

CONTRIBUTIONS FROM THE CUSHMAN
LABORATORY FOR FORAMINIFERAL RESEARCH

192. A NEW SPECIES OF PULVINULINELLA FROM THE
CALIFORNIA MIOCENE

By JOSEPH A. CUSHMAN and PAUL P. GOUDKOFF

The species described below is very characteristic of one of the most widespread zones in the California Miocene. This zone is stratigraphically equivalent to the *Bulimina wigerinaformis* and the *Baggina californica* zones¹, and forms the basal part of the upper Miocene of California and falling within the lower Mohnian stage of R. Kleinpell². Its stratigraphic position is between the *Bolivina hughesi* zone (middle part of upper Miocene) and the *Valvulineria californica* zone (upper part of middle Miocene). The local lithological names used by the California geologists for the zone carrying *Pulvinulinella gyroidinaformis*, n. sp., include the following: McDonald shale, developed along the west side of San Joaquin Valley; and the lower Fruitvale shale or middle part of the Edison shale, as applied to a part of the Miocene section along the east side of the valley. Stratigraphically equivalent to the *Pulvinulinella gyroidinaformis* zone are also: the basal beds of the McLure shale along Reef Ridge in the Coalinga district; the lower part of the Modelo shale above the Topanga-Modelo unconformity near Mohn Spring in the Santa Monica Mountains; the basal beds of the Puente shale in the eastern part of San Jose Hills, west of the town of Pomona; and the upper division of the Altamira shale in the Palos Verdes Hills.

¹ R. D. Reed and J. S. Hollister. Structural Evolution of Southern California.—Bull. Amer. Assoc. Petr. Geol., vol. 20, 1936, p. 1580.

² Kleinpell, R. M. Difficulty of using Cartographic Terminology in Historical Geology.—L. c., vol. 18, 1934, p. 374.

PULVINULINELLA GYROIDINIFORMIS Cushman and Goudkoff, n. sp. (Pl. 1, figs. 1, 2)

Test fairly small, trochoid, plano-convex, dorsal side flattened and somewhat depressed, but slightly convex in the middle, ventral side strongly convex, flattened or somewhat depressed at the umbilical region, periphery broadly rounded, keeled at the dorsal margin; chambers distinct, 7-9 in number in the adult whorl, increasing very gradually in size as added, very slightly inflated on the ventral side; sutures distinct, distinctly limbate, dorsally strongly oblique and somewhat curved, ventrally very slightly depressed, radial, merging into the peripheral keel; wall smooth, finely perforate; aperture elongate, slightly ventral to and nearly parallel to the periphery, the inner end slightly expanded. Diameter 0.27-0.34 mm.; thickness 0.13-0.15 mm.

Holotype (Cushman Coll. No. 24290) from the Miocene shales exposed in the Shale Hills (Sec. 10, T. 27 S.; R. 18 E., Kings Co., California). Paratype from the so-called lower Fruitvale shale at a depth between 3,929 and 3,940 feet in well drilled in Sec. 36, T. 29 S.; R. 28 E., Edison District, Kern Co., California. The top of the so-called *Valvulineria californica* zone in the restricted sense was reached by the well at the depth of 4,355 feet.

193. CRETACEOUS SPECIES OF GÜMBELINA AND RELATED GENERA

By JOSEPH A. CUSHMAN

The species belonging to *Gümbelina* have a very wide range according to the literature. Many of the earlier described forms appeared as *Textularia*. Ehrenberg in particular figured and named numerous species, but the descriptions are inadequate, and his figures which are mostly from specimens mounted in balsam and viewed by transmitted light do not give sufficient characters in most cases to allow definite identification. I studied the Ehrenberg collection in Berlin, and found it very difficult with the balsam imbedded specimens to find adequate surface characters for specific identification and description. As a result, many of the specific names proposed by Ehrenberg must be allowed to lapse. These names are reviewed in the following pages, and

copies of the original figures are given that the evidence may be available to workers on this group.

It is possible that *Gümbelina* represents a pelagic form. It is very thin walled as a rule, develops globular chambers in the adult, and has a large aperture. It is often extremely abundant, especially where Globigerinidae and Globorotaliidae are also common. If it were a pelagic form, it would be supposed that its distribution would be very wide, and its distribution be less dependent on changes in conditions than for those species which live on the ocean bottom. A study of many thousands of specimens representing the Upper Cretaceous of Europe and America seems to show that the distributions are no wider than some other forms, and that vertical ranges are rather restricted in at least some of the species.

From *Gümbelina* in the Upper Cretaceous developed a number of specialized genera which mostly became extinct before the Tertiary. These have very definite ranges, and should make good index fossils.

Genus GÜMBELINA Egger, 1899

Genotype, *Textularia globulosa* Ehrenberg

Gümbelina EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 31.

Textularia (part) of authors (not DEFRANCE).

Test with the early chambers planispiral, at least in the microspheric form, later chambers biserial; wall calcareous, perforate; aperture large and open, arched, at base of inner margin of last-formed chamber. Cretaceous to Oligocene.

The early stages are planispiral in the microspheric form, linking this genus to *Heterohelix* Ehrenberg. Young specimens of the other genera derived from *Gümbelina*, especially of the microspheric form, may not go beyond the biserial stage, and are very easily confused with *Gümbelina*. As will be noted, some of the species are rather difficult to place generically unless large series of both microspheric and megalospheric forms are present.

A review of those named forms is given, and a copy of the original figures.

Textularia aciculata (?) Ehrenberg, Abhandl. k. preuss. Akad. Wiss. Berlin, 1838, p. 134, pl. IV, figs. ii, vii, xii, 8, (not *T. aciculata* d'Orbigny, 1826).

T. aspera Ehrenberg, l. c., p. 134, pl. IV, figs. iv, v, γ . (Pl. 1, figs. 3, 4.) Copies of the original figures of Ehrenberg are given. They are from Gravesend, England and Meudon, France. I have found no specimens from either locality that give a clue to what this species really is. The original description is "testula microscopica superficiei aspera, articulis globosis, forma longiore quam lata."

T. laevis Ehrenberg, l. c., p. 135, pl. IV, fig. ix, ζ . (Pl. 1, fig. 5.) Copies of the original figure of Ehrenberg from "Hamam Farium, Arabien" are given. The description is "testa microscopica, latiore quam longa, superficiei laevi, articulis globosis, ultimis subito maximus." Ehrenberg did not refer to this later.

T. dilatata Ehrenberg, l. c., p. 135, pl. IV, fig. ix, δ . (Pl. 1, fig. 6.) Copy of the original figure is given, from "Hamam Farium, Arabien." The description is "testula microscopica, superficiei laevi, fere aequae lata ac longa articulis globosis." The figure given in 1854 is very similar to *T. striata* Ehrenberg.

T. globulosa Ehrenberg, l. c., p. 135, pl. IV, fig. iv, β . (See later page.)

T. perforata Ehrenberg, l. c., p. 135, pl. IV, fig. xi, ϵ . (Pl. 1, fig. 7.) The original figure is copied here, and the description is as follows: "testula microscopica superficiei foraminibus parvis perforata, forma *T. dilatatae*." The locality given is "Caltanissetta." The figure and description hardly seem adequate for identification. The figure given in 1854 by Ehrenberg seems more probably a *Globigerina*.

T. spinosa Ehrenberg, l. c., p. 135. The description is "testula microscopica longiore quam lata, superficiei in articulorum latere spinulis singulis armata." The locality given is Rügen, but no figures are given, and it was not referred to later by Ehrenberg.

T. striata Ehrenberg, l. c., p. 135, pl. IV, figs. i, ii, iii, α . (See later page.)

In his work, "Mikrogeologie," 1854, Ehrenberg figured numerous forms, and gave them various names. A number of these are from American Cretaceous material. I examined these several years ago in Berlin, and it seemed rather hopeless to identify them with our American material. They are not always drawn in correct detail, but much more so than in the earlier volume already referred to above. For record, notes are given on these forms, and the originals are copied on our plate.

Textilaria globulosa Ehrenberg, var. *obtusa* Ehrenberg, Mikrogeologie, 1854, pl. XXIII, fig. 4. (Pl. 1, fig. 8.)

T. globulosa Ehrenberg, var. *amplior* Ehrenberg, l. c., fig. 5. (Pl. 1, fig. 9.)

T. globulosa Ehrenberg, var. *dilatata* Ehrenberg, l. c., fig. 6. (Pl. 1, fig. 10.)

These figures represent slightly broader forms than the typical, but without more details are not recognizable.

T. subtilis Ehrenberg, l. c., pl. XXIV, fig. 11 (Pl. 1, fig. 11); pl. XXX, fig. 8. The first figure may possibly be a *Gümbelina*, but the latter is probably a *Bolivina*.

T. inflata Ehrenberg, l. c., pl. XXIV, fig. 15 (Pl. 1, fig. 12); pl. XXV, i, A, fig. 10; pl. XXX, fig. 12. Without more details, this is unrecognizable.

T. sulcata Ehrenberg, l. c., pl. XXVII, fig. 4 (Pl. 1, fig. 13). This is probably the same as *Gümbelina striata* Ehrenberg. It is from Meudon, near Paris.

T. ampliata Ehrenberg, l. c., pl. XXVIII, fig. 8 (Pl. 1, fig. 14). Ehrenberg refers this to his *T. aspera* of 1838. It is from Gravesend, England. From our Gravesend material, this may be a slightly roughened specimen of *Gümbelina globulosa* (Ehrenberg).

T. leptotheca Ehrenberg, l. c., pl. XXVIII, fig. 11 (Pl. 1, fig. 15). From our Gravesend material, this seems to be a slender form of *Gümbelina globulosa* Ehrenberg. His other figures are probably a *Virgulina*.

T. pachyaulax Ehrenberg, l. c., pl. XXIX, figs. 21 *a*, *b* (Pl. 1, figs. 16, 17); pl. XXX, fig. 5 (Pl. 1, fig. 18). The types are from the chalk of the Islands of Moen and Rügen. Our material from the latter locality does not show this form which seems to be more coarsely ornamented than typical *Gümbelina striata* (Ehrenberg). He does not again refer to it.

T. americana Ehrenberg, l. c., Abhandl. K. Akad. Wiss. Berlin, 1841, p. 429; Mikrogeologie, 1854, pl. XXXII, i, figs. 4 *a*, 7 (Pl. 1, figs. 19, 20). The types are from "Missouri-Gebietes." The first figure given has peculiar angles to the chambers in the later portion, and may possibly be an early stage of a *Ventilabrella*. The second figure may represent a young stage. It is difficult to refer any of our material to this with any certainty, especially as the latter figure is very similar to the one Ehrenberg referred to his *T. striata* from the same locality.

T. missouriensis Ehrenberg, Mikrogeologie, 1854, pl. XXXII, fig. 5 (Pl. 1, fig. 21). This is very similar to the preceding, but the pores do not form as definite lines. The two are probably the same, but cannot be positively identified.

