CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

232. UPPER CRETACEOUS FORAMINIFERA FROM SANTANDER DEL NORTE, COLOMBIA, S. A.

By JOSEPH A. CUSHMAN and HOLLIS D. HEDBERG

The medial Cretaceous Cogollo and La Luna limestone formations of northwestern Venezuela and northeastern Colombia are overlain by a predominantly shale section of late Cretaceous age. The lower portion of this section consists of about 1,500 feet of gray highly foraminiferal shale (Colon shale). The upper portion consists of about 1,200 feet of greenish-gray silty or sandy sparingly foraminiferal shale (Mito Juan formation). A facies development of thin marine limestones and ironstones in the upper part of the Mito Juan formation is known as the Rio de Oro formation and has yielded species of *Sphenodiscus* and *Coahuilites* indicative of Maestrichtian age. The Mito Juan formation is overlain by a series of alternating shales, sandstones, and coal beds of latest Cretaceous or early Tertiary age included in the "Orocue" or "Third Coal" formation. (A synopsis of formations in this region is given by Hedberg, H. D. and Sass, L. C., Boletin de Geologia y Mineria [Caracas], Vol. 1, Nos. 2, 3, 4, pp. 73-115, 1937.)

The Upper Cretaceous shales are particularly well exposed in the Barco Concession of the Department of Santander del Norte, Colombia, north of the city of Cucuta and between the Rio Sardinata and the Colombia-Venezuela boundary (see sketch map). Collections from numerous sections in this area have shown that these sediments may be zoned readily on the basis of foraminifera as follows (bottom to top):

Pullenia cretacea zone

Lower 1,000 feet of Colon shale. Distinctive forms:

Pullenia cretacea Cushman

Gyroidina globosa (Hagenow)
Siphogenerinoides cretacea Cushman
Haplophragmoides flagleri Cushman and Hedberg
Dorothia cf. *filiformis* (Berthelin)

Siphogenerinoides bramlettei zone

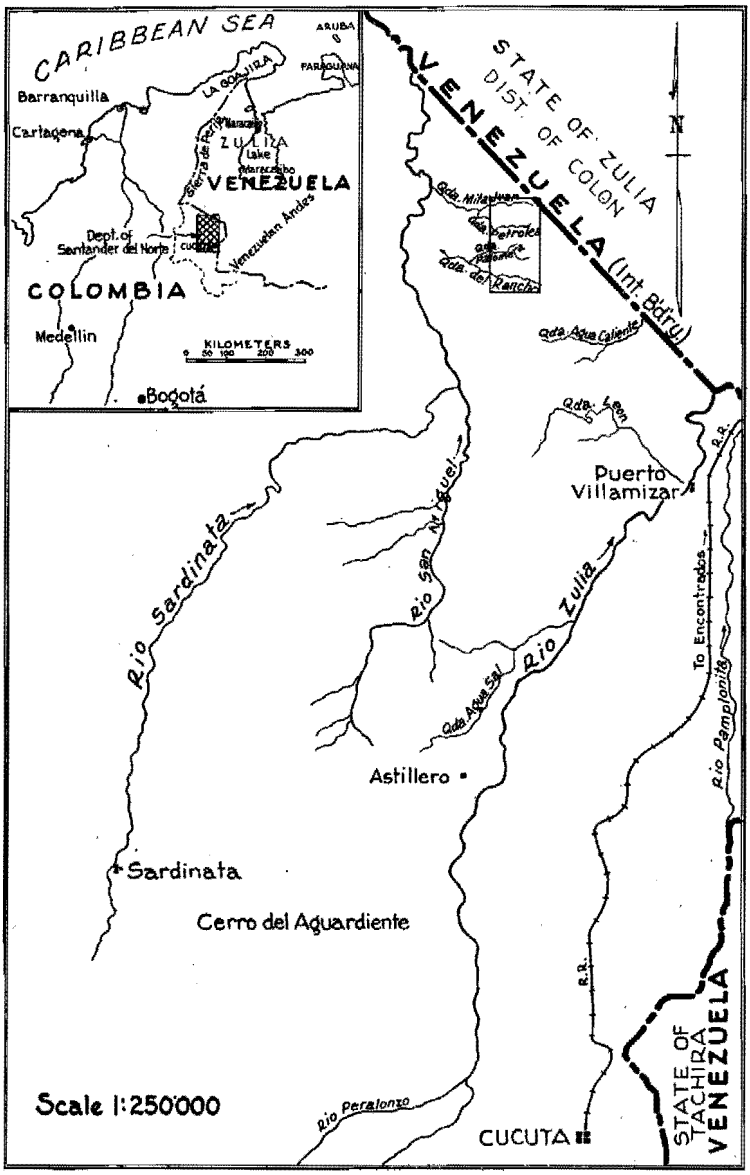
Upper 500 feet of Colon shale. Distinctive forms:

Siphogenerinoides bramlettei Cushman
Allomorphina velascoensis Cushman
Pseudoglandulina lagenoides (Olszewski)
Marginulina silicula (Plummer)
Loxostoma plaitum (Carsey)
Planulina correcta (Carsey)

Ammobaculites colombianus zone

Mito Juan formation and lowermost 300 feet of overlying "Orocue" formation. Largely arenaceous foraminifera, particularly *Ammobaculites colombianus* Cushman and Hedberg and an associated *Haplophragmoides. Vaginulina navarroana* Cushman, *Gümbelitria cretacea* Cushman, and a few other calcareous forms are rare.

