

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH.

165. THE FORAMINIFERAL GENUS AMPHIMORPHINA IN
THE EOCENE OF CUBA

By JOSEPH A. CUSHMAN and PEDRO J. BERMUDEZ

The genus *Amphimorphina* Neugeboren has been known, heretofore, from the Miocene to the Pliocene. As it is a specialized genus derived directly from *Plectofrondicularia*, it is to be looked for as a further development wherever that genus may be found. A number of species of *Plectofrondicularia* have already been described from the Eocene, but no species of *Amphimorphina* have been hitherto described from material older in age than the Miocene. It is, therefore, of special interest to record the following species of *Amphimorphina* from marls of upper Eocene age in Cuba. The genus is widely distributed in the upper Eocene of Cuba, and the junior author will discuss its distribution in a future paper.

AMPHIMORPHINA TENUISTRIATA Cushman and Bermudez, n. sp. (Pl. 1, figs. 1-3)

Test elongate, slender, early portion biserial, adult uniserial; chambers distinct, earlier biserial ones forming a flattened test, later those of the uniserial portion becoming rounded in transverse section and inflated, gradually increasing in size with the last-formed chamber the largest; sutures fairly distinct, earlier ones somewhat limbate, not depressed, later becoming gradually more and more depressed toward the apertural end; walls calcareous, finely perforate, ornamented by numerous longitudinal costae, more or less continuous throughout; aperture terminal, somewhat dendritic with alternating ridges of different length running in from the periphery. Length 1.65-2.60 mm.; diameter 0.22-0.35 mm.

Holotype (Cushman Coll. No. 22580) from upper Eocene, under Library of Havana University, Cuba (Bermudez Sta. 257).

2 CONTRIBUTIONS FROM THE CUSHMAN LABORATORY

Paratype (Cushman Coll. No. 22582) (Pl. 1, fig. 3) from upper Eocene, cut in Avenida de los Presidente, near Havana University, Cuba (Bermudez Sta. 20).

• **AMPHIMORPHINA TENUISTRATA** Cushman and Bermudez, n. sp., var. **SEMINUDA**
Cushman and Bermudez, n. var. (Pl. 1, figs. 4, 5)

Variety differing from the typical in the somewhat finer costae of the earlier portion which, in the adult, gradually become finer and finally obsolescent.

Holotype of variety (Cushman Coll. No. 22583) from upper Eocene, under Library of Havana University, Cuba (Bermudez Sta. 257).

AMPHIMORPHINA LIRATA Cushman and Bermudez, n. sp. (Pl. 1, figs. 6-8)

Test elongate, slightly tapering, earliest portion biserial, somewhat compressed, with the periphery broadly truncate and with two distinct keels, later portion uniserial, gradually becoming rounded in the transverse section; chambers distinct, the later ones becoming inflated in the adult, usually somewhat longer than broad; sutures distinct, especially in the earlier portion, strongly limbate, slightly depressed; walls in addition to the peripheral keels in the earlier portion having a few high, plate-like, longitudinal costae, continuous over the later portion; aperture somewhat dendritic with distinct tooth-like ridges. Length 1.60-2.00 mm.; diameter 0.22-0.30 mm.

Holotype (Cushman Coll. No. 2585) from upper Eocene, under Library of Havana University, Cuba (Bermudez Sta. 257).

The figured specimens show some differences in the later chambers, as there seems to be some variation between the elongate chambers of figures 6 and 8 and the more rounded ones of figure 7 a; however, in a large series of specimens, these differences seem to be largely bridged over by intermediate forms.

AMPHIMORPHINA POLITA Cushman and Bermudez, n. sp. (Pl. 1, figs. 9 a, b)

Test elongate, slightly, if at all, tapering, earlier portion biserial, somewhat compressed, later becoming more inflated, broadly elliptical in transverse section; chambers distinct, earliest ones biserial, quickly followed by uniserial ones which gradually increase in height until, in the adult, height and breadth are about equal; sutures distinct, slightly limbate, later ones becoming somewhat depressed; walls smooth or the earliest portion very slightly striate. Length 2.05 mm.; diameter 0.30 mm.

Holotype (Cushman Coll. No. 22588) from upper Eocene, under Library of Havana University, Cuba (Bermudez Sta. 257).

This species is very rare as far as our material shows, and no specimens with the apertural end complete were found.

AMPHIMORPHINA CRASSA Cushman and Bermudez, n. sp. (Pl. 1, figs. 10 a, b)

Test elongate, very slightly, if at all, tapering, earlier portion biserial, somewhat compressed, later becoming circular in transverse section, in the adult uniserial; chambers gradually increasing in height as added until in the adult, the length slightly exceeds the breadth; sutures distinct, slightly limbate, very slightly depressed; wall ornamented by numerous, rather high, plate-like, longitudinal costae, continuous over all except the very last chambers; aperture apparently terminal, a broadly elliptical opening. Length 2.10 mm.; diameter 0.40 mm.

Holotype (Cushman Coll. No. 22589) from upper Eocene, Alturas de Almendares Quarry, Havana, Cuba (Bermudez Sta. 18).

This species is very rare in our material, and no specimens with the complete aperture were found.

166. THREE NEW FORAMINIFERA FROM THE MIOCENE, BOWDEN MARL, OF JAMAICA

By J. A. CUSHMAN and P. W. JARVIS

Since the publication of our paper on the Miocene of Buff Bay, Jamaica, the junior author has collected additional material from other localities in Jamaica. These have resulted in the finding of some very interesting and striking species, three of which are here described.

ANGULOGERINA EXIMIA Cushman and Jarvis, n. sp. (Pl. 1, figs. 11, 12)

Test only slightly longer than broad, triangular in transverse section, angles subacute or rounded, the sides slightly convex; chambers distinct, slightly inflated, deeply excavated at the base; sutures distinct, depressed, strongly curved; wall ornamented by small, longitudinal costae, those of each chamber distinct from

adjoining ones, the angles, especially in the earlier part, often with a distinct, thin keel; aperture small, rounded, with a definite cylindrical neck and slight lip. Length 0.50-0.60 mm.; diameter 0.40-0.45 mm.

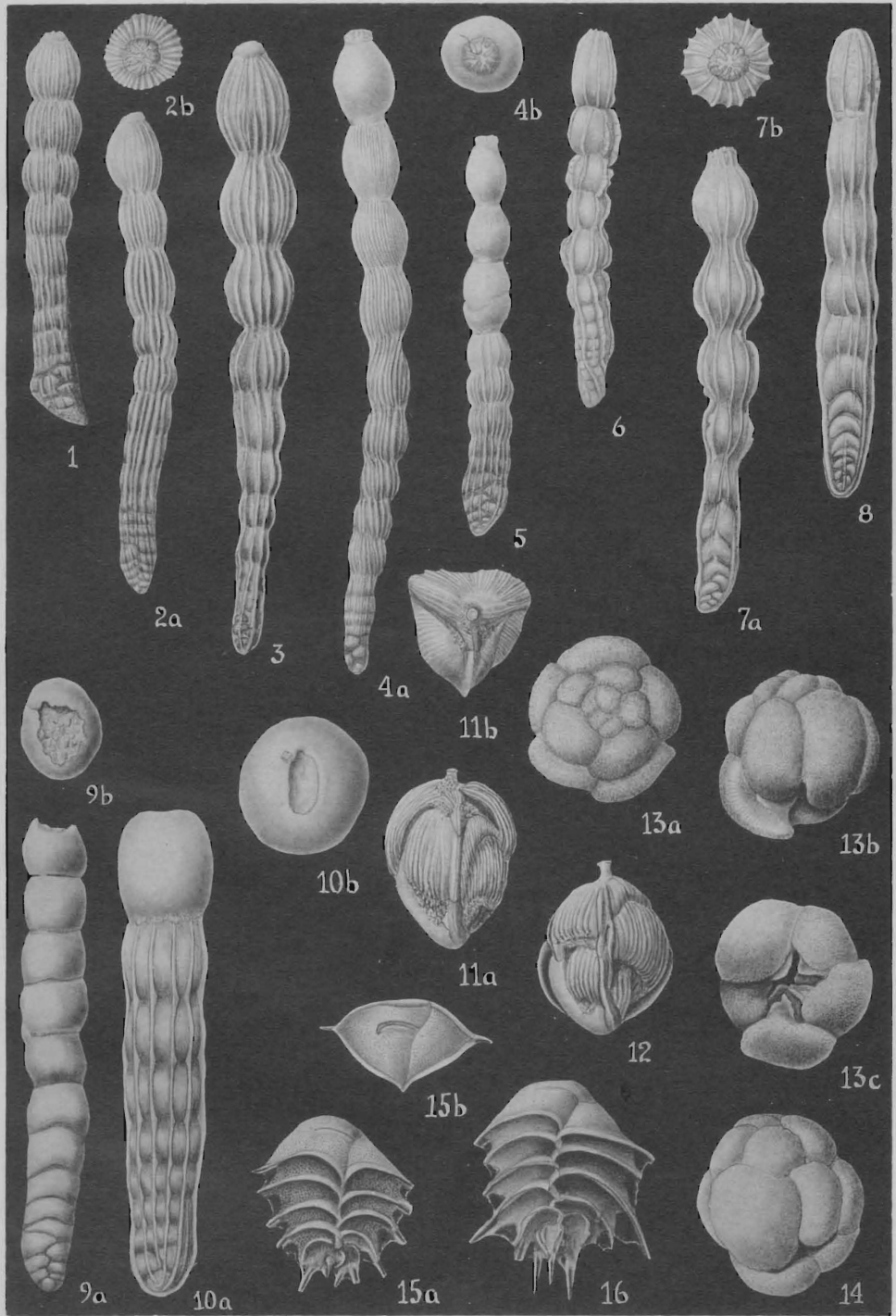
Holotype (Cushman Coll. No. 22478) from the Miocene, Bowden marl, $\frac{1}{2}$ mile E. of Buff Bay, Jamaica.