T. poroconus Ehrenberg, l. c., pl. XXXII, fig. 6 (Pl. 1, fig. 22). This is also from "Missouri," but does not show enough characters to make it recognizable.

T. euryconus Ehrenberg, l. c., pl. XXXII, fig. 9 (Pl. 1, fig. 23). Also from "Missouri," and may be a *Gümbelina*, but is unrecognizable.

T. gomphoconus Ehrenberg, l. c., pl. XXXII, fig. 10 (Pl. 1, fig. 24). Also from "Missouri," but unrecognizable.

Grammostomum tessera Ehrenberg, l. c., pl. XXXII, fig. 18 (Pl. 1, fig. 25). This form, also from "Missouri," has been identified with an American *Gümbelina*, but further study shows that this form of Ehrenberg is probably a *Bolivina*, and the American *Gümbelina* is given a new name.

Textilaria globifera Reuss, Sitz. K. Akad. Wiss. Wien, vol. XL, 1860, p. 232, pl. 13, figs. 7, 8 (Pl. 1, figs. 26, 27). This is from the Upper Cretaceous of Westphalia, and seems to be identical with Ehrenberg's *T. globulosa* although not the same as Reuss' species, *T. globulosa*, from the Pläner, so named in 1845-6.

The following seem to be valid species:

GUMBELINA GLOBULOSA (Ehrenberg) (Pl. 1, figs. 28-35)

Textilaria globulosa EHRENBURG, Abhandl. K. preuss. Akad. Wiss. Berlin, 1838, p. 135, pl. IV, fig. iv, β; Mikrogeologie, 1854, pl. XXI, fig. 87; etc.—ELEY, Geology in the Garden, 1859, pp. 194, 202, pl. 2, fig. 9; pl. 9, fig. 9.—FRANKE, Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 134, pl. 12, fig. 11.—CUSHMAN, Journ. Pal., vol. 1, 1928, p. 215, pl. 34, fig. 8.

Gümbelina globulosa EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 32, pl. 14, fig. 43.—CHAPMAN, Bull. Geol. Surv. W. Australia, No. 72, 1917, p. 14, pl. 2, fig. 17; New Zealand Geol. Surv., Pal. Bull. No. 11, 1926, p. 33, pl. 8, fig. 5.—CUSHMAN, Contr. Cushman Lab. Foramin. Res., vol. 3, 1927, p. 190.—CARMAN, Journ. Pal., vol. 3, 1929, p. 312, pl. 34, figs. 10-20 (?).—WHITE, l. c., p. 36, pl. 4, figs. 10 a, b.—CUSHMAN, Bull. 41, Tenn. Geol. Survey, 1931, p. 43, pl. 7, figs. 3-5; Contr. Cushman Lab. Foramin. Res., vol. 7, 1931, p. 39, pl. 5, figs. 7 a, b; Journ. Pal., vol. 6, 1932, p. 338; Bull. Geol. Soc. Amer., vol. 47, 1936, p. 418, pl. 1, figs. 8 a, b.—MORROW, Journ. Pal., vol. 8, 1934, p. 194, pl. 29, figs. 18 a, b (?).—GLAESSNER, Problems of Paleontology, vol. 1, 1936, p. 108, pl. 2, fig. 2.

Textilaria globifera REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 232, pl. 13, figs. 7, 8.—EGGER, Ber. nat. Ver. Passau, 1907, p. 18, pl. 5, fig.

4; Sitz. kön. bay. Akad. Wiss. München, 1909, p. 22, pl. 2, fig. 16; Ber. nat. Ver. Regensburg, 1910, p. 12, pl. 5, fig. 11.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 11, pl. 1, fig. 13.

Gümbelina globifera EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 33, pl. 14, figs. 35, 36, 53-55.—CHAPMAN, Bull. Geol. Surv. W. Australia, No. 72, 1917, p. 14, pl. 2, fig. 18; New Zealand Geol. Surv., Pal. Bull. No. 11, 1926, p. 33, pl. 8, fig. 4.—WHITE, Journ. Pal., vol. 3, 1929, p. 35, pl. 4, fig. 9.—LOETTERLE, Nebraska Geol. Survey, ser. 2, Bull. 12, 1937, p. 34, pl. 5, fig. 3 (?).

Gümbelina pupa WHITE (not REUSS), Journ. Pal., vol. 3, 1929, p. 38, pl. 4, fig. 11.

Test rapidly tapering, greatest breadth toward the apertural end, initial end subacute, $1\frac{1}{2}$ -2 times as long as broad, in side view with the chambers regularly enlarging to the greatest width at the last-formed chamber, periphery distinctly indented throughout; chambers inflated throughout, increasing in size rather more rapidly toward the apertural end, nearly spherical; sutures distinct, depressed throughout; wall smooth, finely perforate; aperture broad, low, with a slightly thickened rim above. Length 0.30-0.50 mm.; breadth 0.20-0.25 mm.; thickness 0.18-0.25 mm.

Ehrenberg figures this species from the Cretaceous of Gravesend, England, and from the Paris Basin. Two of our figured specimens are from Gravesend. The wall is smooth throughout, and the fine perforations show little or no tendency to form elongate lines. The periphery is lobulate throughout, usually even in the earliest portion.

There are numerous other references for this species which cannot be verified from original material. Reuss' *Textilaria globifera* seems to be a synonym of Ehrenberg's species, although his *T. globulosa* from Bohemia seems to be different from Ehrenberg's, and may be the same as *Gümbelina reussi*, n. sp., described later in this paper.

The species in Europe seems to occur mainly in the Senonian and Maestrichtian, and in America apparently ranges downward from the Kemp clay at the top of the Navarro to at least the middle part of the Taylor marl. It apparently developed from *G. reussi* which occurs in the lower part of the section and does not have the earlier chambers so globose. The references from the Niobrara and other chalks of the Kansas-Nebraska region are given here with some question. An examination of the original material may show them to be *G. reussi*.

GÜMBELINA STRIATA (Ehrenberg) (Pl. 1, figs. 34-40)

Textularia striata EHRENBURG, Abhandl. K. preuss. Akad. Wiss. Berlin, 1838, p. 135, pl. IV, figs. i, ii, iii, α ; Mikrogeologie, 1854, pl. 27, fig. 3; pl. 28, fig. 6; pl. 31, fig. 9; pl. 32, i, fig. 4 b; pl. 32, ii, figs. 11, 14.—CUSHMAN, Journ. Pal., vol. 1, 1928, pp. 215, 216, pl. 34, fig. 4 b; pl. 35, figs. 11, 14.

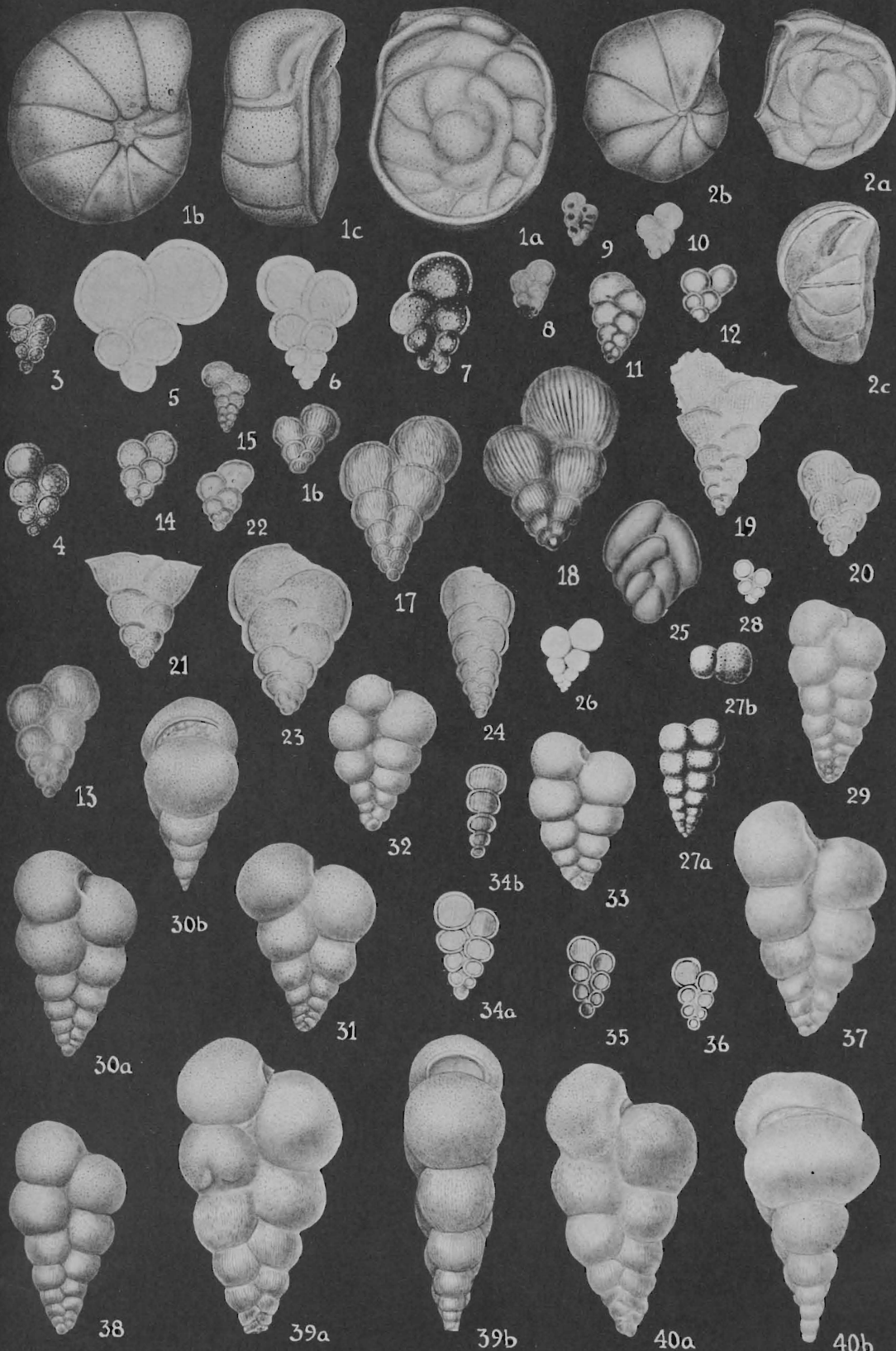
Gümbelina striata EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 33, pl. 14, figs. 37-39 (not 5-7, 10, 11).