The majority of the Colombian species are also known from the Upper Cretaceous of the North American Gulf Coast. A comparison of stratigraphic ranges suggests that the Mito Juan formation and the upper zone of the Colon shale are of Navarro age, while the lower zone of the Colon shale is probably of Taylor age. Since the underlying La Luna limestone of this area appears to be approximately equivalent to the Eagle Ford stage, it is possible that the Austin stage and the lower part of the Taylor stage are either missing from the Colombian sequence or represented by a stratigraphically condensed section in the lowermost part of the Colon shale. In this connection the abrupt lithologic change from La Luna limestone or chert to Colon shale; the equally abrupt change from the dominantly planktonic La Luna foraminiferal fauna to the dominantly benthonic Colon fauna; the presence of a thin but widespread phosphatic zone of sandy glauconite, abraded foraminifera, and fish remains at the base of the Colon shale; and the diminished thickness of the La Luna formation in this region; are all significant.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Dept. of Santander del Norte
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Qda. del Rancho
Qda. Agua Caliente
Qda. Leon
Puerto Villamizar
R.R.
Río Sardinata
Río San Miguel
Río Zulia
To Encontrados
Río Pamplonita
Qda. Agua Sal
Astillero
Sardinata
Cerro del Aguardiente
R.R.
STATE OF TACHIRA
VENEZUELA
Río Peralonzo
CUCUTA
Scale 1:250'000

Species described and figured below are from samples collected in the La Petrolea valley in Quebradas La Petrolea and Mito Juan on the east flank of the La Petrolea structure where the Colon, Mito Juan, and "Orocue" formations outcrop in regular succession from west to east. More exact sample locations may be derived from the S-collection numbers which are tied to plane table traverses of these quebradas.

Family LITUOLIDAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES EXCAVATA Cushman and Waters (Pl. 21, fig. 1)

Haplophragmoides excavata CUSHMAN and WATERS, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 4, 1927, p. 82, pl. 10, figs. 3 *a*, *b*.—CUSHMAN, Trans. Roy. Soc. Canada, Sec. IV, 1927, p. 128, pl. 1, fig. 1.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 12, pl. 3, fig. 1.

Haplophragmoides sp(?), CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 91, pl. 12, fig. 16.

While this species has a fairly wide range in the Navarro and upper Taylor marl of the United States Gulf Coastal Plain area and elsewhere, it is most abundant in the Kemp clay member of the upper part of the Navarro. The occurrence in Colombia is also in the upper part of the section particularly, although scattered through the whole series, showing the close correlation of the two areas.

There is considerable variation in the series of specimens. The one figured has the sutural lines raised while the chamber walls between have collapsed. Specimens are frequently distorted in fossilization.

HAPLOPHRAGMOIDES FLAGLERI Cushman and Hedberg, n. sp. (Pl. 21, fig. 2)

Test small, planispiral, mostly evolute, the sides depressed, periphery broadly rounded, test characteristically found with chambers collapsed or flattened in a plane at right angles to the axis of coiling; chambers of the later portion distinct, 8-10 in the adult coil, those of the earlier coils usually hidden under the accumulated matrix, increasing gradually in size as added but of rather uniform shape throughout; sutures very slightly if at all depressed; wall very finely arenaceous with much cement, smooth;

aperture a low opening at the base of the apertural face at the periphery. Diameter 0.45 mm.; thickness 0.22 mm.

Holotype (Cushman Coll. No. 37901) from the lower zone of the Colon formation, S-6625, Quebrada Mito Juan, Colombia.

This species differs from *H. glabra* Cushman and Waters in the much more evolute test, greatest thickness near the periphery which is broadly rounded. The species is apparently confined to the lower zone of the Colon formation where it is common and constitutes a good guide fossil.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES COLOMBIANUS Cushman and Hedberg (Pl. 21, fig. 3)

Ammobaculites colombiana CUSHMAN and HEDBERG, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 68, pl. 9, figs. 4 *a*, *b*.

This is a fine, large species originally described from the Upper Cretaceous of Rio Lebrija, Department of Santander, Colombia. It is abundant in the "Orocue" and Mito Juan formations, but very rare below. Many specimens show only a slight tendency toward uncoiling, and closely approach *Haplophragmoides*.

AMMOBACULITES LUECKEI Cushman and Hedberg, n. sp. (Pl. 21, fig. 4)

Test with the early portion irregularly coiled, the later portion uncoiled and rectilinear; chambers few, inflated, earlier ones gradually increasing in size as added, later uncoiled ones rounded, slightly overlapping; sutures distinct, depressed; wall finely but distinctly arenaceous, smoothly finished; aperture terminal, elliptical, at the end of a short neck. Length 0.40-0.45 mm.; diameter 0.08-0.10 mm.

Holotype (Cushman Coll. No. 37905) from the lower zone of the Colon formation, S-7050, Quebrada Mito Juan, Colombia.

This species differs from *A. coprolithiformis* (Schwager) in the irregular coiling of the early portion, nearly spherical chambers, and the finely arenaceous, smoothly finished wall.

Family TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA SEMICOMPLANATA (Carsey) (Pl. 21, figs. 5, 6)

Textularia semicomplanata CARSEY, Univ. Texas Bull. 2612, 1926, p. 25, pl. 3, fig. 4.

Spiroplectammina semicomplanata (CARSEY) PLUMMER, Univ. Texas Bull. 3101, 1931, p. 129, pl. 8, fig. 7 (not fig. 8).—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 8, 1932, pp. 94, 96, pl. 11, figs. 8, 9.

Spiroplectammina anceps CUSHMAN and CHURCH (not REUSS), Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 500, pl. 36, figs. 1, 2.—CUSHMAN, Bull. 41, Tenn. Div. Geol., 1931, p. 18, pl. 1, figs. 5 *a*, *b*.

Textularia sagittula DEFRANCE, var. *coonensis* W. BERRY, in W. BERRY and KELLEY, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 3, pl. 2, fig. 3.

This species is a characteristic one of the upper part of the Navarro and its equivalents, although it ranges downward into the upper part of the Taylor. In the Colombia section the species seems to occur most commonly in the upper part of the Colon formation, and less commonly in the lower portion.