This is a very strikingly ornamented species with a very slight neck, and should be easily distinguished from the other known species of the genus.

EXPLANATION OF PLATE 1

- FIGS. 1-3. *Amphimorphina tenuistriata* Cushman and Bermudez, n. sp. Figs. 1, 2 a, 3, $\times 35$; 2 b, apertural view, $\times 50$. Fig. 2, Holotype. Figs. 1, 3, Paratypes. Figs. 1, 2, Microspheric forms. Fig. 3, Megalospheric form. Eocene, Havana, Cuba.
- FIGS. 4, 5. *Amphimorphina tenuistriata* Cushman and Bermudez, n. sp., var. *seminuda* Cushman and Bermudez, n. var. Figs. 4 a, 5, $\times 35$; 4 b, apertural view, $\times 50$. Fig. 5, Holotype. Microspheric form. Fig. 4, Paratype. Megalospheric form. Eocene, Havana, Cuba.
- FIGS. 6-8. *Amphimorphina lirata* Cushman and Bermudez, n. sp. Figs. 6, 7 a, 8, $\times 35$; 7 b, apertural view, $\times 50$. Fig. 8, Holotype. Figs. 6, 7, Paratypes. Fig. 6, Megalospheric form. Figs. 7, 8, Microspheric forms. Eocene, Havana, Cuba.
- FIG. 9. *Amphimorphina polita* Cushman and Bermudez, n. sp. a, front view, $\times 35$; b, apertural view, $\times 50$. Eocene, Havana, Cuba.
- FIG. 10. *Amphimorphina crassa* Cushman and Bermudez, n. sp. a, front view, $\times 35$; b, apertural view, $\times 50$. Eocene, Havana, Cuba.
- FIGS. 11, 12. *Angulogerina eximia* Cushman and Jarvis, n. sp. $\times 50$. Fig. 11, Holotype. a, front view; b, apertural view. Fig. 12, Paratype. Miocene, Bowden marl, $\frac{1}{2}$ mile east of Buff Bay, Jamaica.
- FIGS. 13, 14. *Globigerina altispira* Cushman and Jarvis, n. sp. $\times 35$. Fig. 13, Holotype. a, dorsal view; b, front view; c, ventral view. Fig. 14, Paratype. Miocene, Bowden marl, milestone No. 71, east of Port Antonio, Jamaica.
- FIGS. 15, 16. *Ehrenbergina spinosissima* Cushman and Jarvis, n. sp. $\times 50$. Fig. 16, Holotype. Fig. 15, Paratype. a, front view; b, apertural view. Miocene, Bowden marl, $\frac{1}{2}$ mile east of Buff Bay, Jamaica.

Figures drawn by Patricia G. Edwards.



EHRENBERGINA SPINOSISSIMA Cushman and Jarvis, n. sp. (Pl. 1, figs. 15, 16)

Test somewhat compressed, dorsal side slightly convex, ventral side somewhat angular; chambers distinct, earlier ones slightly coiled, in the adult biserial, of rather uniform shape and size as added, edges, especially on the ventral side, extending out into a narrow, thin keel ending in elongate, acicular spines at the periphery; sutures in later portion depressed, elsewhere obscured by the ornamentation; wall distinct, perforate; aperture an elongate, narrow, somewhat curved opening, generally parallel to the dorsal surface, and ending in the inner margin. Length 0.60-0.75 mm.; breadth 0.50-0.55 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 22480) from the Miocene, Bowden marl, ½ mile E. of Buff Bay, Jamaica.

This is a very striking species with the highly developed plate-like margins of the chambers ending in large spines.

GLOBIGERINA ALTISPIRA Cushman and Jarvis, n. sp. (Pl. 1, figs. 13, 14)

Test composed of about three whorls in a high spire; chambers much higher than broad in the adult, strongly inflated on the ventral side with a distinct, thin, triangular, plate-like structure extending into the umbilicus, about five in the adult whorl; sutures distinct, depressed; wall finely cancellated; aperture on the inner margin opening into the central umbilicus covered by a plate-like tooth. Length 0.75-0.80 mm.; diameter 0.70 mm.

Holotype (Cushman Coll. No. 22482) from Miocene, Bowden marl, at milestone No. 71, east of Port Antonio, Jamaica.

This is a very distinct species, fairly common in this material.

**167. NOTES ON SOME CRETACEOUS SPECIES OF
BULIMINELLA AND NEOBULIMINA**

By JOSEPH A. CUSHMAN and FRANCES L. PARKER

The following notes and descriptions are a result of further studies of Cretaceous material, both European and American, belonging to the genera *Buliminella* and *Neobulimina*. The results are based on a study of types and topotype material. There is a considerable range of form in megalospheric and microspheric specimens.

BULIMINELLA OBTUSA (d'Orbigny) (Pl. 2, figs. 1 a-c)

Bulimina obtusa D'ORBIGNY, Mém. Soc. Géol. France, 1840, p. 39, pl. 4, figs. 5, 6; Prodrôme de Paléont., vol. 2, 1850, p. 282, No. 1399.

Buliminella obtusa CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 28, pl. 5, figs. 1 a, b.

Test large, slightly tapering in the megalospheric form, rapidly tapering in the microspheric; chambers four to a whorl, 4-5 whorls, the last-formed chamber forming a slight, lobular projection; sutures flush with the surface, slightly limbate, appearing as dark lines; wall smooth, polished, coarsely perforate; aperture loop-shaped. Length 0.71 mm.; diameter 0.42 mm.

The figured specimen is from Bougival, France. The form somewhat resembles *Buliminella laevis* (Beissel), but differs from it in the position of the aperture, the flush sutures and the lack of inflation of the chambers.

BULIMINELLA IMBRICATA (Reuss) (Pl. 2, figs. 2 a-c)

Bulimina imbricata REUSS, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 22, pl. 3, fig. 7.—FRANKE, Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 159, pl. 14, fig. 20.

Buliminella imbricata CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 31, pl. 5, figs. 19 a, b.

Test small, somewhat tapering, about one and four-fifths times as long as broad; chambers four to a whorl, four whorls; sutures distinct, dark, spiral suture depressed slightly, others flush with the surface; wall smooth, very coarsely perforate, somewhat polished; aperture comma-shaped, almost at the apex of the apertural face which is somewhat rounded. Length 0.18-0.28 mm.; diameter 0.12-0.16 mm.

The figured specimen is from the type locality at Lemberg. The species closely resembles *Buliminella obtusa* (d'Orbigny) but is much smaller and more slender. A few specimens were found in the Senonian of Germany.

BULIMINELLA LAEVIS (Beissel) (Pl. 2, figs. 3 a-c)

Bulimina laevis BEISSEL, Abhandl. kön. Preuss. geol. Landes., n. ser., vol. 3, 1891, p. 66, pl. 12, figs. 39-43.

Bulimina ovulum FRANKE (not REUSS), Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 25, pl. 2, fig. 17; Abhandl. Preuss. geol. Landes., n. ser., vol. 111, 1928, p. 157, pl. 14, fig. 14.

Test large, about one and four-fifths times as long as broad; chambers four to a whorl, three or more whorls, inflated; sutures depressed to give the test an irregular appearance in the earlier

whorls, usually flush with the surface in the last whorl; wall smooth, finely perforate, sometimes polished; aperture comma-shaped, broad at the base, near the apex of the apertural face, in some specimens with a small depression extending down from it along the base of the last-formed chamber sometimes as far as the suture joining the second and third chambers, also in a few specimens, with a very short depressed area extending up from the base of the aperture along the same suture. Length 0.54-0.91 mm.; diameter 0.42-0.48 mm. (The occasional dwarfed specimens which are found in some localities were not used in compiling these measurements).