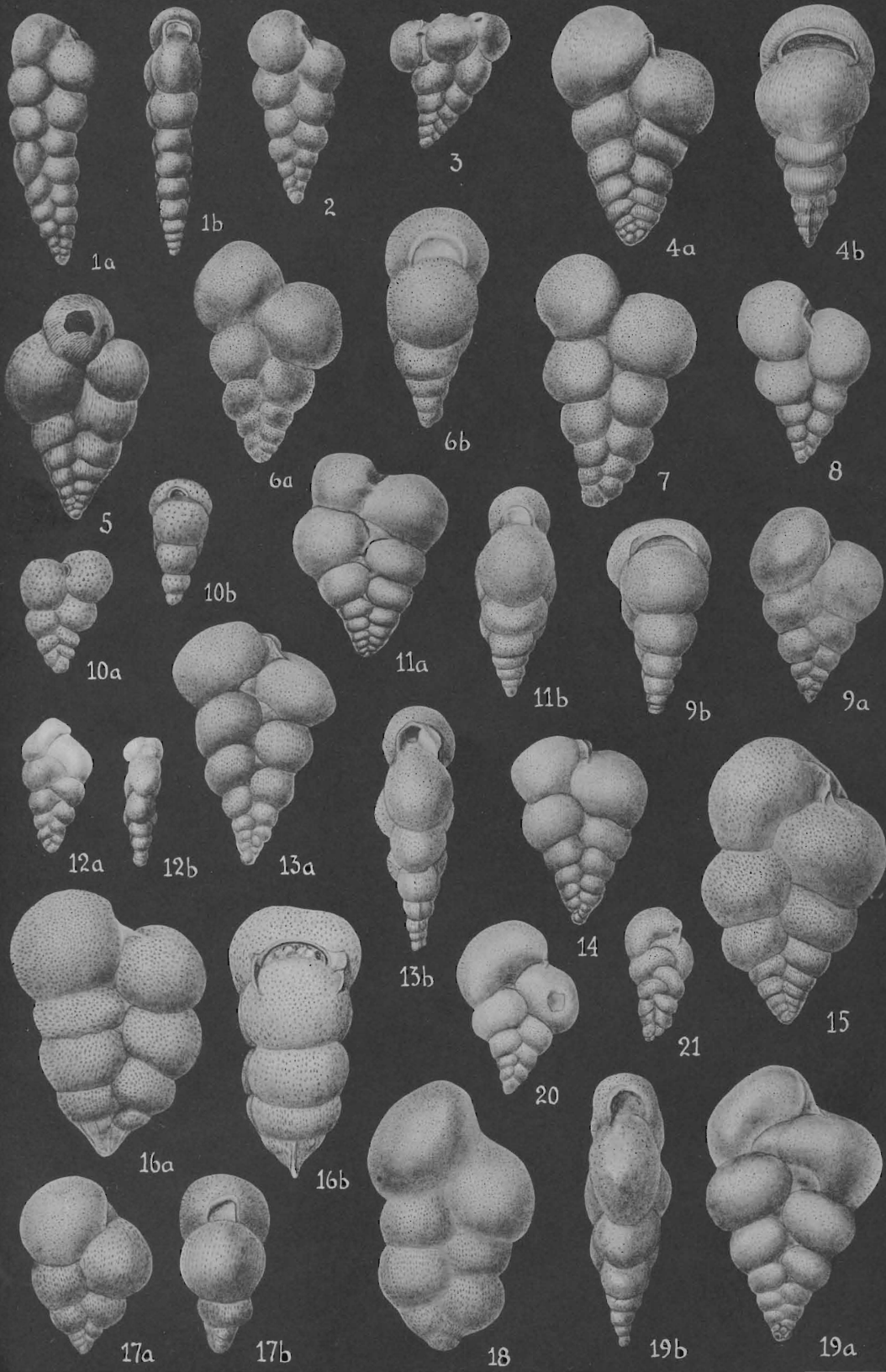
Test in the adult about twice as long as broad, tapering, the greatest breadth toward the apertural end where in the adult the increase in diameter becomes very gradual, periphery distinctly indented throughout; chambers inflated throughout, nearly spherical; sutures distinct, depressed throughout; wall in the earliest portion distinctly and finely longitudinally costate, in the later chambers becoming less clearly costate and represented by

EXPLANATION OF PLATE 1

FIGS.

- 1, 2. *Pulvinulinella gyroidinaformis* Cushman and Goudkoff, n. sp. $\times 115$. 1, Holotype. 2, Paratype. a, a, dorsal views; b, b, ventral views; c, c, peripheral views.
- 3-25. 3, 4, "*Textularia aspera* Ehrenberg." 5, "*T. laevis* Ehrenberg." 6, "*T. dilatata* Ehrenberg." 7, "*T. perforata* Ehrenberg." 8, "*T. globulosa*, var. *obtusa* Ehrenberg." 9, "*T. globulosa*, var. *amplior* Ehrenberg." 10, "*T. globulosa*, var. *dilatata* Ehrenberg." 11, "*T. subtilis* Ehrenberg." 12, "*T. inflata* Ehrenberg." 13, "*T. sulcata* Ehrenberg." 14, "*T. ampliata* Ehrenberg." 15, "*T. leptotheca* Ehrenberg." 16-18, "*T. pachyaulax* Ehrenberg." 19, 20, "*T. americana* Ehrenberg." 21, "*T. missouriensis* Ehrenberg." 22, "*T. proroconus* Ehrenberg." 23, "*T. euryconus* Ehrenberg." 24, "*T. gomphoconus* Ehrenberg." 25, "*Grammostomum tessera* Ehrenberg." (Figs. 3-25, After Ehrenberg.)
- 26, 27. "*Textularia globifera* Reuss." (After Reuss.)
28. "*T. globulosa* Ehrenberg." (After Ehrenberg.)
- 29-33. *Gümbelina globulosa* (Ehrenberg). $\times 90$. 29, Prairie Bluff chalk, Houston rd., 7.4 mi. N. by E. of Sparta, Miss. 30, 31, Chalk, Gravesend, England. 32, 33, Wolfe City sand, member of Taylor marl, 1 mi. out of Wolfe City on road to Pecan Gap, Texas.
- 34-36. "*Textularia striata* Ehrenberg." (After Ehrenberg.)
- 37-40. *Gümbelina striata* (Ehrenberg). $\times 90$. 37, Lower part of Taylor marl, North Flat Creek, 350 feet E. of U. S. Highway 81, about 5 mi. S. of Waco, Texas. 38, Brownstown marl, Paris-Clarkville highway, 1.85 mi. SE. of Bagwell, Texas. 39, 40, Upper Senonian, Granulaten Kalk, Gleidingen, near Hildesheim, Germany.





fine pits in longitudinal lines, and the final chambers in the adult usually smooth; aperture, a rather large opening at the inner margin at the base of the apertural face. Length 0.45-0.60 mm.; breadth 0.25-0.35 mm.; thickness 0.18-0.22 mm.

The localities given by Ehrenberg in his early paper are "Puszkary in Polen," "Danische Inseln," and "Rügen." Our material from the last locality does not show this form clearly, but figures are given from Upper Senonian material of Europe which show the surface characters distinctly. The original description is "testula microscopica superficiei longitudinaliter striata, articulis globosis, forma longiore quam lata."

There is a progressive lessening of the surface ornamentation as growth progresses from a finely costate early stage to smooth final chambers in the adult. Ehrenberg records it from various American and other localities in his 1854 work, but all are figured from specimens in balsam, and give little indication of the surface characters other than rather conventional fine longitudinal lines. In actual specimens in side view, these follow the general curved surface, and our figures attempt to show these changes that appear.

In America this species has been confused with *G. costulata*, n. sp., which is very distinct. *G. striata* may be distinguished from *G. globulosa* by its surface characters, and its somewhat longer proportions with a less flaring tendency in the adult.

EXPLANATION OF PLATE 2

FIGS.

- 1-3. *Gümbelina moremani* Cushman, n. sp. × 90. 1, Holotype. 2, 3, Paratypes.
- 4, 5. *G. globocarinata* Cushman, n. sp. × 90. 4, Holotype. 5, Paratype.
- 6-9. *G. reussi* Cushman, n. sp. × 90. 6, Holotype. 7, Paratype. 8, 9, Plänermergel, Luschitz, Bohemia.
10. *G. spinifera* Cushman. × 90. Holotype.
11. *G. lata* Egger. × 90. Cretaceous, Pattenauer, Bavaria, Germany.
12. *G. pulchra* Brotzen. × 90. Cretaceous, Eriksdal, Sweden.
- 13, 14. *G. planata* Cushman, n. sp. × 90. 13, Holotype. 14, Paratype.
- 15, 16. *G. punctulata* Cushman, n. sp. × 90. 15, Paratype. 16, Holotype.
- 17, 18. *G. ultimatimida* White. × 90. Velasco shale, near Velasco, Mexico.
- 19-21. *G. pseudotessera* Cushman, n. sp. × 115. 19, Holotype. 20, 21, Paratypes.

From drawings by Patricia G. Edwards.

In Europe, it occurs in the upper part of the Cretaceous, and in America it ranges from the Austin chalk up through the Taylor marl and the Neylandville, but is not found typically in the upper part of the Navarro.

GUMBELINA MOREMANI Cushman, n. sp. (Pl. 2, figs. 1-3)

Gümbelina globulosa MOREMAN (not EHRENBURG), Journ. Pal., vol. 1, No. 1, July, 1927, p. 99, pl. 16, fig. 10.

Gümbelina globifera CARMAN (not REUSS), I. c., vol. 3, 1929, p. 311, pl. 34, fig. 3.—MORROW, I. c., vol. 8, 1934, p. 194, pl. 29, figs. 15, 17.

Test elongate, $2\frac{1}{2}$ -3 times as long as broad, gradually tapering throughout, only slightly enlarging in the later portion, periphery distinctly indented throughout; chambers globular, often slightly irregular and occasionally with one developed at the side in the adult; sutures distinct and depressed throughout; wall smooth, finely perforate; aperture, a high, arched opening at the inner margin of the last-formed chamber, with a slight lip which may reach forward at the sides onto the previously formed chamber. Length 0.35-0.45 mm.; breadth 0.15-0.18 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 24370) from Cretaceous, lower part of Eagle Ford shale, S. bank of small stream, 100 yds. E. of highway, 2.1 mi. N. of Itasca, Hill Co., Texas.

This species differs from *G. globulosa* (Ehrenberg) in the larger number of chambers and more slender and less tapering test. It occurs in the Eagle Ford and equivalent formations in considerable numbers, and occasionally shows a tendency toward *Ventilabrella*.

GUMBELINA GLOBOCARINATA Cushman, n. sp. (Pl. 2, figs. 4, 5)

Test rapidly tapering from the subacute initial end to the greatest breadth formed by the last two chambers, early portion compressed and slightly carinate, periphery in the early portion entire, later distinctly indented; chambers of the early portion compressed, much broader than high, thence increasing gradually in relative height, last-formed pair much enlarged and inflated; sutures distinct, early ones slightly limbate, depressed strongly in the later portion; wall of the early portion finely costate longitudinally, later with longitudinal rows of fine pits; aperture, a large, arched opening at the inner margin of the chamber. Length 0.40-0.50 mm.; breadth 0.28-0.30 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 24372) from Taylor marl, upper

part, Milton rd., west-facing slope of a branch valley, 1 mi. W. of Deport, Lamar Co., Texas.