Genus TEXTULARIA Defrance, 1824

TEXTULARIA cf. SUBCONICA Franke (Pl. 21, fig. 7)

A few specimens similar to that figured here occur in the Cretaceous of Colombia. They are not entirely typical, and are usually distorted somewhat in fossilization.

Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA cf. LAEVIGATA Franke (Pl. 21, fig. 8)

Numerous specimens occur, in nearly all the samples from both zones of the Colon formation, that closely resemble this species. Specimens are usually somewhat distorted in fossilization, but the figured one shows the general characters. On our Coastal Plain the species is characteristic of the Taylor. It also somewhat resembles var. *pyramidata* from the Velasco shale of Mexico but is not like the type specimen.

Genus PSEUDOGAUDRYINELLA Cushman, 1936

PSEUDOGAUDRYINELLA COLOMBIANA Cushman and Hedberg, n. sp. (Pl. 21, figs. 9, 10)

Test elongate, earliest portion triserial, triangular, with subacute angles, later irregularly biserial, then uniserial in the adult; chambers distinct, later ones strongly inflated, circular in section; sutures of the triserial portion indistinct, later ones distinct and depressed; wall distinctly arenaceous, with much

cement, smoothly finished; aperture large, terminal, circular. Length 0.85-1.25 mm.; diameter of adult portion 0.30-0.35 mm.

Holotype (Cushman Coll. No. 37912) from the lower zone of the Colon formation, S-7050, Quebrada Mito Juan, Colombia.

This species resembles *P. capitosa* (Cushman), but differs in the smaller size, more symmetrical triserial portion, and less acute angles. This seems to be a characteristic species of the lower zone of the Colon formation, but occurs very sporadically.

Family VALVULINIDAE

Genus DOROTHIA Plummer, 1931

DOROTHIA cf. FILIFORMIS (Berthelin) (Pl. 21, fig. 11)

A number of rather poorly preserved specimens occur in the lower zone of the Colon formation which somewhat resemble this species which is known largely from the Lower Cretaceous. More and better specimens are needed to place it with certainty.

DOROTHIA BULLETTA (Carsey) (Pl. 21, fig. 12)

Gaudryina bulletta CARSEY, Univ. Texas Bull. 2612, 1926, p. 28, pl. 4, fig. 4.

Dorothia bulletta (CARSEY) PLUMMER, l. c., Bull. 3101, 1931, p. 132, pl. 8, figs. 13-17.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 271, pl. 41, figs. 9, 10.—CUSHMAN, Special Publ. No. 4, Cushman Lab. Foram. Res., 1933, pl. 12, figs. 8 *a*, *b*; Special Publ. No. 5, 1933, pl. 8, figs. 10 *a*, *b*; Bull. Geol. Soc. Amer., vol. 47, 1936, p. 416, pl. 11, figs. 2 *a*, *b*; Special Publ. No. 8, Cushman Lab. Foram. Res., 1937, p. 84, pl. 9, figs. 4-9.

From the known records, this species is most abundant in the Corsicana marl member of the Navarro, but ranges downward into the upper Taylor. It occurs in both zones of the Colon formation.

Family MILIOLIDAE

Genus MASSILINA Schlumberger, 1893

MASSILINA TEXASENSIS Cushman (Pl. 21, fig. 13)

Massilina texasensis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 13, 1937, p. 100, pl. 15, figs. 2, 3.

The figured specimen is perhaps not as typical as some of the others in our material, but is more nearly complete. Specimens are rare in the upper zone of the Colon formation, and seem to

correlate this part of the section in Colombia with the Kemp clay member of the upper part of the Navarro of Texas to which this species seems to be limited.

Family LAGENIDAE

Genus ROBULUS Montfort, 1808

ROBULUS MÜNSTERI (Roemer) (Pl. 21, fig. 14)

Robulina münsteri ROEMER, Verst. norddeutsch. Oölith., Nachtrag, 1839, p. 48, pl. 20, fig. 29; Verst. norddeutsch. Kreide, 1840-41, p. 98, pl. 15, fig. 30.

Cristellaria münsteri (ROEMER) REUSS, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 77, pl. 9, figs. 3, 4.