The figured specimen is from the type locality at Friedrichsberg near Aachen, Germany. Some authors have confused this form with *Bulimina ovulum* Reuss (*Buliminella reussi* Morrow), which is distinctly a *Bulimina* in form. Reuss himself in later papers has seemed to include this form in the species. Specimens were found in great abundance throughout the Senonian of Europe and England. The Bavarian specimens are somewhat shorter and broader, with five chambers to the whorl and with the last whorl inflated.

BULIMINELLA VITREA Cushman and Parker, n. sp. (Pl. 2, figs. 4 a-c)

Test small, about one and one-half times as long as broad, slightly tapering; chambers distinct, 3-4 whorls, the last-formed whorl forming more than half the test, slightly inflated; sutures distinct, depressed; wall partially transparent, coarsely perforate; aperture comma-shaped. Length 0.16-0.25 mm.; diameter 0.08-0.15 mm.

Holotype (Cushman Coll. No. 22575) from the Selma chalk, 2 miles west of Guntown, Mississippi.

This form resembles *Buliminella imbricata* (Reuss), but differs from it in the greater curve of the sutures, the inflation of the chambers and the transparency of the test. All our specimens were from the Selma chalk of Mississippi and Tennessee.

BULIMINELLA FABILIS Cushman and Parker, n. sp. (Pl. 2, figs. 5 a-c)

Test small, about twice as long as broad, tapering; chambers distinct, 4-5 whorls, the last-formed whorl taking up about two-thirds of the test, the chambers in the last whorl very slightly inflated; sutures distinct, slightly depressed; wall smooth, perforate; aperture loop-shaped. Length 0.16-0.20 mm.; diameter 0.08-0.10 mm.

Holotype (Cushman Coll. No. 22574) from the Lower Taylor, Bank of small stream, 45° north of Hillsboro-Corsicana road, 14.2 miles east of Hillsboro, Texas.

This species differs from *Buliminella vitrea* Cushman and Parker, n. sp., in the far greater slenderness of the test, the less curved sutures, the shape of the chambers and the non-transparency of the wall. Specimens were found in the Taylor and Austin formations.

BULIMINELLA CARSEYI Plummer (Pl. 2, figs. 6 a-c)

Bulimina compressa CARSEY, Univ. Texas Bull. No. 2612, 1926, p. 29, pl. 4, fig. 14.

Buliminella carseyi PLUMMER, Univ. Texas Bull. 3101, 1931, p. 179, pl. 8, fig. 7.—CUSHMAN, Journ. Pal., vol. 6, 1932, p. 340.

Specimens of this form described by Mrs. Plummer were found in the Lower Navarro, Taylor, Selma of Alabama and Mississippi, and Austin. It is closely related to *Buliminella laevis* (Beissel), but is much smaller and shows much more inflation of the chambers. The Austin forms, occurring in the Upper Gober chalk, seem to be rather consistently broader and shorter than the typical.

BULIMINELLA CARSEYI Plummer, var. **PLANA** Cushman and Parker, n. var.
(Pl. 2, figs. 7 a-c)

Test small, about one and one-half times as long as broad; chambers distinct, usually four whorls, the last-formed whorl forming at least half the test, somewhat inflated; sutures distinct, depressed; wall smooth, perforate; aperture comma-shaped. Length 0.18-0.24 mm.; diameter 0.10-0.15 mm.

Holotype (Cushman Coll. No. 22571) from the Navarro, San Antonio road, 6 miles east of Castroville, Bexar Co., Texas.

This variety varies from *Buliminella carseyi* Plummer in the smaller size of the test and the much smaller inflation of the chambers. All of our specimens are from the Middle Navarro.

BULIMINELLA CUSHMANI Sandidge

Buliminella cushmani SANDIDGE, Journ. Pal., vol. 6, 1932, p. 280, pl. 42, figs. 18, 19.

Owing to the lack of topotype material and of opportunity to study the types, the discussion of this species will be left to a later paper.

NEOBULIMINA IRREGULARIS Cushman and Parker, n. sp. (Pl. 2, figs. 8 a, b)

Test elongate, practically the same width throughout except for the initial end which is tapering, about five times as long as broad in the microspheric form, shorter in the megalospheric, about five whorls in the triserial stage and four in the biserial stage of the adult form; chambers distinct, globular, irregular; sutures distinct, depressed; wall coarsely perforate; aperture broadly loop-shaped, extending from the base of the last-formed chamber. Length 0.20-0.43 mm.; diameter 0.08-0.20 mm.

Holotype (Cushman Coll. No. 22576) from the Ector Tongue of the Austin chalk, 2.3 miles south of Sherman, Grayson Co., Texas.

Specimens of this form were found in the Austin chalk (Gober and Ector Tongues, and Bonham clay) and the Eagle Ford formation.

NEOBULIMINA CANADENSIS Cushman and Wickenden (Pl. 2, figs. 9, 10 a, b)

Neobulimina canadensis CUSHMAN and WICKENDEN, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 13, pl. 1, figs. 1, 2.—CUSHMAN, Bull. 41, Tenn. Geol. Survey, 1931, p. 48, pl. 8, figs. 1 a-c; Special Publ. No. 4, Cushman Lab. Foram. Res., 1933, pl. 22, figs. 24 a, b; l. c. No. 5, 1933, pl. 27, figs. 15 a-c.

This form closely resembles Cushman and Wickenden's species. The microspheric form here figured (figs. 10 a, b) is somewhat more irregular and twisted than the typical. The megalospheric form is figured here also (fig. 9), as it occurs more abundantly than the microspheric. Specimens were found in the Taylor marl, the Selma chalk of Mississippi and Tennessee and in two stations of the Upper Austin.

NEOBULIMINA SPINOSA Cushman and Parker, n. sp. (Pl. 2, figs. 11 a, b)

Test small, about one and one-half times as long as broad, widest portion of the test at a point two-thirds of the distance from the initial end, the initial end irregularly covered with short spines sometimes as much as one-third of the way up the test; chambers inflated, nine in the triserial portion and two in the biserial; sutures distinct, depressed; wall transparent or partially so, coarsely perforate; aperture loop-shaped with a distinct, slightly flaring lip, nearly terminal. Length 0.16-0.25 mm.; diameter 0.10-0.17 mm.

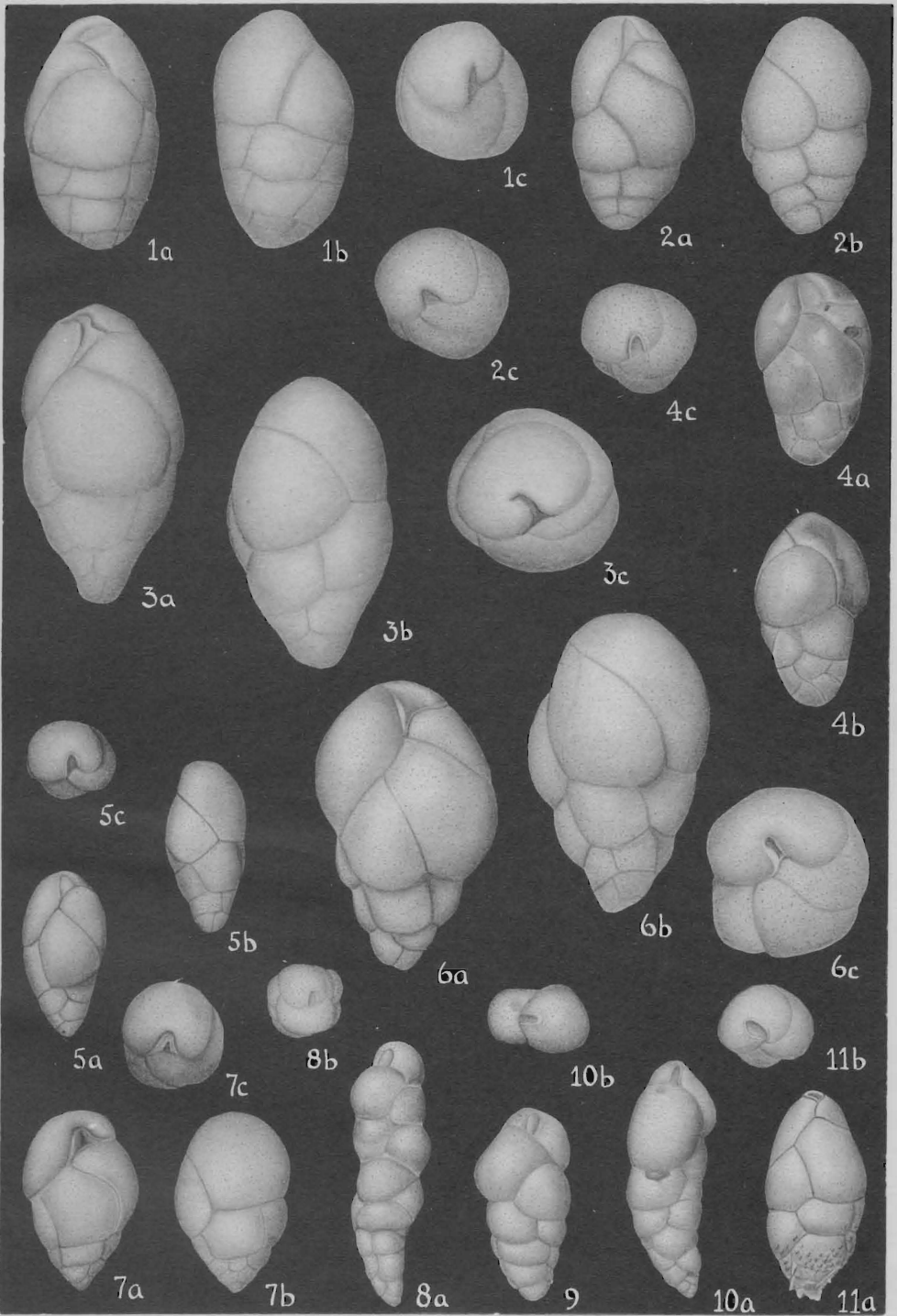
Holotype (Cushman Coll. No. 22579) from the Selma chalk, 1½ miles west of Sardis, on Sardis-Henderson road, Henderson Co., Tennessee.