This species differs from *G. striata* (Ehrenberg) in the carinate and compressed early portion, and the very rapidly expanding last chambers.

The range of the species seems to be throughout the Taylor marl upward and into the Neylandville marl, but not above.

GUMBELINA REUSSI Cushman, n. sp. (Pl. 2, figs. 6-9)

Textularia globulosa REUSS (not EHRENBERG), Verstein. böhm. Kreide, 1845-46, pt. 1, p. 39, pl. 12, fig. 23(?).

Test about $1\frac{1}{2}$ times as long as broad, rapidly tapering, greatest breadth formed by the last pair of chambers, periphery of early part usually entire, later distinctly indented; chambers globular, and in the later portion distinctly set apart with a triangular, depressed area between; sutures distinctly depressed throughout; wall smooth, finely perforate, the earliest portion sometimes showing longitudinal rows of perforations; aperture high, semicircular, at the inner border of the chamber. Length 0.40-0.50 mm.; breadth 0.28-0.30 mm.; thickness 0.22-0.25 mm.

Holotype (Cushman Coll. No. 24374) from the lower part of the Austin chalk, ditch, W. side of Sherman-Dennison highway, 3 mi. N. of Sherman, Texas.

This species differs from *G. globulosa* Ehrenberg in the tendency for the early portion to have an entire periphery, and the chambers less overlapping and clearly set off from one another with a triangular indented area between. This species ranges from the lower part of the Austin into the lower part of the Taylor marl.

GUMBELINA SPINIFERA Cushman (Pl. 2, fig. 10)

Gumbelina spinifera CUSHMAN, Bull. 41, Tenn. Geol. Survey, 1931, p. 43, pl. 7, figs. 8 a, b; Special Publ. No. 5, Cushman Lab. Foram. Res., 1933, pl. 26, fig. 7.

Test slightly longer than broad, rapidly tapering, periphery indented throughout; chambers inflated, globular in the adult, in the early portion broader than high; sutures distinctly depressed; wall ornamented by short spines scattered over the whole surface; aperture small, semicircular, with a slight lip. Length 0.20-0.25 mm.; breadth 0.15 mm.; thickness 0.10 mm.

The types of this species are from the Selma chalk of Tennessee, and it has not been noted elsewhere in our material.

12 CONTRIBUTIONS FROM THE CUSHMAN LABORATORY

GUMBELINA LATA Egger (Pl. 2, fig. 11)

Gümbelina lata EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, pt. 1, 1899, p. 35, pl. 14, figs. 12, 13 (19?).

Test in the early portion slightly keeled, rapidly tapering, later portion decreasing in width and also in thickness, periphery of early portion entire, later indented; chambers of early portion broader than high, adult ones about as high as broad, with a small, depressed, triangular area between; sutures slightly depressed; wall finely to coarsely perforate, otherwise smooth; aperture, a rather high, arched opening with lateral flanges running onto the preceding chamber. Length 0.30-0.35 mm.; breadth 0.22-0.25 mm.; thickness 0.12-0.15 mm.

Egger described this species from the Upper Cretaceous of Bavaria. Our figured specimen is from Pattenaur, Bavaria, Germany, one of Egger's localities.

GUMBELINA PULCHRA Brotzen (Pl. 2, fig. 12)

Gümbelina pulchra BROTZEN, Sver. Geol. Under. Ser. C, No. 396, 1936, p. 121, pl. 9, figs. 2 a, b, 3 a, b.

Under this name Brotzen figures two forms, one of which is very irregularly spread out similar to *Ventilabrella*, the other normally biserial. A topotype from the Upper Cretaceous of Eriksdal, Sweden, kindly sent us by Dr. Brotzen, is figured on our plate. It is narrowly tapering, has the later chambers much lower than broad and the sutures curved, the apertural end of the final chamber contracted. It measures: length 0.25 mm.; breadth 0.12 mm.; thickness 0.08 mm.

This somewhat resembles the American species previously referred to *G. tessera* (Ehrenberg), but is now given a new name, *G. pseudotessera*, n. sp.

GUMBELINA PLANATA Cushman, n. sp. (Pl. 2, figs. 13, 14)

Test compressed, about $1\frac{1}{2}$ times as long as broad, rapidly tapering with the greatest breadth formed by the last pair of chambers, periphery slightly keeled in the early portion, in the remainder deeply indentate; chambers broader than high throughout, somewhat compressed, in the adult portion separated by depressed triangular areas; sutures distinctly depressed, somewhat curved; wall smooth, finely perforate, the perforations tending to be in longitudinal lines; aperture high, arched, with distinct, lateral flanges running out onto the preceding chamber.

Length 0.35-0.45 mm.; breadth 0.25-0.30 mm.; thickness 0.12-0.14 mm.

Holotype (Cushman Coll. No. 24376) from Taylor marl, Paris highway, 1.8 mi. E. of Deport, west-facing slope of Mustang Creek Valley, Red River Co., Texas.

This species differs from *G. striata* in the broader, more compressed chambers, slight keel in the early portion, and the smoother surface.

So far, the species has been found only in the lower part of the upper portion of the Taylor.

GUMBELINA PUNCTULATA Cushman, n. sp. (Pl. 2, figs. 15, 16)

Test broad and rounded, about $1\frac{1}{2}$ times as broad, initial portion rapidly tapering, later portion of nearly uniform width, periphery of early portion keeled, later indented; chambers of the early portion somewhat compressed, keeled, much broader than high, rapidly inflated in the adult where they are globular; sutures in the early portion slightly depressed and limbate, later strongly depressed; wall in the early portion slightly costate or with the fine perforations in vertical lines, in the adult thicker-walled with the surface rather coarsely punctate; aperture, a low, broad arch with a slight lip, the sides continuing in a flange onto the preceding chamber. Length 0.45-0.55 mm.; breadth 0.32-0.35 mm.; thickness 0.22-0.25 mm.

Holotype (Cushman Coll. No. 24378) from Taylor marl, Paris highway, 1.8 mi. E. of Deport, west-facing slope of Mustang Creek Valley, Red River Co., Texas.

This species differs from *G. striata* in the compressed and keeled early portion, very rapid expansion of the later chambers, rather uniform width in the adult, and the coarsely punctate surface in the adult. The range seems to be the upper part of the Taylor marl, including the Pecan Gap chalk and Wolfe City sand members, the Annona chalk, and also the Neylandville marl.

GUMBELINA ULTIMATUMIDA White (Pl. 2, figs. 17, 18)

Gümbelina ultimatumida WHITE, Journ. Pal., vol. 3, 1929, p. 39, pl. 4, fig. 13.—VOORWIJK, Proc. Roy. Acad. Amsterdam, vol. 40, No. 2, 1937, p. 7, pl. 1, figs. 5, 6.

Textularia pupa CUSHMAN (not REUSS), Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 584, pl. 15, figs. 5, 6.

Gümbelina pupa CUSHMAN (not REUSS), Journ. Pal., vol. 1, 1927, p. 157, pl. 27, figs. 6 a, b.

Test about $1\frac{1}{2}$ times as long as broad, early portion rapidly tapering, later portion with little increase in width, periphery slightly indented; chambers inflated throughout, strongly so in the adult; sutures depressed; wall in the early portion faintly striate, later with the perforations in lines, and smooth in the adult; aperture, a high arch with a slightly thickened border. Length 0.40-0.60 mm.; breadth 0.25-0.35 mm.; thickness 0.20-0.25 mm.

The types are from the Cretaceous, Mendez shale, in an arroyo in Chapacao, $5\frac{1}{2}$ kms. N. of Chijol Station, Mexico. Our figured specimens are from the Velasco shale of Mexico. From the series available, the type specimen is probably immature, and both young and adult forms are given on our plate.

Besides occurring in Mexico, the species occurs in the Upper Cretaceous of Trinidad, and has been recorded from Texas, but the records are not accompanied by figures.

GUMBELINA PSEUDOTESSERA Cushman, n. sp. (Pl. 2, figs. 19-21)

Gümbelina tessera CUSHMAN (not *Grammostomum tessera* EHRENBURG), Journ. Pal., vol. 6, 1932, p. 338, pl. 51, figs. 4, 5.—LOETTERLE, Nebraska Geol. Survey, Ser. 2, Bull. 12, 1937, p. 34, pl. 5, fig. 4.

Test compressed, $1\frac{1}{2}$ -2 times as long as broad, rapidly tapering with greatest breadth at the last pair of chambers, periphery indented throughout; chambers somewhat inflated, broader than high throughout, in the adult somewhat curved and broader; sutures depressed, somewhat curved in the last portion; wall smooth and polished, very finely perforate; aperture, a very high, arched opening with a slight lip and distinct flanges, but not extending far onto the preceding chamber. Length 0.25-0.50 mm.; breadth 0.20-0.30 mm.; thickness 0.08-0.12 mm.

Holotype (Cushman Coll. No. 24380) from Taylor marl, upper part, 4.9 mi. E. of Forney, on Forney-Terrell highway, Kaufman Co., Texas.

This species differs from *G. globulosa* in the compressed test, broader chambers, particularly in the last portion, and the somewhat curved sutures. The microspheric form is much broader than the megalospheric, and occasional specimens of the megalospheric form are very narrow.

A further study of the original figure given by Ehrenberg shows that his form is probably a *Bolivina*, or at least not a true *Gümbelina*.

G. pseudotessera apparently ranges through most of the Austin chalk and Taylor marl from our records.

GUMBELINA GLABRANS Cushman, n. sp. (Pl. 3, figs. 1, 2)

Gümbelina tessera CUSHMAN (not *Grammostomum tessera* EHRENBERG),
Bull. Geol. Soc. Amer., vol. 47, 1936, p. 418, pl. 1, figs. 9 a, b.

Test nearly twice as long as broad, tapering throughout, much compressed, early portion with the periphery entire and slightly keeled, later moderately indented; chambers in the microspheric form mostly slightly broader than high, in the megalospheric form with the later chambers with the height often as great or greater than the breadth, later ones more inflated but somewhat compressed throughout; sutures in the early portion slightly limbate, in the adult depressed; wall in the early portion coarsely punctulate, somewhat roughened, in the adult smooth and polished; aperture higher than broad, arched, with a slight lip and flanges at the sides extending onto the preceding chamber. Length 0.40 mm.; breadth 0.20-0.25 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 24382) from Cretaceous, Navarro group, base of Kemp clay, Branch of Mustang Creek, 1 mi. WSW. of Noack, 900 ft. downstream from road, 0.2 mi. SW. of Christ Evangelical Lutheran Church, Williamson Co., Texas.

This species differs from *G. globulosa* in the much compressed test, early portion keeled and roughened, and the later portion smooth and polished. It seems to be confined to rocks of Navarro age, occurring in the Corsicana marl, Kemp clay, and Prairie Bluff chalk. The specimens from the Georges Bank Canyon in the reference above also belong here.