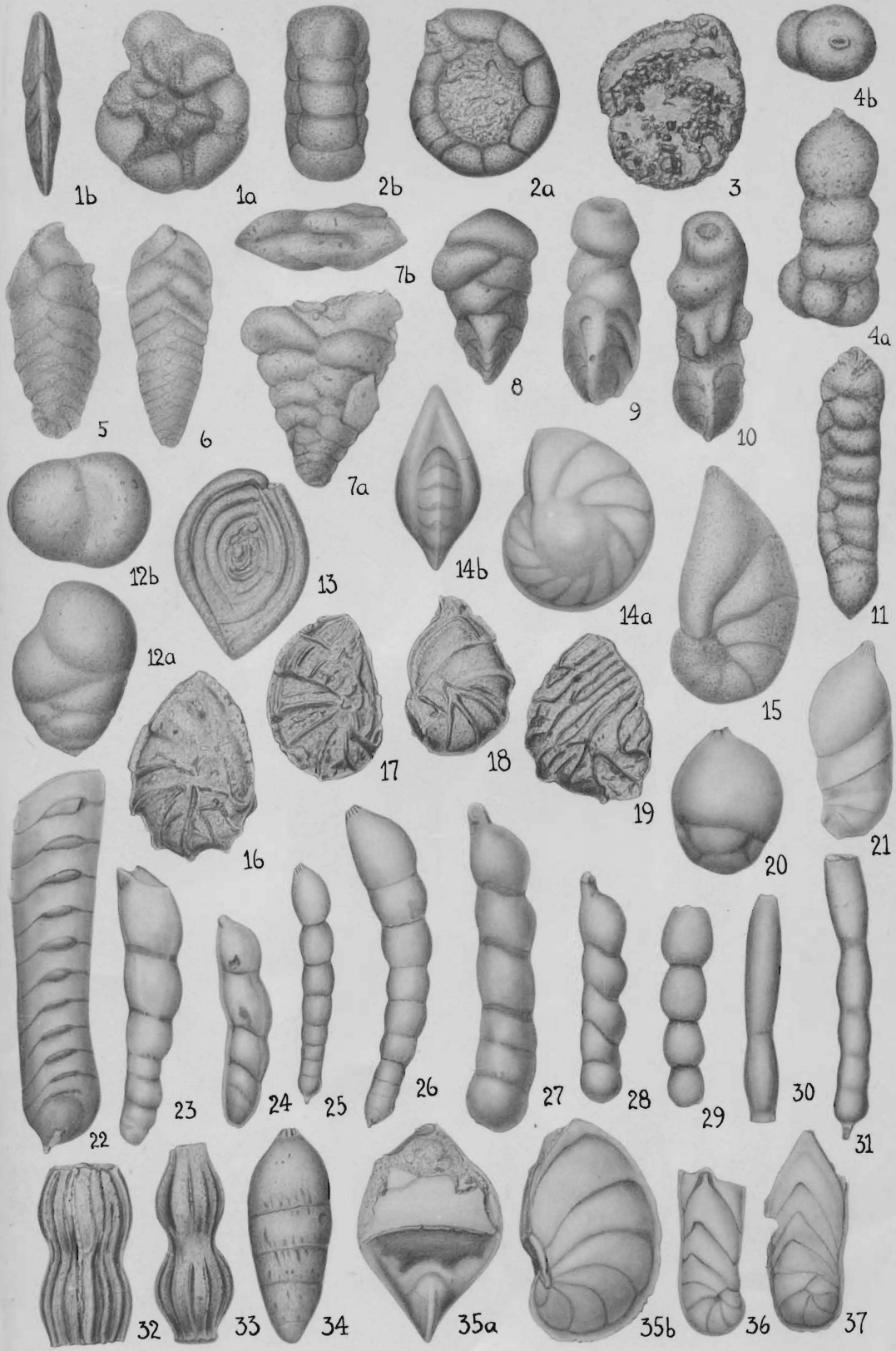
Robulus münsteri (ROEMER) CUSHMAN, Journ. Pal., vol. 6, 1932, p. 334, pl. 50, figs. 2 *a*, *b*.

In the Gulf Coastal Plain region this species ranges downward from the upper part of the Taylor. It has occurred in both zones of the Colon formation.

EXPLANATION OF PLATE 21

FIG. 1. *Haplophragmoides excavata* Cushman and Waters. × 40. *a*, front view; *b*, apertural view. 2. *H. flagleri* Cushman and Hedberg, n. sp. × 60. *a*, front view; *b*, apertural view. 3. *Ammobaculites colombianus* Cushman and Hedberg. × 22. 4. *A. lueckei* Cushman and Hedberg, n. sp. × 80. *a*, front view; *b*, apertural view. 5, 6. *Spiroplectammina semicomplanata* (Carsey). 5, × 80. 6, × 60. 7. *Textularia* cf. *subconica* Franke. × 55. *a*, front view; *b*, apertural view. 8. *Gaudryina* cf. *laevigata* Franke. × 28. 9, 10. *Pseudogaudryinella colombiana* Cushman and Hedberg, n. sp. 9, Holotype. × 40. 10, Paratype. × 28. 11. *Dorothia* cf. *filiformis* (Berthelin). × 40. 12, *D. bulletta* (Carsey). × 33. *a*, front view; *b*, apertural view. 13. *Massilina texasensis* Cushman. × 80. 14. *Robulus münsteri* (Roemer). × 33. *a*, side view; *b*, apertural view. 15. *Planularia* sp. × 55. 16-19. *P. dissona* (Plummer), var. *santanderensis* Cushman and Hedberg, n. var. × 35. 17, Holotype. 16, 18, 19, Paratypes. 20. *Marginulina* cf. *bullata* Reuss. × 85. 21. *M.* cf. *texana* Cushman. × 60. 22. *M. silicula* (Plummer). × 22. 23. *Dentalina* cf. *basiplanata* Cushman. × 40. 24. *D.* cf. *basitorta* Cushman. × 40. 25, 26. *D.* cf. *wimani* Brotzen. × 40. 27, 28. *D.* cf. *lorneiana* d'Orbigny. × 50. 29. *D.* sp. × 90. 30, 31. *D.* cf. *consobrina* d'Orbigny. × 40. 32, 33. *Nodosaria paupercula* Reuss. × 22. 34. *Pseudoglandulina lagenoides* (Olszewski). × 55. 35. *Saracenaria triangularis* (d'Orbigny). × 50. *a*, apertural view; *b*, side view. 36, 37. *Palmula primitiva* Cushman. × 55.