Specimens of this species were found in the Navarro below the Nacatoch sand, in the Taylor, and in the Selma chalk of Mississippi and Tennessee.

EXPLANATION OF PLATE 2

- FIG. 1. *Buliminella obtusa* (d'Orbigny). × 50. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous Craie blanche, Bougival, France.
- FIG. 2. *Buliminella imbricata* (Reuss). × 110. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Lemberg, Galicia.
- FIG. 3. *Buliminella laevis* (Beissel). × 50. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Mucronaten Kreide, Friedrichsberg bei Aachen.
- FIG. 4. *Buliminella vitrea* Cushman and Parker, n. sp. × 110. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Selma chalk, 2 miles west of Guntown, Mississippi.
- FIG. 5. *Buliminella fabilis* Cushman and Parker, n. sp. × 125. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Taylor marl, 14.2 miles east of Hillsboro, Texas.
- FIG. 6. *Buliminella carseyi* Plummer. × 110. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Taylor marl, southeast of Del Valle, Texas.
- FIG. 7. *Buliminella carseyi* Plummer, var. *plana* Cushman and Parker, n. var. × 110. *a*, front view; *b*, rear view; *c*, apertural view. Cretaceous, Navarro, 6 miles east of Castroville, Texas.
- FIG. 8. *Neobulimina irregularis* Cushman and Parker, n. sp. × 80. *a*, front view; *b*, apertural view. Cretaceous, Austin chalk, 2.3 miles south of Sherman, Texas.
- FIGS. 9, 10. *Neobulimina canadensis* Cushman and Wickenden. × 125. Fig. 9, Cretaceous, Taylor marl, 7.7 miles east of McKinney, Texas. Fig. 10, Cretaceous, Taylor marl, 4.25 miles west of Ennis, Texas. *a*, front view; *b*, apertural view.
- FIG. 11. *Neobulimina spinosa* Cushman and Parker, n. sp. × 125. *a*, front view; *b*, apertural view. Cretaceous, Selma chalk, 1.5 miles west of Sardis, Tennessee.

Figures drawn by Ann Shepard.



168. NOTES ON SOME AMERICAN CRETACEOUS
FRONDICULARIAS*

By JOSEPH A. CUSHMAN

A study of some thousands of specimens of *Frondicularia*, especially from the Gulf Coastal Plain region of the United States, and comparison with types and topotypes of European species has given some important evidence as to specific determinations that seem worthy of record. In a study of this genus, the fact of considerable variation, in both the microspheric and megalospheric forms, must be taken into account. Also, series showing the young and adult stages of both forms should be available before a complete checking of a species is possible. Fortunately, the writer has seen and studied material of nearly all of the species of the genus, and the notes here are based on this evidence.

A number of species previously described from Europe are to be found in the American Cretaceous, and their vertical ranges agree remarkably well in the two areas. Some of the ranges seem to be unusually long but these are, as a rule, of species which lack ornamentation or very striking characters. There are evidently other species in our material, not included here, which are represented by insufficient material to warrant full specific determinations. As more than a hundred species and varietal names have been given to European Cretaceous species, the task of applying specific names is a considerable one. The retouched photographs on the accompanying plates should assist in the determination of our species.

FRONDICULARIA DIMIDIA Bagr (Pl. 3, fig. 1)

Frondicularia angusta (NILSSON), var. *dimidia* BAGG, Bull. 88, U. S. Geol. Survey, 1898, p. 47, pl. 3, figs. 7 a, b.—WELLER, Geol. Survey New Jersey, Pal., vol. 4, 1907, p. 225, pl. 2, figs. 20, 21.

This species was originally described from the Upper Cretaceous of Vincentown, New Jersey. It is characterized by an elongate, narrow, tapering test, thickest along the median line, thence decreasing in thickness to periphery. The sutures are

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strongly oblique and depressed. The main body of each chamber is somewhat raised and ornamented by strongly raised, longitudinal costae usually wanting over the sutures. As Nilsson's species is very poorly described and figured, it cannot be determined satisfactorily, and Bagg's variety is here given specific rank.

Frondicularia dimidia occurs in our Cretaceous material from the Lower Navarro, southeast edge of Greenville, 3 miles south of fair grounds, Hunt Co., Texas.

FRONDICULARIA ARKADELPHIANA Cushman, n. sp. (Pl. 3, figs. 2, 3)

Test elongate, narrow, slightly tapering, periphery truncate, slightly concave, broader surfaces nearly flat, proloculum spherical, somewhat thicker than the remainder of the test in the megalospheric form; chambers distinct, increasing gradually and regularly in size as added, not inflated; sutures distinct, strongly oblique, slightly curved, somewhat raised; wall ornamented with fine longitudinal, raised costae, becoming somewhat finer and more numerous on the later chambers, the costae at the base of each chamber fusing into the raised sutural ridge; aperture small, terminal, with a slight neck, radiately toothed. Length 2 mm. or more; breadth 0.65-0.70 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 22486) from the Cretaceous, Arkadelphia clay, from 5½ miles northeast of Hope, Hempstead Co., Arkansas.

This somewhat resembles some of the ornamented European species, but is distinct from any of them. As far as seen, it is confined in its range to the uppermost Cretaceous in the Arkadelphia clay.

FRONDICULARIA CLARKI Bagg (Pl. 3, figs. 4-6)

Frondicularia clarki BAGG, Bull. 88, U. S. Geol. Survey, 1898, p. 48, pl. 3, fig. 4.—WELLER, Geol. Survey New Jersey, Pal., vol. 4, 1907, p. 227, pl. 2, fig. 23.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 34, pl. 5, figs. 1, 2.—PLUMMER (part), Univ. Texas Bull. 3101, 1931, p. 171, pl. 9, fig. 17 (not fig. 16).

The test in the microspheric form (Pl. 3, figs. 4, 5) has a somewhat different shape near the base than the megalospheric (Pl. 3, fig. 6). The surface is smooth, but the sutures are usually distinct and peculiarly curved, giving an almost elliptical shape to the test, especially in the adult megalospheric form. The whole test is very flat and thin. The initial end usually has a short

spine, and the megalospheric proloculum may have a few longitudinal costae. Bagg described this species from the Upper Cretaceous of Atlantic Highlands, New Jersey.

In our Texas Cretaceous material, it has been found to be common and characteristic of the *Bulimina* zone or Calcareous marl zone of the Navarro found above the Nacatoch sand, and was not found elsewhere.

FRONDICULARIA UNDULOSA Cushman, n. sp. (Pl. 3, figs. 7-11)

Test typically elongate with the sides nearly parallel or gently tapering, but in some specimens somewhat broader and flaring, periphery truncately rounded, undulate, broader sides flattened, whole test thin; chambers distinct, increasing gradually in size as added, the basal portion rounded to form the lobular periphery, apertural end narrow, extended; sutures distinct, strongly oblique, nearly straight or slightly concave toward the outer side; wall smooth except for the proloculum in the megalospheric form which has a single, raised, longitudinal costa, the base with a short, stout spine; aperture small, at the end of a somewhat slender neck. Length up to 2.50 mm.; breadth 0.50-0.75 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 22491) from the Cretaceous, Austin chalk, 2.3 miles north of Dallas, on Dallas-Sherman highway, Texas.