GUMBELINA PLUMMERAE Loetterle (Pl. 3, figs. 3-5)

Gümbelina plummerae LOETTERLE, Nebraska Geol. Survey, Ser. 2, Bull. 12, 1937, p. 33, pl. 5, figs. 1, 2.

Textularia globulosa CARSEY (not EHRENBERG), Univ. Texas Bull. 2612, 1926, p. 25, pl. 5, fig. 2.

Test comparatively large and stout, rapidly tapering in the early portion, in the adult much more gradually tapering or even contracted, thickness often greater than the breadth, periphery of the early portion slightly keeled, later deeply indented; chambers of the later portion strongly inflated, occasionally with one or more irregularly placed chambers at the upper end tending toward *Ventilabrella*; sutures depressed, somewhat curved in the

later portion; wall of the early portion distinctly costate becoming less marked in the later chambers; aperture, a low, broad arch with a slight lip. Length 0.50-0.65 mm.; breadth 0.30-0.40 mm.; thickness 0.40-0.45 mm.

From the original description of this species, it seems that it is a widely distributed one not only in the Nebraska-Kansas region, but in the Gulf Coastal Plain region as well. It has occurred at many localities in our material ranging from the Austin chalk upward through the Taylor marl and into the Neylandville marl. In the upper part of the Navarro it is replaced by *Ventilabrella carseyae* Plummer which is evidently derived from it.

GUMBELINA SEMICOSTATA Cushman, n. sp. (Pl. 3, fig. 6)

Test about $1\frac{1}{2}$ times as long as broad, compressed, gradually tapering, less rapidly in the later portion, early portion slightly keeled, later portion with the periphery slightly indentate, initial end acute; chambers with the faces flattened but broadly rounded at the periphery, broader than high throughout; sutures broadly limbate, slightly if at all depressed, curved; wall in the middle and inner portions smooth, toward the periphery with several strongly curved costae; aperture, a rounded, arched opening with a thickened, rounded lip. Length 0.35 mm.; breadth 0.20 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 24386) from the lower beds of the upper part of the Taylor marl, road cut, E. bank, near crest of hill, 14.4 mi. S. of Paris, 0.9 mi. N. of Lake City, Delta Co., Texas.

This species differs from *G. striata* in the strongly limbate costae, well developed, curved costae at the outer side of the chambers and compressed test. It is one of the most striking species of the genus, and its range seems to be confined to the upper part of the Taylor marl. It should be an excellent index fossil for this part of the section.

GUMBELINA COSTULATA Cushman, n. sp. (Pl. 3, figs. 7-9)

Test $1\frac{1}{2}$ -2 times as long as broad, rather rapidly tapering, initial end often acute with a slight point, somewhat compressed, earlier portion with the periphery slightly keeled, later portion slightly indented; chambers slightly inflated, mostly broader than high, last ones with the inner portion reduced in height; sutures

in the early portion slightly limbate and little if at all depressed, later depressed and slightly curved; wall ornamented throughout with fine longitudinal costae, becoming somewhat curved and nearly parallel to the periphery in the later part; aperture semi-circular, with a slightly thickened lip. Length 0.25-0.30 mm.; breadth 0.15-0.20 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 24387) from lower beds of the upper part of the Taylor marl, gully N. of road W. of iron bridge over branch of Kickapoo Creek, 1.9 mi. NW. of Annona, Red River Co., Texas.

This species differs from *G. striata* in the smaller size, compressed test, lower and broader chambers and distinctly costate surface throughout. It occurs in greatest numbers in the middle and upper portions of the Taylor marl and its equivalents, but also continued on through the Navarro where it evidently gave rise to the somewhat larger and more coarsely ornamented *G. excolata*.

GÜMBELINA EXCOLATA Cushman (Pl. 3, fig. 11)

Gümbelina excolata CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 20, pl. 2, fig. 9; Journ. Pal., vol. 1, 1927, p. 157, pl. 28, fig. 13.—WHITE, l. c., vol. 3, 1929, p. 34, pl. 4, fig. 7.—PLUMMER, Univ. Texas Bull. 3101, 1931, p. 176, pl. 8, fig. 10.

Textularia costata CARSEY, l. c., 2612, 1926, p. 26, pl. 1, fig. 4.

Test about $1\frac{1}{2}$ times as long as broad, tapering, in the later portion increasing only slightly in breadth, somewhat compressed, becoming more so in the last chambers, early portion with the periphery entire, later indented; chambers broader than high in the early portion, becoming somewhat higher in the later portion, the apertural end reduced in height; sutures of the early portion slightly limbate, later slightly depressed; wall ornamented with very coarse costae nearly parallel to the periphery; aperture semicircular, with a slight lip. Length 0.40-0.50 mm.; breadth 0.25-0.30 mm.; thickness 0.15-0.18 mm.

The types of this species are from Cretaceous shales, E. bank of Tamuin River, 5 kms. SE. of Guerrero, San Luis Potosi, Mexico. It is common in the Papagallos and particularly the Mendez shale of Mexico. In the Gulf Coastal Plain region it occurs in the Corsicana, Kemp, and Arkadelphia formations of Navarro age. It is a larger and much more coarsely ornamented species than *G. costulata*, and was probably developed from that species.

GÜMBELINA CARINATA Cushman, n. sp. (Pl. 3, fig. 10)

Test only slightly longer than broad, much compressed, early portion rapidly tapering, later with the sides nearly parallel, all but the latest chambers keeled; chambers broader than high, increasing somewhat in relative height in the last chambers, only slightly inflated; sutures of the early portion slightly limbate, later ones slightly depressed; wall in the early portion slightly costate, later smooth, finely perforate; aperture low, arched. Length 0.20-0.22 mm.; breadth 0.15-0.18 mm.; thickness 0.06-0.08 mm.

Holotype (Cushman Coll. No. 24390) from lower part of Taylor marl, ditch SE. of Commerce-Paris highway, 6 mi. S. of T. & P. R. R. station in Paris, Lamar Co., Texas.

This species differs from *G. striata* in the smaller, much compressed test, which is strongly carinate. It occurs mostly in the lower part of the Taylor marl, but specimens occur rarely in the Annona chalk and Wolfe City sand member of the Taylor. It is evidently the ancestral form of some of those species with compressed and carinate early stages. It was at first thought possible the young of some of the other species, but seems to be distinct.

GÜMBELINA PAUCISTRIATA Albritton (Pl. 3, figs. 12, 13)

Gümbelina paucistriata ALBRITTON, Journ. Pal., vol. 11, 1937, p. 22, pl. 4, figs. 8-10.

"Test in microspheric form with earliest chambers planispirally coiled, later chambers biserial; in megalospheric form apparently biserial from beginning, chambers globose, as a rule increasing regularly in size as added; sutures depressed, distinct; wall with fine longitudinal striae discontinuous at the sutures, in some specimens the striations are obscure, in others strength of ribbing decreases with increasing size of test; aperture moderately large, a crescentic opening at the inner margin of the final chamber. Height 0.31 mm.; breadth 0.20 mm.; thickness 0.11 mm."

The types are from the Lower Cretaceous, basal sandstone and conglomerate member of the Torcer formation of Adkins, V-Canyon, Malone Mts., Texas.

This is apparently the ancestral form of the Upper Cretaceous species, *G. striata* (Ehrenberg).

Genus GÜMBELITRIA Cushman, 1933

Genotype, *Gümbelitria cretacea* Cushman*Gümbelitria* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 9, 1933, p. 37; Special Publ. No. 4, 1933, p. 209.

Test similar to *Gümbelina*, but triserial; wall calcareous, finely perforate; aperture large, semicircular, at the inner edge of the last-formed chamber.—Upper Cretaceous, Recent.

GÜMBELITRIA CRETACEA Cushman (Pl. 3, fig. 14)

Gümbelitria cretacea CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 9, 1933, p. 37, pl. 4, figs. 12 *a, b*; Special Publ. No. 4, 1933, pl. 21, figs. 3*a, b*; Special Publ. No. 5, 1933, pl. 26, fig. 9; Bull. Soc. Geol. Amer., vol. 47, 1936, p. 418, pl. 1, figs. 12 *a, b*.

Test small, triserial; chambers globular, nearly spherical, increasing rather rapidly in size as added; sutures much depressed; wall smooth, finely to rather coarsely perforate; aperture large, semicircular or semi-elliptical at the inner margin of the last-formed chamber. Length 0.18-0.25 mm.; breadth 0.15-0.20 mm.

This species is a characteristic one of rocks of Navarro age above the Nacatoch sand, widely distributed in the Corsicana marl, Kemp clay, Arkadelphia marl, and Prairie Bluff chalk. It is usually conspicuously perforate and rather widely flaring. A somewhat smoother, more finely perforate form occurs rarely in the upper part of the Taylor marl, but not in sufficient quantities in our material to give its full characters. It may be the same. Also in the Austin chalk, a similar triserial form occurs sparingly, which it has not been possible to separate from the later Cretaceous form.

Genus RECTOGÜMBELINA Cushman, 1932

Genotype, *Rectogümbelina cretacea* Cushman*Rectogümbelina* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 6; Special Publ. No. 4, 1933, p. 209.

Test with early portion similar to *Gümbelina*, later chambers uniserial, rectilinear, subglobular; wall calcareous, finely perforate; aperture in the early stages like that of *Gümbelina*, in the adult terminal, rounded, with a distinct neck.—Upper Cretaceous, America and Europe

This genus is directly derived from *Gümbelina* by the addition of the uniserial stage. From the material at hand, it is evident

that there are other species than those described here but more specimens are needed for full details of these species. The species are evidently specialized and short lived, and should make good index fossils.

RECTOGÜMBELINA CRETACEA Cushman (Pl. 3, figs. 15, 16)

Rectogümbelina cretacea CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 6, pl. 1, figs. 11, 12; Special Publ. No. 4, 1933, pl. 21, fig. 4; Special Publ. No. 5, 1933, pl. 26, fig. 11.

Test with early portion biserial as in *Gümbelina*, adult uniserial; chambers distinct, in the biserial portion broader than high, increasing rapidly in size and height as added, uniserial portion with two or three chambers, subglobular or slightly pyriform, slightly overlapping, apertural end somewhat extended with a short neck; sutures distinct, depressed; wall smooth, thin, very finely perforate; aperture circular at the end of the tubular neck. Length 0.25-0.35 mm.; breadth 0.08-0.10 mm.; thickness 0.05-0.07 mm.

The types of this species are from Arkadelphia marl, 5½ mi. NE. of Hope, Hempstead Co., Arkansas. This is close to the Cretaceous-Eocene contact, but other species seem to indicate its Cretaceous age. A species very close to it occurs rarely in material from the uppermost part of the Taylor marl.

RECTOGÜMBELINA TEXANA Cushman (Pl. 3, figs. 17-19)

Rectogümbelina texana CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 6, pl. 1, figs. 8-10; Special Publ. No. 5, 1933, pl. 26, fig. 10.