Figures drawn by Ann Shepard Green.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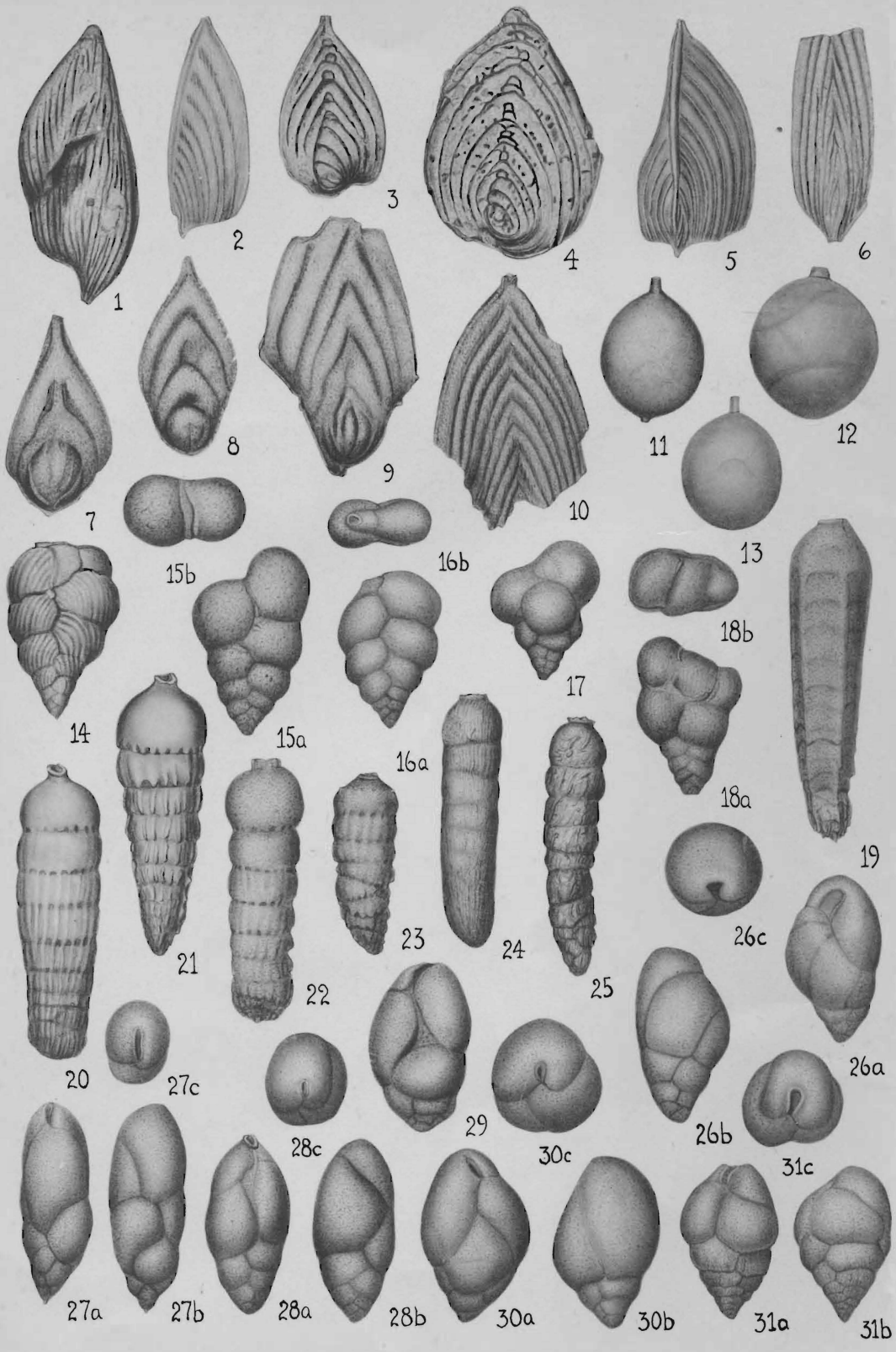
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Genus PLANULARIA Defrance, 1824

PLANULARIA sp. (Pl. 21, fig. 15)

The single specimen figured here is difficult to assign to any described species. It is from the upper zone of the Colon formation, and may possibly be related to *P. dissona* (Plummer).

PLANULARIA DISSONA (Plummer), var. SANTANDERENSIS Cushman and Hedberg, n. var. (Pl. 21, figs. 16-19)

Several specimens of a peculiarly ornamented, flattened species occurred in our material. They seem related to *P. dissona* (Plummer) which is a very variable species, but the ornamentation of the Colombian form is quite different.

Holotype of variety (Cushman Coll. No. 37924) from the Mito Juan formation, S-5599, from near kilometer post 33 west of Cucuta, Colombia, on road to Santiago.

It is known only from the Mito Juan formation.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA cf. BULLATA Reuss (Pl. 21, fig. 20)

A very few, evidently megalospheric specimens, resembling this species, occur in the lower zone of the Colon formation.

EXPLANATION OF PLATE 22

FIG. 1. *Vaginulina navarroana* Cushman. × 40. 2. *V. barcoensis* Cushman and Hedberg, n. sp. × 50. 3, 4. *Palmula rugosa* (d'Orbigny), var. *projecta* (Carsey). × 50. 5. *Frondicularia* sp. × 33. 6. *F. watersi* Cushman. × 40. 7-10. *F. goldfussi* Reuss. 7-9, Young stages. × 50. 10, Adult. × 25. 11-13. *Lagena* cf. *globosa* (Montagu). 11, × 100. 12, 13, × 75. 14. *Gümbelina excolata* Cushman. × 90. 15. *G. globulosa* (Ehrenberg). × 80. *a*, front view; *b*, apertural view. 16. *G. glabrans* Cushman. × 100. *a*, front view; *b*, apertural view. 17. *Gümbelitria cretacea* Cushman. × 100. 18. *Ventilabrella carseyae* Plummer. × 55. *a*, front view; *b*, apertural view. 19. *Siphogenerinoides bramlettei* Cushman. × 55. 20-23. *S. cretacea* Cushman. 20, 22, Megalospheric. 21, 23, Microspheric. × 33. 24. *S. parva* Cushman, var. × 40. 25. *S. parva* Cushman. × 55. 26. *Buliminella carseyae* Plummer, var. *plana* Cushman and Parker. × 85. *a*, *b*, opposite sides; *c*, apertural view. 27. *Bulimina laddi* Cushman and Hedberg, n. sp. × 60. *a*, *b*, opposite sides; *c*, apertural view. 28. *B. kickapooensis* Cole. × 55. *a*, *b*, opposite sides; *c*, apertural view. 29. *B. kickapooensis* Cole, var. *pingua* Cushman and Parker. × 40. 30. *B. reussi* Morrow. × 85. *a*, *b*, opposite sides; *c*, apertural view. 31. *B. petroleana* Cushman and Hedberg, n. sp. × 55. *a*, *b*, opposite sides; *c*, apertural view.

