, 1932, pp. 203-207, pl. 29.) *Menasha.*

Describes and figures several species, none new.

Liebus, Adalbert.

The Variability of *Vulvulina pennatula* Batsch.

(Journ. Pal., vol. 6, No. 2, June, 1932, pp. 208-210, figs. 1-8 [in text].) *Menasha.*

Notes various forms assigned to this species.

Cushman, Joseph Augustine.

The Foraminifera of the Tropical Pacific Collections of the "Albatross", 1899-1900. Part 1, Astrorhizidae to Trochamminidae.

(Bull. 161, U. S. Nat. Mus., pt. 1, 1932, pp. 1-84, pls. 1-17.) *Washington.*

Describes and figures numerous species and varieties, 19 new.

Sandidge, John R.

Significant Foraminifera from the Ripley Formation of Alabama.

(The American Midland Naturalist, vol. XIII, No. 4, July, 1932, pp. 190-202, pl. XIX.) *Notre Dame.*

Describes and figures several species, 3 new.

Plummer, Helen Jeanne.

Ammobaculoides, A New Foraminiferal Genus.

(The American Midland Naturalist, vol. XIII, No. 2, March, 1932, pp. 86-88, figs. 1 *a-d* [in text].) *Notre Dame.*

This new genus is from the Upper Navarro.

Lacroix, E.

Discammina: nouveau genre méditerranéen de Foraminifères arénacés.

(Bull. Inst. Océanographique, No. 600, June 15, 1932, pp. 1-4, figs. *a-e* [in text].) *Monaco.*

A new genus related to *Ammodiscus.*

Scheffen, W.

Ostindische Lepidocyclinen. I. Teil.

(Wetenschappelijke Mededeelingen No. 21, 1932, pp. 1-76, pls. 1-14, figs. 1-6 [in text].) *Batavia.*

Many fine plates, 13 new species and varieties.

Heron-Allen, Edward and Arthur Earland.

Foraminifera. Part I. The Ice-free Area of the Falkland Islands and Adjacent Seas.

(*Discovery* Reports, vol. IV, 1932, pp. 291-460, pls. VI-XVII). *Cambridge.*

Contains 419 species and varieties (38 new), excellent plates, and 1 new genus, *Patellinoides.*

Caudri, C. M. B.

De Foraminiferen-Fauna van eenige *Cycloclypeus*-houdende Gesteenten van Java.

(Verhandl. Geol.-Mijn. Gen. Nederland en Koloniën. Geol. Ser., Deel IX, 1932, pp. 171-204, pls. I-III.) *Gravenhage.*

A detailed paper on this group with 1 new species.

Heron-Allen, E. and Arthur Earland.

Some New Foraminifera from the South Atlantic, IV. Four New Genera from South Georgia.

(Journ. Roy. Micr. Soc., vol. LII, 1932, pp. 253-261, pls. I, II.) *London.*

Four new genera and 6 new species and varieties.

Ellis, Brooks Fleming.

Gallowayina browni, A New Genus and Species of Orbitoid from Cuba, with Notes on the American Occurrence of *Omphalocyclus macropora.*

(Amer. Mus. Novitates, No. 568, Sept. 22, 1932, pp. 1-8, 9 figs. [in text].) *New York.*

Arni, P.

Eine neue Siderolites Species (S. Heracleae) (aus dem Senon von Eregli, an der Kleinasiatischen Schwarzmeer-Küste) und Versuch einer Bereinigung der Gattung.

(Eclogicae geologicae Helvetiae, vol. 25, No. 2, 1932, pp. 199-221, pls. VIII-X, 4 figs. [in text], and 2 tables.) *Basel.*

Sandidge, John R.

Fossil Foraminifera from the Cretaceous, Ripley Formation, of Alabama.

(The American Midland Naturalist, vol. XIII, No. 5, Sept., 1932, pp. 312-318, pl. XXIX.) *Notre Dame.*

Four new species described and figured.

Sample, C. H.

Cribratina, A New Genus of Foraminifera from the Comanchean of Texas.

(l. c., 1932, pp. 319-322, pl. XXX.) *Notre Dame.*

Sandidge, John R.

Foraminifera from the Ripley Formation of Western Alabama.

(Journ. Pal., vol. 6, No. 3, Sept. 1932, pp. 265-287, pls. 41-44.) *Menasha.*

Records 45 species, 11 new.

J. A. C.