Test very elongate, slightly tapering, first 3-4 chambers biserial, similar to *Gümbelina*, later and larger portion uniserial, rectilinear; chambers globular, latest ones somewhat pyriform, slightly overlapping; sutures distinct, depressed; wall thin, finely perforate, surface roughened, slightly spinose; aperture rounded, at the end of a tubular neck. Length 0.25-0.30 mm.; diameter 0.06-0.07 mm.

This species is a rather rare one, but occurs from the upper part of the Eagle Ford to the middle part of the Austin chalk. The biserial portion is very restricted, especially when compared with the following species.

RECTOGUMBELINA HISPIDULA Cushman, n. sp. (Pl. 3, figs. 20-22)

Test elongate, slightly tapering, biserial for most of the length, latest portion uniserial; chambers inflated, earliest ones biserial, gradually becoming more loosely so, and last-formed ones rectilinear and nearly globular or slightly pyriform; sutures depressed; wall finely hispid throughout; aperture rounded, at the end of a short neck which is usually excentrically placed. Length 0.25-0.30 mm.; diameter 0.08-0.10 mm.

Holotype (Cushman Coll. No. 24401) from middle portion of Austin chalk, road cut, N. side of W. Dallas pike, 5.3 mi. NE. of Austin-Eagle Ford contact at Chalk Hill, Texas.

This species differs from *R. texana* in the much longer, biserial stage and loosely biserial characters in the adult. It occurs at several stations in the lower and middle portions of the Austin chalk. In the loosely biserial character it resembles the figures given of *Tubitextularia* from the Cretaceous of Bohemia.

Genus PSEUDOTEXTULARIA Rzehak, 1886

Genotype, *Pseudotextularia varians* Rzehak

Pseudotextularia RZEHAK, Ver. Nat. Ver. Brünn, vol. 24, 1885 (1886), Sitz., p. 8.—CUSHMAN, Journ. Wash. Acad. Sci., vol. 15, 1925, p. 133; Journ. Pal., vol. 1, 1927, p. 157; Contr. Cushman Lab. Foram. Res., vol 3, 1927, p. 59; Special Publ. No. 1, 1928, p. 231.—WHITE, Journ. Pal., vol. 3, 1929, p. 40.—CUSHMAN, Special Publ. No. 4, 1933, p. 210.

Gümbelina (part) of authors.

Test with early chambers as in *Gümbelina*, and nearly all chambers in the microspheric form biserial, adult with a series of globular chambers arranged in a more or less spiral manner about the periphery of the upper portion of the test.—Upper Cretaceous, Europe and America.

There is a great variation in the relative time of taking on the later chambers in the microspheric and megalospheric forms, the microspheric form sometimes failing entirely to develop the later spirally arranged chambers.

PSEUDOTEXTULARIA VARIANS Rzehak (Pl. 4, figs. 1-4)

Pseudotextularia varians RZEHAK, Ann. k. k. Nat. Hofmuseums, vol. 10, pt. 2, 1895, p. 217, pl. 7, figs. 1-3.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 17, pl. 2, figs. 4 a, b; Journ. Pal., vol. 1, 1927, p. 157, pl. 27, figs. 2 a, b.—WHITE, l. c., vol. 3, 1929, p. 40; pl. 4, figs. 15 a, b.—VOORWIJK, Proc. Roy. Acad. Amsterdam, vol. 40, No. 2, 1937, p. 7, pl. 1, figs. 14, 15.

P. elegans RZEHAK, var. *varians* GLAESSNER, Problems of Paleontology, vol. 1, 1936, p. 101, pl. 1, figs. 3-5, text fig. 1 c.

Gümbelina fruticosa EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 35, pl. 14, figs. 8, 9.

Test comparatively large, in the early stages biserial and in the microspheric form almost entirely so, with a spiral series of globular chambers about the upper margin, the central area somewhat depressed; sutures distinct except in the early portion; wall longitudinally costate, later portion irregularly punctate. Length up to 1.5 mm.; breadth about 1 mm.; thickness 0.40-1.00 mm.

This species is often abundant in the Mendez shale of Mexico, and fairly common in the uppermost Cretaceous of the Upper Bavarian region of Europe. It varies greatly in the size and number of the later spiral chambers, and White gives varietal names, var. *mendezensis* and var. *textulariformis* to two of these variations. The former is somewhat compressed, and the latter shows the small chambers which develop in the microspheric form of the species both in America and Europe. Rare specimens occur in the Kemp clay, and the species has been recorded without figures from various localities, but it is to be suspected that they are really young stages of *Ventilabrella eggeri* or *Gümbelina plummerae* from their stratigraphic position.

Genus PLANOGLOBULINA Cushman, 1927

Genotype, *Gümbelina acervulinoides* Egger

Planoglobulina CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 4, 1927, p. 77; vol. 3, pt. 1, 1927, p. 61; Journ. Pal., vol. 1, 1927, p. 157; Special Publ. No. 1, Cushman Lab. Foram. Res., 1928, p. 231.—WHITE, Journ. Pal., vol. 3, 1929, p. 33.—CUSHMAN, Special Publ. No. 4, Cushman Lab. Foram. Res., 1933, p. 212.

Test in the early stages similar to *Pseudotextularia*, later chambers tending to be added in a single plane, and somewhat spreading.—Upper Cretaceous, Europe and America.

This genus seems to be directly derived from *Pseudotextularia* by the addition of the chambers in a single plane. In the adult, it is similar to *Ventilabrella*, but that genus develops directly from *Gümbelina* with no intermediate stages. It is most common in the Upper Cretaceous of Mexico and Europe, but at least one other species occurs in the Taylor marl.

PLANOGLOBULINA ACERVULINOIDES (Egger) (Pl. 4, figs. 5-8)

Gümbelina acervulinoides EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 36, pl. 14, figs. 17, 18, 20-22.

Pseudotextularia acervulinoides CUSHMAN, Journ. Wash. Acad. Sci., vol. 15, 1926, p. 134; Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 17.

Planoglobulina acervulinoides CUSHMAN, l. c., vol. 3, 1927, pl. 13, fig. 5; Journ. Pal., vol. 1, 1927, p. 158, pl. 27, fig. 3; Special Publ. No. 1, Cushman Lab. Foram. Res., 1928, pl. 33, figs. 8, 9; pl. 34, fig. 5.—WHITE, Journ. Pal., vol. 3, 1929, p. 33, pl. 4, fig. 6.—CUSHMAN, Special Publ. No. 4, Cushman Lab. Foram. Res., 1933, pl. 21, fig. 8; Special Publ. No. 5, 1933, pl. 26, fig. 17.—JEDLITSCHKA, Mitth. nat. Ver. Troppau, C. S. R., 1935, pl., figs. 15, 16.—VOORWIJK, Proc. Roy. Acad. Amsterdam, vol. 40, No. 2, 1937, p. 8, pl. 1, fig. 19.

Test much compressed, early stages similar to *Pseudotextularia*, later with the subglobular chambers spread out in one plane; sutures fairly distinct, depressed; wall longitudinally costate. Length up to 0.75 mm.; breadth 0.75 mm.; thickness 0.10-0.15 mm.

This species first described from the Upper Cretaceous of the Bavarian Alps where it is common, occurs in America, particularly in the Mendez shale of Mexico where it is also common. Specimens apparently identical occur in the Ripley formation, at Old Canton Landing, Alabama River, Ala., showing all stages in development and much variation. Some of these are shown in our plate.

PLANOGLOBULINA TAYLORANA Cushman, n. sp. (Pl. 4, figs. 9, 10)

Test short and broad, early portion biserial, later with the chambers arranged about a terminal depression, and last portion having the chambers in one plane; chambers globular throughout; sutures slightly depressed; wall coarsely perforate. Length up to 0.60 mm.; breadth 0.50-0.55 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 24403) from basal Taylor marl, Dallas road, 1.5 mi. E. of Garland, Dallas Co., Texas.

This species differs from *P. acervulinoides* in the fewer chambers and lack of surface ornamentation. It was fairly common at the type locality, but has not yet been found elsewhere in our material.

Genus VENTILABRELLA Cushman, 1928

Genotype, *Ventilabrella eggeri* Cushman

Ventilabrella CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 2; Special Publ. No. 1, 1928, p. 231; Special Publ. No. 4, 1933, p. 212.

Gümbelina (part) of authors.

Test in the early stages as in *Gümbelina*, in the adult with chambers alternating and spreading out fan-shaped in a single plane; wall calcareous, finely or coarsely perforate; aperture in biserial stage single, in adult chambers one aperture at each side near the base of the median line.—Upper Cretaceous, Europe and America.

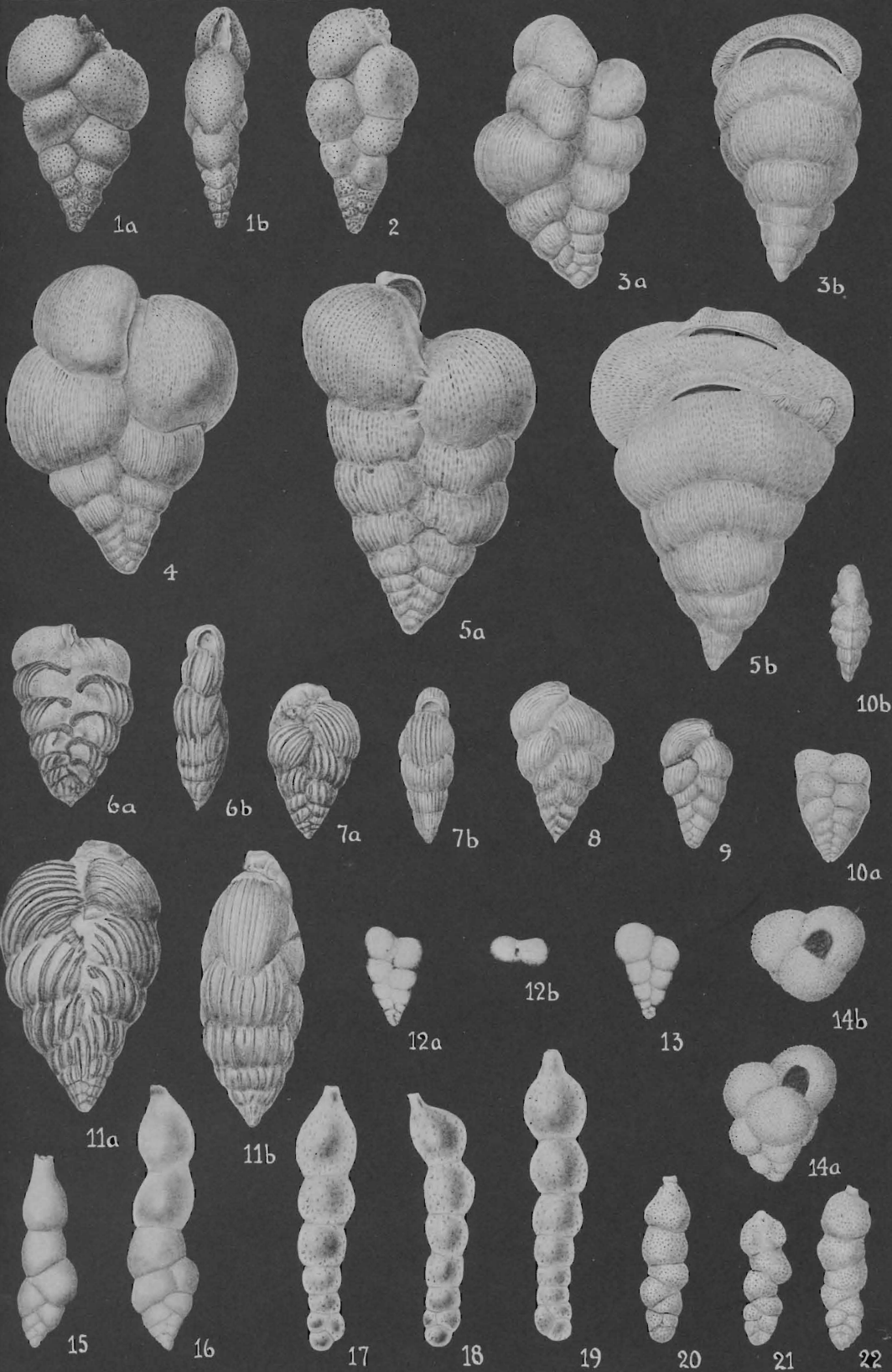
The species of this genus show all stages in the development from *Gümbelina*. The microspheric form is usually retarded, and often does not develop beyond the biserial stage, while the megalospheric form adopts the *Ventilabrella* character at various stages. The series therefore make a rather bewildering array of forms which really must be in considerable abundance in order to show the full range of the species.