Figures drawn by Ann Shepard Green.

MARGINULINA cf. TEXANA Cushman (Pl. 21, fig. 21)

The figured specimen closely resembles some of the specimens referred to this species, but more specimens are needed to give the full characters. The species is common in the upper part of the Taylor. The few records from Colombia are from the Colon formation.

MARGINULINA SILICULA (Plummer) (Pl. 21, fig. 22)

Hemicristellaria silicula PLUMMER, Univ. Texas Bull. 3101, 1931, p. 148, pl. 10, figs. 8, 9.

Vaginulina (?) *trilobata* (?) CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 30, pl. 4, fig. 11.

Marginulina silicula (PLUMMER) CUSHMAN, l. c., vol. 13, 1937, p. 97, pl. 14, figs. 19-22.

This species is an excellent marker for the upper part of the Navarro, and its occurrence in typical form in the upper zone of the Colon formation still further defines the relationship in age of these two areas of Cretaceous.

Genus SARACENARIA Defrance, 1824

SARACENARIA TRIANGULARIS (d'Orbigny) (Pl. 21, fig. 35)

Cristellaria triangularis D'ORBIGNY, Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 27, pl. 2, figs. 21, 22.

Saracenaria triangularis (D'ORBIGNY) CUSHMAN and CHURCH, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 505, pl. 37, figs. 13, 14.

This species has a wide distribution in the Cretaceous from the many references to it. It occurs in both the upper and lower zones of the Colon formation. In the Coastal Plain region it ranges from the Navarro into the Austin.

Genus DENTALINA d'Orbigny, 1826

DENTALINA cf. BASIPLANATA Cushman (Pl. 21, fig. 23)

A few poorly preserved specimens from the Colon formation seem related to this species which is known to have a wide range in the Navarro and Taylor.

DENTALINA cf. BASITORTA Cushman (Pl. 21, fig. 24)

Our figured specimen and others from the Colon formation are probably identical with this species known from the Navarro and Taylor but more characteristic of the latter.

DENTALINA cf. WIMANI Brotzen (Pl. 21, figs. 25, 26)

These specimens from the Colon formation very closely resemble the species described by Brotzen from the Upper Cretaceous of Sweden.

DENTALINA cf. LORNEIANA d'Orbigny (Pl. 21, figs. 27, 28)

Specimens from the Colon formation closely resemble specimens from the Ripley formation of Tennessee that have been referred to d'Orbigny's species. They are evidently megalospheric.

DENTALINA cf. CONSOBRINA d'Orbigny (Pl. 21, figs. 30, 31)

While incomplete, the figured specimens seem identical with specimens from the Cretaceous of Trinidad and the Ripley formation of Tennessee that have been referred to d'Orbigny's species. Our specimens are from the lower zone of the Colon formation.

DENTALINA sp. (Pl. 21, fig. 29)

The fragmentary specimen figured is from the upper zone of the Colon formation, and seems distinct from any of those of the lower zone.

Genus NODOSARIA Lamarck, 1812

NODOSARIA PAUPERCULA Reuss (Pl. 21, figs. 32, 33)

Nodosaria paupercula REUSS, Verst. böhm. Kreide., pt. 1, 1845, p. 26, pl. 12, fig. 12.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 33, pl. 10, figs. 14, 15.

Although only very fragmentary specimens occur, they resemble this species recorded previously from the Cretaceous of Trinidad and occurring also in the Velasco shale of Mexico.

Genus PSEUDOGLANDULINA Cushman, 1929

PSEUDOGLANDULINA LAGENOIDES (Olszewski) (Pl. 21, fig. 34)

Glandulina lagenoides OLSZEWSKI, Sprawozd. Kom. Fizyj. Akad. Umiej., Krakowie, vol. 9, 1875, p. 107, pl. 1, fig. 8.

Pseudoglandulina sp. PLUMMER, Univ. Texas Bull. 3101, 1931, p. 158, pl. 10, figs. 16, 17.

In this species, which is small and often has a spine at the base in the microspheric form, the chambers are not inflated, the periphery is entire, and the whole test has a tapering, fusiform shape.

It occurs in the Navarro and in the upper part of the Taylor. Our specimens are largely from the upper zone of the Colon formation.

Genus PALMULA Lee, 1833

PALMULA PRIMITIVA Cushman (Pl. 21, figs. 36, 37)

Palmula simplex CUSHMAN (not *Flabellina simplex* REUSS), Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 36, pl. 6, fig. 1.

Palmula primitiva CUSHMAN, l. c., vol. 15, 1939, p. 91, pl. 16, figs. 4, 5.

Our specimens from the upper zone of the Colon formation seem identical with this species which so far as known is characteristic of the upper part of the Taylor.

PALMULA RUGOSA (d'Orbigny), var. PROJECTA (Carsey) (Pl. 22, figs. 3, 4)

Frondicularia projecta CARSEY, Univ. Texas Bull. 2612, 1926, p. 41, pl. 6, fig. 5.

Flabellina projecta (CARSEY) PLUMMER, l. c., Bull. 3101, 1931, p. 165, pl. 12, figs. 5-8.

This variety seems to be distinguishable from the typical form of the species. Our specimens are from both zones of the Colon formation.

Genus VAGINULINA d'Orbigny, 1826

VAGINULINA NAVARROANA Cushman (Pl. 22, fig. 1)

Vaginulina navarroana CUSHMAN, Bull. Geol. Soc. Amer., vol. 47, 1936, p. 416, pl. 1, fig. 3.

This is a characteristic Navarro species especially common in the Corsicana marl member. Our specimens are typical and are from the Mito Juan formation and uppermost Colon.