This species with its undulate periphery and usually narrow test seems to be characteristic of the Gober chalk member of the Austin, although a somewhat broader form, otherwise similar, occurs very rarely in one or two of our Taylor localities.

There is but a single raised costa in the proloculum, both in the more slender and in the broader forms. As in many of the species of this genus, the form is variable. In the Taylor specimens, which may be found to be distinct, the test is usually more flaring, but there seems to be a close relationship between the two forms.

FRONDICULARIA AUSTINANA Cushman, n. sp. (Pl. 3, figs. 12, 13)

Test much compressed, broad faces flattened, outline nearly elliptical, somewhat more pointed at the apertural end, initial end with a short spine, periphery entire, slightly truncate; chambers narrow, elongate, increasing rather regularly in size as added, earliest ones in microspheric form tending to be flabelline, proloculum elongate, narrow; sutures distinct, flush with the

surface, gently but rather evenly convex toward the outside; wall with short, nearly vertical costae, several on each chamber, and not crossing the sutures; aperture small, at the end of a very slight neck. Length about 2 mm.; breadth 0.50-0.70 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 22497) from Cretaceous, Austin chalk, clay marl in lower part of Gober tongue, Bonham road, 2.3 miles west of Petty, Lamar Co., Texas.

This species is characteristic of the Austin chalk. It has the surface with characteristic ornamentation which is wanting in the following species. The early chambers in what seem to be microspheric specimens have a flabelline arrangement, but in those with a much larger proloculum, the chambers are often frondicularian throughout.

It is probable that the specimen I have figured as *Fronidularia cordai* from the Austin chalk (Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 34, pl. 5, fig. 17) belongs here.

FRONIDULARIA WATERSI Cushman, n. sp. (Pl. 8, figs. 14, 15)

Test strongly compressed, broad faces flattened, outline generally elliptical, the apertural end somewhat extended and the initial end tending to be truncated, with a stout basal spine, periphery entire, slightly truncate; chambers narrow, elongate, increasing rather regularly in size as added, earliest ones in the microspheric form tending to be flabelline, proloculum elongate, narrow, in the microspheric form shorter and with several fine, longitudinal costae; sutures distinct, flush with the surface toward the apertural end often with fine vertical lines, rather evenly convex toward the periphery; wall smooth throughout except over the microspheric proloculum and the outer ends of the sutures; aperture small, at the end of a very slight neck. Length up to 2.25 mm.; breadth up to 0.85 mm.; thickness 0.10-0.15 mm.

Holotype (Cushman Coll. No. 22500) from Cretaceous, upper Taylor, 3.2 miles southwest of Mart, McLennon Co., Texas.

This species differs from *F. austinana* mainly in the lack of the surface ornamentation. The base is usually somewhat more truncate, and the chambers tend to be narrower and more numerous.

F. watersi is characteristic of the Taylor and its equivalents, our records including the general Taylor of Texas, the Pecan Gap chalk, the Saratoga chalk of Arkansas and the Selma chalk of Alabama and Mississippi. The species is named for Mr. James

A. Waters, Chief Paleontologist of the Sun Oil Company. The Saratoga chalk material that I have previously referred to *Frondicularia cordai* Reuss (Journ. Pal., vol. 5, 1931, p. 307, pl. 35, fig. 8) belongs here.

FRONDICULARIA MUCRONATA Reuss (Pl. 3, figs. 16, 17)

Frondicularia mucronata REUSS, Die Verstein. Böhmen Kreide, 1845, p. 31, pl. 13, figs. 43, 44; Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 96, pl. 2, figs. 14-16.—PERNER, Ceska Akad. Cisare Frantiska Josepha, vol. 3, 1897, p. 41, pl. 4, fig. 4.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 48, pl. 4, fig. 3; Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 61, pl. 5, fig. 5.

The figured specimens show the typical form of this species, with basal spine, very elongate proloculum with a raised central ridge and nearly embracing chambers of rather uniform size extended at the apertural end into a definite neck, the sides flattened, periphery truncate and sutures distinct but not depressed.

Reuss' types were from the Cretaceous of Bohemia. Typical material was seen in the collections of Reuss now in Dresden and Vienna. Some of the European material referred to this species is not correctly identified, particularly that of Karrer which was also examined. The above references are those which seem to belong here.

In the American Cretaceous the species occurs in typical form in the Gober tongue of the Austin chalk, and is found also in the basal Taylor marl of Texas.

FRONDICULARIA GOLDFUSSI Reuss (Pl. 3, figs. 21, 22)

Frondicularia goldfussi REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 192, pl. 4, fig. 7.—EGGER, Abhandl. Kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 89, pl. 13, figs. 12, 13, 16, 17.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 33, pl. 5, fig. 3.

The species has a basal spine and a rounded or slightly elongate proloculum, the following chambers increasing very slightly in width as added, the sutures becoming progressively more curved, slightly limbate, but not rising above the generally smooth, flattened, broad face of the test. The periphery is distinctly truncate, even slightly concave. The apertural end usually projects slightly into a very short, apertural neck. At the base, the chambers reach well back, and form a broadly wedge-shaped base with the central portion projecting.

Reuss' species described from the Upper Cretaceous of Westphalia, Germany, occurs in rather typical form in our American material. It seems to be most characteristic of the Taylor marl, but there are a few specimens from the upper Austin that closely resemble these. The specimens I have figured under this name from the Annona chalk (Journ. Pal., vol. 6, 1932, p. 336, pl. 50, figs. 8, 9) should be referred to *Frondicularia cordata* Roemer.

FRONDICULARIA INVERSA Reuss (Pl. 3, figs. 23, 24)

Frondicularia inversa REUSS, Geog. Skizzen Böhmen, vol. 2, 1844, p. 211; Die Verstein. böhm. Kreide, 1845, p. 31, pl. 8, figs. 15-19; pl. 13, fig. 42; Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 94, pl. II, 21, figs. 5-7, 11.—PERNER, Foram. Cesk. Cen., (Resumé), 1892, p. 59, pl. 7, fig. 9.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 48, pl. 4, fig. 1.

This species has been recorded by various authors whose combined records give a range from the Gault of the Lower Cretaceous to the top of the Upper Cretaceous. A glance at the figures given will show how dissimilar are the various forms grouped under this name.

Fortunately the Cambridge (Massachusetts) set of Reuss' has a fine suite of specimens named by him. The proloculum is elongate and narrow, the sutures usually crossed by fine vertical costae, especially near the apertural end of each, the general surface smooth or occasionally with a few, short, vertical costae. The chambers fail to extend back as far as the previous ones gradually receding from the base, which gives a narrow, tapering base. The sutures are very strongly oblique and greatly curved.

In our American material the species is characteristic of the Austin. Material recorded under this name from the Taylor is not characteristic, and is referred elsewhere.

FRONDICULARIA GLABRANS Cushman

Frondicularia glabrans CUSHMAN, Bull. 41, Tenn. Geol. Survey, 1931, p. 34, pl. 4, figs. 12 a, b.

This species, described from the Selma chalk of Tennessee, has not yet been found elsewhere.

FRONDICULARIA CORDATA Roemer (Pl. 4, figs. 1-3)

Frondicularia cordata ROEMER, Verst. nord. deutsch. Kreide, 1840-41 (1841), p. 96, pl. 15, fig. 8.

The specimens here figured are referred to the species described and figured by Roemer in the above reference from the

Upper Cretaceous of northern Germany. Some of the specimens referred to *F. cordai* Reuss in the literature may belong here, although the specimens I have referred to Reuss' species probably do not belong there.

The species has frequently a rather definite heart-shaped form, particularly in megalospheric specimens. Microspheric specimens are usually more pointed at the base. The megalospheric proloculum has one or more longitudinal costae, and is short and rounded. The test is much flattened with a smooth surface, truncate periphery, distinctly limbate sutures which are nearly straight in the early stages, but which become convex later.

The typical form is most common in the Taylor marl, but occasional specimens of very similar characters appear in the upper Austin.

FRONDICULARIA LINGUIFORMIS Marsson (Pl. 3, figs. 18-20)

Frondicularia linguiformis MARSSON, Mitth. nat. Ver. New-Vorpommern u. Rügen, Jahrb. 10, 1878, p. 135, pl. 2, figs. 14 a-c.—FRANKE, Bronn. Verh. Nat. Hist. Ver., vol. 59, 1912 (1913), p. 273; Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 50, pl. 4, fig. 14; Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 65, pl. 5, figs. 17 a, b.

This species was originally described by Marsson from the Upper Cretaceous chalk of the Island of Rügen, and recorded by Franke from chinks of similar age in northern Germany. Our figured specimens are from the Annona chalk, from two localities, east of Clarksville, Red River Co., Texas. There are other specimens from the Taylor of similar age. These have been compared with type and topotype material, and the American specimens seem identical with the European ones. The vertical range both in Europe and America is short and very similar, so that this should make an excellent species for correlation purposes.