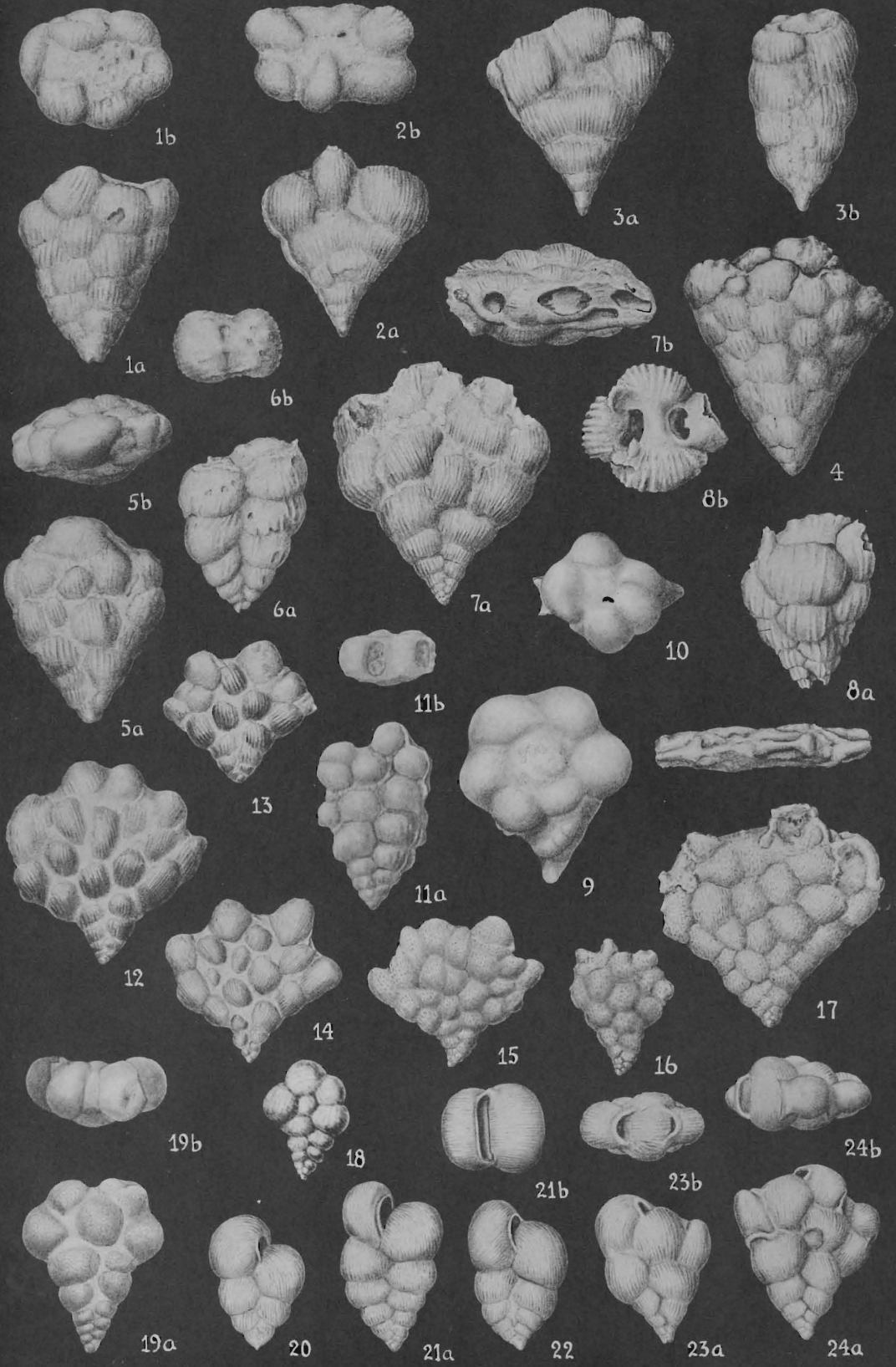
EXPLANATION OF PLATE 3

FIGS.

- 1, 2. *Gümbelina glabrans* Cushman, n. sp. × 90. 1, Holotype. 2, Paratype.
- 3-5. *G. plummerae* Loetterle. × 115. Upper part of Taylor marl, road cut, 0.9 mi. N. of Lake City, Delta Co., Texas.
6. *G. semicostata* Cushman, n. sp. × 90. Holotype.
- 7-9. *G. costulata* Cushman, n. sp. × 90. 7, Holotype. 8, 9, Paratypes.
10. *G. carinata* Cushman, n. sp. × 90. Holotype.
11. *G. excolata* Cushman. × 90. Navarro group, Corsicana marl, Mexia highway, at forks of Wortham road, 2.8 mi. ESE. of Cooledge, Limestone Co., Texas.
- 12, 13. *G. paucistriata* Albritton. × 45. (After Albritton.)
14. *Gümbelitra cretacea* Cushman. × 115. Holotype.
- 15, 16. *Rectogümbelina cretacea* Cushman. × 135. 15, Paratype. 16, Holotype.
- 17-19. *R. texana* Cushman. × 150. 17, 18, Paratypes. 19, Holotype.
- 20-22. *R. hispidula* Cushman, n. sp. × 90. 20, Holotype. 21, 22, Paratypes.

From drawings by Patricia G. Edwards.





VENTILABRELLA EGGERI Cushman (Pl. 4, figs. 12-14)

Ventilabrella eggeri CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, pl. 1, figs. 10-12; Special Publ. No. 5, 1933, pl. 26, figs. 14, 15.

Gümbelina acervulinoides EGGER (part), Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 36, pl. 14, fig. 20.

Test in the early stages biserial, adult rhomboid or fan-shaped, compressed; chambers normally in one plane, distinct, later ones globular; sutures distinct, depressed, often somewhat limbate; wall ornamented with longitudinal costae, especially heavy on the biserial portion; aperture in the early stages, as in *Gümbelina*, later with an aperture at each side near the base. Length 0.45-0.55 mm.; breadth 0.45-0.55 mm.; thickness 0.10 mm.

The species is apparently found in the region of upper Bavaria in some numbers, as shown by our material. It occurs abundantly in the Texas Cretaceous, particularly in the lower part of the Taylor marl, but also found in the upper part of the Austin chalk.

EXPLANATION OF PLATE 4

FIGS.

- 1-4. *Pseudotextularia varians* Rzehak. $\times 55$. Cretaceous, Mendez shale, Mexico. Showing various stages in development.
- 5-8. *Planoglobulina acervulinoides* (Egger). 5, $\times 55$. Mendez shale, Mexico. 6-8, $\times 70$. Ripley formation, Old Canton Landing, Alabama River, Ala. Showing various stages in development.
- 9, 10. *P. taylorana* Cushman, n. sp. $\times 90$. 9, Holotype. 10, Paratype.
11. *Ventilabrella ornatissima* Cushman and Church. $\times 60$. (After Cushman and Church.) Cretaceous, California.
- 12-14. *V. eggeri* Cushman. 12, $\times 55$. Lower part of Taylor marl. Bluff on Walnut Creek, 1½ mi. below Sprinkle road crossing, Travis Co., Texas. 13, 14, $\times 45$. Lower part of Taylor marl, Chilton rd., 10 mi. SSE. of Waco, Texas.
- 15-17. *V. eggeri* Cushman, var. *glabrata* Cushman, n. var. $\times 55$. 15, 16, Paratypes. 17, Holotype.
18. *V. decurrens* (Chapman). $\times 65$. (After Chapman.) Chalk, Taplow, England.
19. *V. austinana* Cushman, n. sp. $\times 55$. Holotype.
- 20-24. *V. carseyae* Plummer. $\times 55$. Arkadelphia marl, 7 mi. N. by W. of Hope, Hempstead Co., Ark. Showing various stages in development.

VENTILABRELLA EGGERI Cushman, var. GLABRATA Cushman, n. var. (Pl. 4, figs. 15-17)

Variety differing from the typical in the ornamentation of the surface which is slightly costate in the early stages, but in the adult smooth, with the perforations sometimes appearing in a linear series.

Holotype of variety (Cushman Coll. No. 24406) from upper part of Taylor marl, clay pit at Palmer, Ellis Co., Texas.

This variety replaces the more typical, highly ornamented form in the upper part of the Taylor marl, possibly extending into the basal Navarro.

VENTILABRELLA AUSTINANA Cushman, n. sp. (Pl. 4, fig. 19)

Ventilabrella eggeri CARMAN (not CUSHMAN), Journ. Pal., vol. 3, 1929, p. 314, pl. 34, fig. 7.—LOETTERLE, Nebraska Geol. Survey, Ser. 2, Bull. 12, 1937, p. 35, pl. 5, fig. 5.

Test with a large series of biserial chambers and but few expanded chambers in the adult, typically of but two rows, compressed; chambers globular in the later portion, uniformly increasing in size; sutures slightly depressed; wall smooth, punctate. Length 0.45-0.55 mm.; breadth 0.45-0.50 mm.; thickness 0.15-0.20 mm.

Holotype (Cushman Coll. No. 24409) from the middle portion of the Gober chalk of the Austin-Randolph rd., 4 mi. N. of Leonard, Fannin Co., Texas.

The species differs from *V. eggeri* in the fewer and larger adult chambers and smooth surface without costae. The species occurs in the middle and upper portions of the Austin chalk, and evidently in the Niobrara chalk of Nebraska and Kansas.