VAGINULINA BARCOENSIS Cushman and Hedberg, n. sp. (Pl. 22, fig. 2)

Test strongly compressed, initial end acute, with a blunt spine, dorsal margin with a distinct keel, ventral margin truncate, greatest breadth near the base; chambers distinct, not inflated, increasing gradually in size as added, each reaching back to the basal line; sutures distinct, curved, slightly limbate; wall ornamented with numerous, very fine, longitudinal costae, nearly parallel to the dorsal margin; aperture terminal, radiate. Length 0.70-0.75 mm.; breadth 0.25 mm.; thickness 0.03 mm.

Holotype (Cushman Coll. No. 37952) from lower zone of the Colon formation at S-7052, Quebrada Mito Juan, Colombia.

This species differs from *V. navarroana* Cushman in the extension of all the chambers to the basal margin, more compressed test, and the numerous, very fine, longitudinal costae.

Genus FRONDICULARIA Defrance, 1826

FRONDICULARIA WATERSI Cushman (Pl. 22, fig. 6)

Frondicularia watersi CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 14, pl. 3, figs. 14, 15.

This species is characteristic of the Taylor and its equivalents, with a few occurrences in the lower part of the Navarro. Our specimens from the lower zone of the Colon formation seem to be identical.

FRONDICULARIA GOLDFUSSI Reuss (Pl. 22, figs. 7-10)

Frondicularia goldfussi REUSS, Sitz. Akad. Wiss. Wien, Math.-nat. Klass., vol. 40, 1860, p. 192, pl. 4, fig. 7.—EGGER, Abhandl. kon. bay. Akad. Wiss., Math.-nat. Klass., 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; vol. 12, 1936, p. 15, pl. 3, figs. 21, 22.

Our figured specimens are from the upper zone of the Colon formation, and seem close to this species. Various stages in the development are shown. It is most characteristic of the Taylor marl.

FRONDICULARIA sp. (Pl. 22, fig. 5)

The peculiar specimen here figured is from the lower zone of the Colon formation. There are not enough specimens to warrant specific identification.

Genus LAGENA Walker and Jacob, 1798

LAGENA cf. GLOBOSA (Montagu) (Pl. 22, figs. 11-13)

There are a number of specimens, some of which are figured, from both zones of the Colon formation which may be tentatively assigned to this species. They are generally spherical with a tubular neck. The lines suggesting sutures are probably due to fossilization.

Family HETEROHELICIDAE

Genus GÜMBELITRIA Cushman, 1933

GÜMBELITRIA CRETACEA Cushman (Pl. 22, fig. 17)

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*; No. 5, 1933, pl. 26, figs. 9 *a*, *b*; Bull. Geol. Soc. Amer., vol. 47, 1936, p. 418, pl. 1, figs. 12 *a*, *b*; Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 19, pl. 3, fig. 14.

This is a very characteristic species of the Navarro. It has occurred in the "Orocue," Mito Juan, and the upper zone of the Colon formation. It should be a good indicator of the age of these formations.

Genus GÜMBELINA Egger, 1899

GÜMBELINA EXCOLATA Cushman (Pl. 22, fig. 14)

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.—COLE, Florida Dept. Conservation, Geol. Bull. No. 1, 1938, p. 34, pl. 3, fig. 4.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 17, pl. 3, fig. 11.

Textularia costata CARSEY, Univ. Texas Bull. 2612, 1926, p. 26, pl. 1, fig. 4.

This species described from the Upper Cretaceous of Mexico, occurs in the upper part of the Navarro. It occurs in our material most commonly in the upper zone of the Colon formation adding still further evidence to the Navarro age of this part of the formation.

GÜMBELINA GLOBULOSA (Ehrenberg) (Pl. 22, fig. 15)

This species has been widely recorded in the literature, and the name has been used for more than one species. It occurs in the Navarro and Taylor in the Gulf Coastal Plain region. In the section in Colombia it occurs in both the upper and lower zones of the Colon formation.

GÜMBELINA GLABRANS Cushman (Pl. 22, fig. 16)

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

Gümbelina glabrans CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 15, pl. 3, figs. 1, 2.

This species is characteristic of the upper part of the Navarro, particularly of the Corsicana marl member. It occurs in our material from the upper zone of the Colon formation, and still further fixes the age of that part of the section in Colombia.

Genus VENTILABRELLA Cushman, 1928

VENTILABRELLA CARSEYAE Plummer (Pl. 22, fig. 18)

Ventilabrella carseyae PLUMMER, Univ. Texas Bull. 3101, 1931, p. 178, pl. 9, figs. 7-10.—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*; l. c., Contr., vol. 14, 1938, p. 26, pl. 4, figs. 20-24.

Ventilabrella 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*.

This is another species characteristic of that portion of the Navarro which occurs above the Nacotoch sand. It occurs in the upper zone of the Colon formation.

Genus SIPHOGENERINOIDES Cushman, 1927

SIPHOGENERINOIDES BRAMLETTEI Cushman (Pl. 22, fig. 19)

Siphogenerinoides bramlettei CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 56, pl. 9, figs. 5, 6.

This species was originally described from the Colon shale of Quebrada Honda, Venezuela. It is very characteristic of the upper zone of the Colon formation of Colombia.

SIPHOGENERINOIDES CRETACEA Cushman (Pl. 22, figs. 20-23)

Siphogenerinoides cretacea CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 58, pl. 9, figs. 14, 15.

This is the largest species of the group. It was originally described from the Colon shale of Quebrada Honda, Venezuela. There is considerable variation in the strength of the costae. In some specimens there is a tendency to excavation at the base of the chambers similar to *S. ewaldi* (Karsten).

This species is almost entirely confined to the lower zone of the Colon formation and, with the preceding species, the two make excellent markers for the two zones of the Colon formation.

SIPHOGENERINOIDES PARVA Cushman (Pl. 22, fig. 25)

Siphogenerinoides parva CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 58, pl. 9, figs. 11-13.