The vertical costae between the sutures are very fine and numerous, and the whole test may reach a length of 5 mm. The test is narrow and gradually tapering, and the proloculum rounded, with about three distinct longitudinal costae, and thicker than the remainder of the test. The specimen figured from the Cretaceous of Trinidad, as "*Frondicularia gracilis* Franke (?)" (Cushman and Jarvis, Proc. U. S. Nat. Mus., vol. 80, art. 14, 1932, p. 40, pl. 12, fig. 5) should be referred to Marsson's species.

FRONDICULARIA STRIATULA Reuss (Pl. 4, figs. 4, 5)

Frondicularia striatula REUSS, Geog. Skizzen Böhmen, vol. 2, 1844, p. 212; Verstein. böhm. Kreide, 1845, p. 30, pl. 8, fig. 23; Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 94, pl. II, 21, figs. 2 a-c.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 51, pl. 4, fig. 15; Abhandl. Preuss. Geol. Landes., vol. 111, 1928, p. 67, pl. 6, figs. 1 a, b, 2.

Frondicularia gracilis PERNER, Foram. Ceskeho Cenomann, (Résumé), 1892, p. 60, pl. 8, fig. 9.

Reuss described this species from the Upper Cretaceous of Bohemia, and later recorded it from the Saxon Basin. Material from both localities has been studied, and while they show some variation, a single species seems to be rather definite. It has an elongate, tapering form with flattened sides, the sutures very distinct and raised, somewhat thickened at the outer end, and a sigmoid curve starting near the apex as concave to the periphery, and at the base becoming convex. Between the sutures the surface has a few short, distinctly raised costae.

Our figured specimens are from the Taylor. The species is distinct from the preceding in the curvature of the sutures and the much coarser ornamentation of the surface.

FRONDICULARIA FRANKEI Cushman, n. sp. (Pl. 4, figs. 6, 7)

Frondicularia angusta REUSS (not NILSSON), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 196, pl. 4, fig. 5.

Frondicularia archiaciana D'ORBIGNY, var. *strigillata* BAGG (not *F. strigillata* REUSS), Bull. 88, U. S. Geol. Survey, 1898, p. 47, pl. 3, fig. 5.

Frondicularia gracilis FRANKE (not PERNER), Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 50, pl. 4, fig. 9.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 37, pl. 5, fig. 16.

Test elongate, tapering gradually from the subacute initial end to the greatest width toward the apertural end, periphery truncate, central part of the test somewhat thickened; chambers numerous, gradually and regularly increasing in size; sutures slightly depressed in the later portion, in the earliest portion often slightly raised, strongly oblique; wall of the individual chambers ornamented with strongly raised, short, stout, vertical costae usually discontinuous over the sutures; aperture small, at the end of a short, projecting neck. Length up to 5 mm.; breadth 1 mm.

Holotype (Cushman Coll. No. 22526) from Cretaceous, upper Taylor marl, 3.2 miles southwest of Mart, McLennon Co., Texas.

The species is characteristic of the upper and middle Taylor and equivalents of Texas, and of the Selma chalk of Mississippi and Tennessee. Its vertical range in Europe is very similar.

FRONDICULARIA ARCHIACIANA d'Orbigny (Pl. 4, figs. 8-10)

Frondicularia archiaciana D'ORBIGNY, Mém. Soc. Géol. France, 1840, p. 20, pl. 1, figs. 34-36.—ELEY, Geology in the Garden, London, 1859, p. 197, pl. 4, fig. 19.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 419, pl. 7, figs. 11, 12.—FRANKE, Abhandl. geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 52, pl. 4, fig. 18; Abhandl. Preuss. Geol. Landes., vol. 111, 1928, p. 71, pl. 6, figs. 14, 15.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 37, pl. 5, figs. 9-12; Bull. 41, Tenn. Geol. Survey, 1931, p. 35, pl. 4, figs. 13 *a*, *b*.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 278, pl. 42, figs. 15, 26.—CUSHMAN, l. c., p. 335.

Topotypes of this species were studied, and they seem to be identical with our American material that is common in the general Taylor, including the Annona chalk and the Selma chalk. The proloculum is ornamented with several costae, and its diameter is greater than that of the remainder of the test. The form is slender and gently tapering, the sutures distinct, strongly oblique or slightly sigmoid. Except for the proloculum, the test is smooth.

FRONDICULARIA VERNEUILIANA d'Orbigny (Pl. 4, fig. 11)

Frondicularia verneuiliana D'ORBIGNY, Mém. Soc. Géol. France, 1840, p. 20, pl. 1, figs. 32, 33.—BROWN, Ann. Mag. Nat. Hist., ser. 2, vol. 12, 1853, p. 241, pl. 9, fig. 5.—EGGER, Ber. nat. Ver. Passau, 1907, p. 29, pl. 1, figs. 6, 15, 16.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 419, pl. 7, fig. 15.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 36, pl. 5, figs. 5, 6.

The above records are from the Upper Cretaceous of Europe and America where this species in typical form is confined to the Senonian and its equivalent, the Taylor marl, of America. American specimens occur in the general Taylor and in the upper Ozan, Annona chalk and Pecan Gap chalk as well as in the Selma chalk of Mississippi and Alabama. The test is thicker in the middle than at the periphery, and the ends of the sutures are expanded into raised costae.

FRONDICULARIA CUSPIDATA Cushman (Pl. 4, figs. 12-14)

Frondicularia cuspidata CUSHMAN, Bull. 41, Tenn. Geol. Survey, 1931, p. 36, pl. 5, figs. 4, 5.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 278, pl. 42, figs. 16, 17.

This species was originally described from the Selma chalk of

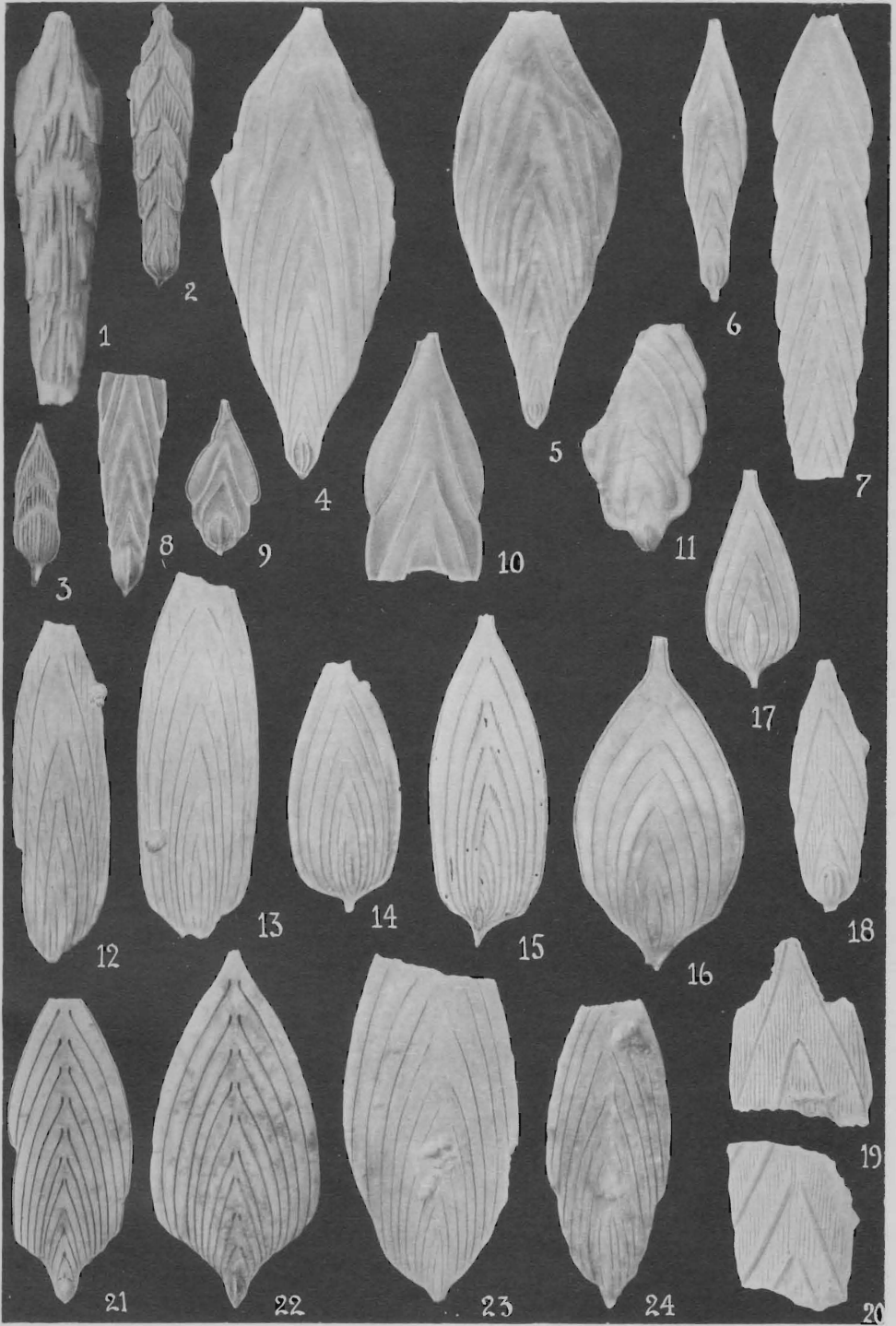
Tennessee, and later recorded by Sandidge from the Ripley formation of Alabama. Further study has shown that the species is common in the middle and upper Taylor of Texas and its equivalents. There are specimens in our material from the Pecan Gap chalk, Wolfe City sand and Annona chalk of Texas, as well as from the Selma chalk of Tennessee and Alabama.