VENTILABRELLA CARSEYAE Plummer (Pl. 4, figs. 20-24)

Ventilabrella carseyae PLUMMER, Univ. Texas Bull. 3101, 1931, p. 178, pl. 9, figs. 7-9, 10.—SANDIDGE, Amer. Midland Nat., vol. 13, 1932, p. 362, pl. 31, fig. 29.—CUSHMAN, Special Publ. No. 4, Cushman Lab. Foram. Res., 1933, pl. 21, figs. 6 a, b.

V. plummerae SANDIDGE, Amer. Midland Nat., vol. 13, 1932, p. 195, pl. 19, figs. 5, 6.

Pseudotextularia a, d, PLUMMER, Univ. Texas Bull. 2644, 1926 (1927), p. 172, pl. 2, figs. 1 a, b, 4 a, b.

Test mostly biserial, especially in the microspheric form, in some specimens showing three or more chambers in a horizontal series in the later stages; chambers inflated, rapidly increasing in

size as added; sutures distinct, strongly depressed; wall thin, longitudinally costate; aperture large, low, and broad, on the inner basal margin, with a slight lip, and with a supplementary opening on the outer basal margin in the chamber last preceding the expanded portion in the adult. Length 0.45-0.55 mm.; breadth 0.30-0.45 mm.; thickness 0.20-0.25 mm.

This species is especially abundant and characteristic of rocks of Navarro age above the Nacatoch sand, occurring in the Corsicana marl, Kemp clay, Arkadelphia marl, and Prairie Bluff chalk. It probably occurs in the Ripley formation, although the abundant form from the upper part of the Ripley is here placed under *Planoglobulina acervulinoides* (Egger).

A large part of the specimens do not progress beyond the *Gümbelina* stage, but in any large series a certain number of megalospheric forms show *Ventilabrella* chambers. There is considerable variation in the inflation of the chambers in the biserial stage and altogether it is a very variable species. It seems to be a later derivative from *Gümbelina plummerae* Loetterle, which is less ornamented, found earlier stratigraphically, and has a lesser tendency to *Ventilabrella* chambers than does *V. carseyae*.

It is possible that the species recently described by Voorwijk as *Gümbelina nuttalli* (Proc. Roy. Acad. Amsterdam, vol. 40, No. 2, 1937, p. 5, pl. 2, figs. 1-9) from the Upper Cretaceous of Havana, Cuba, may belong here. I have seen no original material.

VENTILABRELLA DECURRENS (Chapman) (Pl. 4, fig. 18)

Textularia decurrens CHAPMAN, Quart. Journ. Geol. Soc., vol. 48, 1892, p. 515, pl. 15, fig. 6.

Ventilabrella decurrens CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, p. 92.

This species from the chalk of Taplow, England, is apparently a *Ventilabrella*, but I have no specimens of it.

VENTILABRELLA ORNATISSIMA Cushman and Church (Pl. 4, fig. 11)

Ventilabrella ornatissima CUSHMAN and CHURCH, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 512, pl. 39, figs. 12-14.

"Test compressed, all chambers in one plane, subglobular, the early ones biserial, later ones spreading out irregularly, sides in the adult nearly parallel, periphery rounded; sutures distinct, somewhat depressed; wall calcareous, perforate, the earlier ones ornamented by longitudinal costae, each somewhat beaded; aper-

ture in the adult irregular, near the base of the chamber. Length up to 0.70 mm.; breadth 0.40-0.45 mm.; thickness 0.25 mm."

The types of this species are from the Upper Cretaceous, California Northern Petroleum Company Well No. 19, Sec. 2, T. 21 S., R. 14 E., M. D. M., Fresno Co., California, depth 1,135 ft.

There are no other published records for this species.

194. SOME NEW NAMES IN THE FORAMINIFERA

By JOSEPH A. CUSHMAN

Since the recent publication of the Monographic studies of several groups of the foraminifera (Special Publs. Nos. 6-9, Cushman Lab. Foram. Res., 1936, 1937), my attention has been called to certain names that have already been used in the literature necessitating new names for some of them. I am especially indebted to Dr. Hans E. Thalmann for calling attention to these.

GAUDRYINA SUBTENUIS Cushman, n. name

Gaudryina tenuis CUSHMAN (not GRZYBOWSKI, 1897), Spec. Publ. 6, Cushman Lab. Foram. Res., 1936, p. 10, pl. 2, figs. 5 a, b; Spec. Publ. 7, 1937, p. 70, pl. 10, figs. 2, 3.

Although it is very doubtful just what Grzybowski's species may be, the rules necessitate a new name for this Recent species from off the Philippines.

VERNEUILINA ORNATA Cushman, n. name

Verneuilina limbata CUSHMAN (not TERQUEM, 1882), Spec. Publ. 6, Cushman Lab. Foram. Res., 1936, p. 2, pl. 1, fig. 2; Spec. Publ. 7, 1937, p. 12, pl. 1, fig. 21; pl. 2, figs. 1-5.

Terquem's name, although the species appears to be a *Reussella*, necessitates a new designation for the true *Verneuilina* from the Cretaceous of Europe.

BOLIVINA EGGERI Cushman, n. name

Bolivina substriata EGGER (not *B. beyrichi* REUSS, var. *substriata* REUSS, 1870), Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 298, pl. 8, figs. 4-6.—CUSHMAN, Spec. Publ. 9, Cushman Lab. Foram. Res., 1937, p. 138, pl. 18, fig. 3.

BOLIVINA MARGINATA Cushman, var. **GRACILLIMA** Cushman, n. name

Bolivina marginata CUSHMAN, var. *gracilis* CUSHMAN and KLEINPELL (not *B. gracilis* CUSHMAN and APPLIN, 1926), Contr. Cushman Lab. Foram. Res., vol. 10, 1934, p. 10, pl. 2, figs. 3 *a*, *b*.—CUSHMAN, Spec. Publ. 9, 1937, p. 88, pl. 10, fig. 15.

RECENT LITERATURE ON THE FORAMINIFERA

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

Keller, B. M. Stratigraphy of the Cretaceous Deposits of the Western Caucasus.—Bull. Acad. Sci., U. R. S. S., 1936, pp. 619-656.—Some foraminifera listed.

Correlation of the Upper Cretaceous Deposits in Eastern Mexico and in the Western Caucasus.—L. c., 1937, pp. 825-838.—Numerous foraminifera listed.

Harris, R. W., H. R. Born, W. W. Butcher, W. J. Hilseweck, and H. N. Tappan. A Microfaunal Range Chart of the Discovery Well of the Flour Bluff Field, Flour Bluff, Texas.—Proc. Oklahoma Acad. Sci., vol. XVII, 1937, 1 p., 1 chart.

Bermudez, Pedro J. Foraminíferos pequeños de las margas eocénicas de Guanajay, Provincia Pinar del Río, Cuba.—Mem. Soc. Cubana Hist. Nat., vol. XI, No. 5, Dec., 1937, pp. 319-346, 1 map.—Lists of foraminifera, with notes on species.

Bartenstein, Helmut and Erich Brand. Mikro-paläontologische Untersuchungen zur Stratigraphie des nordwest-deutschen Lias und Doggers. Abhandl. Senck. Nat. Ges., No. 439, Dec., 1937, pp. 1-224, pls. 1-20, text figs. 1-20.—Over 150 species and varieties, with 13 new.

Hedberg, Hollis D. Stratigraphy of the Rio Querecual Section of Northeastern Venezuela.—Bull. Geol. Soc. Amer., vol. 48, 1937, pp. 1971-2024, 9 pls., 2 text figs.—Lists numerous foraminifera.

Tan Sin Hok. On the Genus *Spiroclypeus* H. Douvillé, with a Description of the Eocene *Spiroclypeus vermicularis* nov. sp. from Koetai in East Borneo.—“De Ingenieur in Nederlandsch-Indië,” IV, Mijnbouw Geol., Jaargang IV, No. 10, Oct., 1937, pp. 177-193, pls. I-IV, 1 text fig.

Garrett, J. B. and A. D. Ellis, Jr. Distinctive Foraminifera of the Genus *Marginulina* from Middle Tertiary Beds of the Gulf Coast.—Journ. Pal., vol. 11, No. 8, Dec., 1937, pp. 629-633, pl. 86.—5 species and varieties described, 4 new:

- Hedberg, H. D. Foraminifera of the Middle Tertiary Carapita Formation of Northeastern Venezuela.—L. c., pp. 661-697, pls. 90-92, text figs.—Over 60 species and varieties noted, 23 new.
- Newell, Norman D. and Raymond P. Keroher. The Fusulinid, *Wedekindellina*, in Mid-Pennsylvanian Rocks of Kansas and Missouri.—L. c., pp. 698-705, pl. 93, 4 text figs.—A new species, *W. ultimata*.
- Coryell, H. N. *Textularia hockleyensis*, var. *malkinae* Coryell and Embich, A New Name for *Textularia hockleyensis*, var. *panamensis* Coryell and Embich.—L. c., p. 714.
- Plummer, Helen Jeanne. Adhaerentia, a New Foraminiferal Genus.—Amer. Mid. Nat., vol. 19, No. 1, Jan., 1938, pp. 242-244, text figs. 1 a-g.—*Adhaerentia*, n. gen., genotype *A. midwayensis*, n. sp. Midway Eocene of Alabama.
- Cosijn, A. J. Statistical Studies on the Phylogeny of Some Foraminifera. Cycloclypeus and Lepidocyclina from Spain, Globorotalia from the East-Indies.—Leiden, 1938, 70 pp., 5 pls., 12 text figs.
- Hada, Yoshine. Studies on the Foraminifera of Brackish Waters. II. Hachiro-Gata. III. Koyama-Ike.—Zool. Mag. (Japan), vol. 49, No. 10, 1937, pp. 341-347, text figs. 1-7.—1 n. var., *Proteonina difflugiformis* (Brady), var. *limnetica*, n. var.
- Asano, Kiyosi. On the Japanese Species of Cassidulina.—Jap. Journ. Geol. Geog., vol. XIV, No. 2-3, 1937, pp. 143-153, pls. XIII, XIV.—14 species and varieties figured, 9 new.
- Scheffen, W. Die besondern Vorteile der Transparent-Zelle bei der Untersuchung von Klein- und Gross-Foraminiferen.—Senckenbergiana, vol. 19, 1937, pp. 193-200, text figs. 1-5.
- Henson, F. R. S. Larger Foraminifera from Aintab, Turkish Syria.—Eclogae geologicae Helvetiae, vol. 30, No. 1, 1937, pp. 45-57, pls. II-VI, 5 text figs.—1 n. sp., 1 n. var.
- Scheffen, W. Neuere Methoden und Erfolge der Micro-paläontologie.—Oel und Kohle vereinigt mit Erdoel und Teer, 13 Jahrg., Heft 21, June 1, 1937, pp. 483-486, 11 text figs.