In the original type material 2-chambered specimens were the most common, but later material has shown the adult to have

EXPLANATION OF PLATE 3

- FIG. 1. *Frondicularia dimidia* Bagg. × 25. Navarro, Greenville, 3 miles south of fair grounds, Hunt Co., Texas.
- FIGS. 2, 3. *Frondicularia arkadelphia* Cushman, n. sp. × 25. Fig. 2, Holotype. Fig. 3, Paratype. Arkadelphia clay, 5.5 miles northeast of Hope, Hempstead Co., Arkansas.
- FIGS. 4-6. *Frondicularia clarki* Bagg. × 25. Fig. 6, Young stage. Figs. 4, 6, Navarro, 2.8 miles east-southeast of Cooledge, Limestone Co., Texas. Fig. 5, Pit of Corsicana Brick Co., Navarro Co., Texas.
- FIGS. 7-11. *Frondicularia undulosa* Cushman, n. sp. × 25. Fig. 7, Holotype. Figs. 7, 8, 10, Austin chalk, 2.3 miles north of Dallas, Texas. Fig. 9, Austin chalk, 6.5 miles east by north of Allen, Collin Co., Texas. Fig. 11, Austin chalk, 2.2 miles west of High, Lamar Co., Texas.
- FIGS. 12, 13. *Frondicularia austinana* Cushman, n. sp. × 25. Fig. 12, Holotype. Austin chalk, 2.3 miles west of Petty, Lamar Co., Texas. Fig. 13, Austin chalk, Pecan Creek, 3.4 miles south by east of Troy, Bell Co., Texas.
- FIGS. 14, 15. *Frondicularia watersi* Cushman, n. sp. × 25. Fig. 14, Holotype. Upper Taylor, 3.2 miles southwest of Mart, McLennon Co., Texas. Fig. 15, 3.5 miles (air line) southeast of Converse, Bexar Co., Texas.
- FIGS. 16, 17. *Frondicularia mucronata* Reuss. × 25. Fig. 16, Taylor, 1.9 miles west-southwest of Prairie Hill, Limestone Co., Texas. Fig. 17, Austin chalk, 2.3 miles west of Petty, Lamar Co., Texas.
- FIGS. 18-20. *Frondicularia linguiformis* Marsson. × 20. Fig. 18, Annona chalk, 4 miles east of Clarksville, Red River Co., Texas. Figs. 19, 20, Annona chalk, 6.5 miles east of Clarksville, Red River Co., Texas.
- FIGS. 21, 22. *Frondicularia goldfussi* Reuss. × 20. Taylor, ¼ mile north of Castroville, Bexar Co., Texas.
- FIGS. 23, 24. *Frondicularia inversa* Reuss. × 20. Fig. 23, Austin chalk, 2.5 miles east by south of Troy, Bell Co., Texas. Fig. 24, Austin chalk, Pecan Creek, 3.4 miles south by east of Troy, Bell Co., Texas.

From micro-photographs by Frances L. Parker.



several chambers and to reach a length of nearly 4 mm.

The proloculum is very elongate, with a fairly long basal spine and several longitudinal costae. In the adult the periphery is often somewhat undulate, and the apertural end drawn out into a distinct, elongate neck. The surface except that of the proloculum is unornamented.

FRONDICULARIA CUSPIDATA Cushman, var. *COSTIFERA* Cushman, n. var. (Pl. 4, fig. 15)

Variety differing from the typical in the surface which has the sutures of the adult distinctly depressed and the wall of the chambers with distinct, short costae.

Holotype of variety (Cushman Coll. No. 22550) from Cretaceous, Taylor marl, Milton road, 1 mile west of Deport, Lamar Co., Texas. This is the only locality so far noted for this variety.

FRONDICULARIA LINEARIS Franke (Pl. 4, figs. 19, 20)

Frondicularia linearis FRANKE, Abhandl. Preuss. Geol. Landes., vol. 111, 1928, p. 72, pl. 6, figs. 17, 18.

Specimens of small size, very slender, and with the sides nearly parallel and the broader faces usually slightly concave occur in samples from the upper Austin through most of the Taylor marl. These fit in fairly well with the species described by Dr. Franke from northern Germany. Some of them may represent very narrow, young specimens of other species, but they have been grouped here for convenience.

FRONDICULARIA INTERMITTENS Reuss (Pl. 4, figs. 16-18)

Frondicularia intermittens REUSS, Sitz. Akad. Wiss. Wien, vol. 52, 1865, p. 460, figs. 11 a, b.

Frondicularia inversa CUSHMAN (not REUSS), Bull. 41, Tenn. Geol. Survey, 1931, p. 35, pl. 5, figs. 1, 2.

Frondicularia verneuiliana CUSHMAN (not D'ORBIGNY), Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 36, pl. 5, figs. 5, 6.

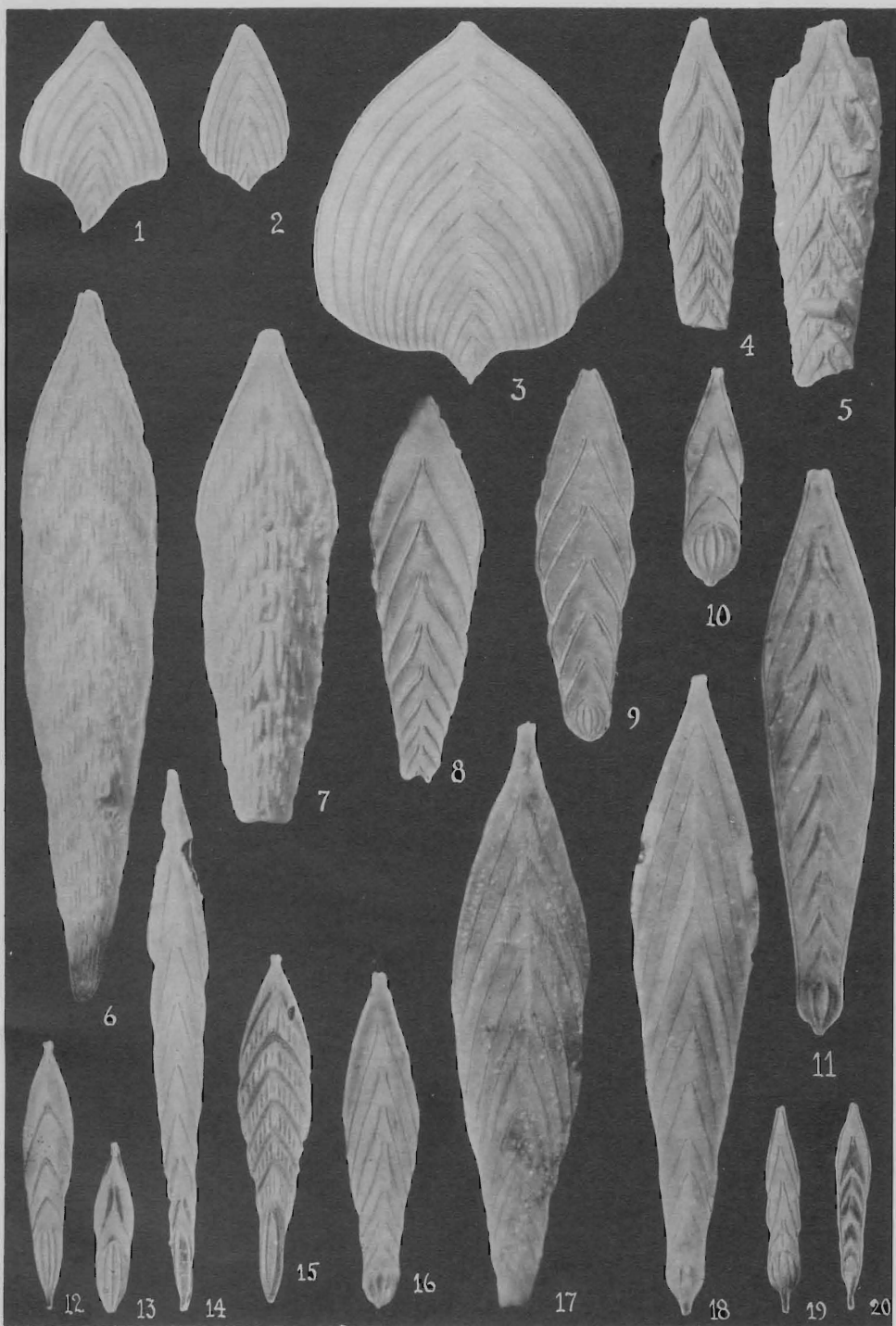
Specimens similar to those figured here, of elongate tapering shape, and nearly straight or slightly curved sutures, seem to belong under Reuss' *F. intermittens*. It is a characteristic Taylor species, and reaches a fairly large size. In some respects it resembles *F. clarki* of the Navarro, but that species has much more curved sutures and a slightly different shape.

There are several other species in the American Cretaceous, but they have already been published elsewhere, and seem to need no revision at the present time. They will be discussed in a forthcoming comprehensive report on the American Cretaceous.

EXPLANATION OF PLATE 4

- FIGS. 1-3. *Fronidicularia cordata* Roemer. × 20. Figs. 1, 2, Taylor, well samples, 1339-1342 ft. Yost No. 1, Sun Oil Co., Bastrop Co., Texas. Fig. 3, Cretaceous, Austin chalk, Pecan Creek, 3.4 miles south by east of Troy, Bell Co., Texas.
- FIGS. 4, 5. *Fronidicularia striatula* Reuss. × 20. Fig. 4, Taylor, 1.8 miles east of Deport, Red River Co., Texas. Fig. 5, Austin chalk, 2.3 miles west of Petty, Lamar Co., Texas.
- FIGS. 6, 7. *Fronidicularia frankei* Cushman, n. sp. × 20. Fig. 6, Holotype. Taylor, 3.2 miles southwest of Mart, McLennon Co., Texas. Fig. 7, Taylor, 3 miles west of Rogers, Bell Co., Texas.
- FIGS. 8-10. *Fronidicularia archiaciana* d'Orbigny. × 25. Figs. 8, 9, Taylor, 3.5 miles (air line) south-southwest of Scott, Falls Co., Texas. Fig. 10, Taylor, 2 miles north of Nevada, Collin Co., Texas.
- FIG. 11. *Fronidularia verneuiliana* d'Orbigny. × 25. Selma chalk, 3.5 miles northwest of Booneville, Miss.
- FIGS. 12-14. *Fronidularia cuspidata* Cushman. × 25. Figs. 12, 13, Taylor, 1.8 miles northwest of Annona, Red River Co., Texas. Fig. 14, Taylor, 3.2 miles southwest of Mart, McLennon Co., Texas.
- FIG. 15. *Fronidularia cuspidata* Cushman, var. *costifera* Cushman, n. var. × 25. Taylor, 1 mile west of Deport, Lamar Co., Texas.
- FIGS. 16-18. *Fronidularia intermittens* Reuss. × 25. Figs. 16, 17, Taylor, ¼ mile north of Castroville, Bexar Co., Texas. Fig. 18, Pecan Gap chalk, southeastern Falls Co., Texas.
- FIGS. 19, 20. *Fronidularia linearis* Franke. × 25. Fig. 19, Austin chalk, 6.1 miles east of McKinney, Collin Co., Texas. Fig. 20, Annona chalk, 2.5 miles northwest of Clarksville, Red River Co., Texas.

From micro-photographs by Frances L. Parker.



RECENT LITERATURE ON THE FORAMINIFERA

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

Goudkoff, Paul P. Subsurface Stratigraphy of Kettleman Hills Oil Field, California.—Bull. Amer. Assoc. Petr. Geol., vol. 18, No. 4, April, 1934, pp. 435-475.

Senn, Alfred. Die stratigraphische Verbreitung der tertiären Orbitoiden, mit spezieller Berücksichtigung ihres Vorkommens in Nord-Venezuela und Nord-Marokko.—Eclogae geologicae Helvetiae, Vol. 28, No. 1, 1935, pp. 51-113.—Many lists and much data for correlation.

Nachtrag zu: Die stratigraphische Verbreitung der tertiären Orbitoiden.—l. c., pp. 369-373, pls. VIII, IX.

Shupack, Benjamin. Some Foraminifera from Western Long Island and New York Harbor.—Amer. Mus. Novitates, No. 737, Aug. 15, 1934, pp. 1-12, 1 pl., 2 text figs.—Eight species, two new: *Elphidium florentinae*, *E. brooklynense*.

Bailey, Willard F. Micropaleontology and Stratigraphy of the Lower Pennsylvanian of Central Missouri.—Journ. Pal., vol. 9, No. 6, Sept., 1935, pp. 483-502, 3 charts, pl. 55.—Notes occurrence of eight genera of foraminifera.

Greig, D. A. *Rotalia viennoti*, an Important Foraminiferal Species from Asia Minor and Western Asia.—l. c., pp. 523-526, pl. 58.—A new species.

Rutten, M. G. Larger Foraminifera of Northern Santa Clara Province, Cuba.—l. c., pp. 527-545, pls. 59-62.—Five new species described, a new subgenus, *Cryptasterorbis*, and a new subfamily, Pseudorbitoidinae.

A Note on *Actinosiphon vichayalensis* (Rutten).—l. c., pp. 546, 547, 2 text figs.

Palmer, Dorothy K. The Foraminiferal Genus *Gümbelina* in the Tertiary of Cuba.—Mem. Soc. Cubana Hist. Nat., vol. 8, No. 2, 1934, pp. 73-76, text figs. 1-8.—Two species, one new: *Gümbelina cubensis*.

DeFlandre, Georges. Sur un Foraminifère siliceux fossile des diatomites miocènes de Californie: *Silicotextulina diatomitarum* n. g., n. sp.—Comptes Rendus, Acad. Sci., Paris, vol. 198, 1934, pp. 1446-1448.

Paalow, Richard. Die Foraminiferen im Zechstein des östlichen Thüringen.—Jahrb. Preuss. Geol. Landes. für 1935, v. 56, 1935, pp. 28-45, pls. 3-5.—40 species described and figured, 19 new.

Palmer, Dorothy K. and Pedro J. Bermudez. Late Tertiary Foraminifera from the Matanzas Bay region, Cuba.—Mem. Soc. Cubana Hist. Nat., vol. IX, No. 4, January, 1936, pp. 237-258, pls. 20-22.—105 species and varieties, 12 new species and a new genus, *Cushmanella*.

Chapman, F. and Irene Crespin. Foraminiferal Limestones of Eocene Age from North-West Division, Western Australia.—Proc. Roy. Soc. Victoria, vol. XLVIII, pt. 1, n. ser., Dec. 2, 1935, pp. 55-62, pls. III, IV.

- Silvestri, Alfredo.** Sulla Validita del Genere "Fusulina" Fischer.—Boll. Soc. Geol. Ital., vol. LIV, 1935, pp. 203-219, pl. 9, text figs. 1-3.
- Rhumbler, L.** Rhizopoden der Kieler Bucht; gesammelt durch A. Remane. I. Teil.—Schrift. Nat. Ver. Schleswig-Holstein, Bd. XXI, Heft. 2, 1935, pp. 143-194, pls. 1-9.—Figures and describes many new arenaceous forms, 34 new, and 5 new genera: *Pilalla*, *Psammella*, *Amphifenestrella*, *Saccodendron*, *Leptodermella*.
- Colom, G.** Notes sobre Foraminifers.—Bull. Institut. Catalana Hist. Nat., vol. XXXV, 1935, pp. 1-12, pls. 6, 7, text figs. 1-8.—Describes and figures various genera and species of the Anomaliniidae.
- Chapman, F.** Correlations of the Carboniferous and Permian Formations of Australia. IV. Note on the Correlation of the Carboniferous and Permian Rocks of Australia.—Rep't. Melbourne (1935) Meeting of Australian and New Zealand Assoc. Adv. Sci., 1935, p. 460.—Notes occurrence of several genera.
- Chapman, F. and Irene Crespin.** The Sequence and Age of the Tertiaries of Southern Australia.—l. c., pp. 118-126.—Mention characteristic foraminifera.
- Arni, Paul.** Assilina praespira Douvillé.—Eclogae geologicae Helvetiae, vol. 28, 1935, pp. 123-127, pl. XI, 1 text fig.
Über die Stratigraphie des Untereocaens und einige Nummuliten des Ruchbergsandsteins.—l. c., pp. 643-648.
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—J. A. C.