This small species was also described from the Colon formation of Quebrada Honda, Venezuela. The ornamentation is less regular than in the two preceding species. There are rare occurrences in the Mito Juan formation and uppermost Colon shale.

SIPHOGENERINOIDES PARVA Cushman, var. (Pl. 22, fig. 24)

Variety differing from the typical in the ornamentation which consists of numerous, very fine, longitudinal costae, usually more or less continuous across the sutures. This occurs in the *S. bramlettei* zone of the Colon shale. The figured specimen is from the State of Tachira, Venezuela.

Family BULIMINIDAE

Genus BULIMINELLA Cushman, 1911

BULIMINELLA CARSEYAE Plummer, var. PLANA Cushman and Parker (Pl. 22, fig. 26)

Buliminella carseyae PLUMMER, var. *plana* CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 8, pl. 2, figs. 7 *a-c*.

This variety is characteristic of the Navarro of the Gulf Coastal Plain region. It occurs in the upper zone of the Colon formation of Colombia.

Genus BULIMINA d'Orbigny, 1826

BULIMINA LADDI Cushman and Hedberg, n. sp. (Pl. 22, fig. 27)

Test about three times as long as broad, fusiform, consisting of about three whorls, initial end tapering to a point, with a short but distinct spine; chambers distinct, somewhat inflated, rounded, increasing rapidly in height as added, those of the last-formed whorl in the adult making up nearly two-thirds of the size of the test; sutures distinct, depressed; wall smooth, perforate; aperture narrow, elongate, with a slight lip. Length 0.50-0.55 mm.; diameter 0.18-0.20 mm.

Holotype (Cushman Coll. No. 37985) from the upper zone of the Colon formation, S-7061, Quebrada Mito Juan, Colombia.

This species differs from *B. kickapooensis* Cole in the more slender form, higher and narrower chambers, and pointed, spinose initial end.

BULIMINA KICKAPOOENSIS Cole (Pl. 22, fig. 28)

Bulimina kickapooensis COLE, Florida Dept. Conservation, Geol. Bull. 16, 1938, p. 45, pl. 3, fig. 5.

Bulimina quadrata CUSHMAN and PARKER (part) (not PLUMMER), Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 100, pl. 15, figs. 13, 14 (not 12, 15, 16).

The typical form occurs in the Navarro and Taylor formations. Specimens referable to this species occur in both zones of the Colon formation.

BULIMINA KICKAPOOENSIS Cole, var. PINGUA Cushman and Parker (Pl. 22, fig. 29)

Bulimina kickapooensis COLE, var. *pingua* CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 16, 1940, p. 44, pl. 8, figs. 13, 14.

This variety is characteristic of the Navarro. It occurs in both zones of the Colon formation.

BULIMINA REUSSI Morrow (Pl. 22, fig. 30)

Bulimina reussi MORROW, Journ. Pal., vol. 8, 1934, p. 195, pl. 29, fig. 12. —CUSHMAN and PARKER, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 99, pl. 15, figs. 8 *a*, *b*, 10.

Bulimina ovulum REUSS, Verstein. Bohm. Kreide, pt. 1, 1845, pl. 8, fig. 57; pl. 13, fig. 73 (not *Bulimina ovula* D'ORBIGNY, 1839).

Bulimina murchisoniana CUSHMAN (not D'ORBIGNY), Journ. Pal., vol. 5, 1931, p. 309, pl. 35, figs. 14 *a*, *b*; l. c.; vol. 6, 1932, p. 340.

This species has a wide range from the Navarro downward into the Austin. It has been recorded under various names. The species occurs in the Colombia section in both zones of the Colon formation.

BULIMINA PETROLEANA Cushman and Hedberg, n. sp. (Pl. 22, fig. 31)

Test about 1½ times as long as broad, consisting of 6-8 whorls, the greatest diameter above the middle formed by the last whorl of chambers which makes up about half the test, rapidly tapering to the subacute initial end which occasionally has a short spine; chambers distinct, inflated in the later portion, increasing rapidly in size as added; sutures distinct, later ones strongly depressed; wall of the earlier portion ornamented with numerous fine costae, last whorl usually smooth; aperture broadly loop-shaped. Length 0.40-0.45 mm.; diameter 0.25 mm.

Holotype (Cushman Coll. No. 37993) from the upper zone of the Colon formation at S-6673, Quebrada La Petrolea, Colombia.

This species differs from *B. arkadelphiana* Cushman and Parker, in the more regularly tapering test, the very fine costae and the unornamented last whorl.

This species occurs in both zones of the Colon formation.

Genus LOXOSTOMA Ehrenberg, 1854

LOXOSTOMA PLAITUM (Carsey) (Pl. 23, fig. 1)

Bolivina plaita CARSEY, Univ. Texas Bull. 2612, 1926, p. 26, pl. 4, fig. 2. —BERRY and KELLEY, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 4, pl. 1, fig. 14.

Loxostomum plaitum (CARSEY) CUSHMAN, Bull. 41, Tenn. Geol. Surv., 1931, p. 51, pl. 8, fig. 9; Bull. Geol. Soc. Amer., vol. 47, 1936, p. 419, pl. 1, figs. 10 *a*, *b*.

Loxostoma plaitum (CARSEY) PLUMMER, Univ. Texas Bull. 3101, 1931, p. 182, pl. 10, figs. 5-7.—SANDIDGE, Amer. Midland Nat., vol. 13, 1932, p. 363, pl. 31, fig. 22.—CUSHMAN, Special Publ. No. 9, Cushman Lab. Foram. Res., 1937, p. 169, pl. 20, figs. 1-4.

This species is often abundant in the Navarro, and extends into the Taylor. Typical specimens occur in our Colombian Cretaceous material, almost entirely in the upper zone of the Colon formation.

Family ELLIPSOIDINIDAE

Genus ELLIPSONODOSARIA A. Silvestri, 1900

ELLIPSONODOSARIA cf. HORRIDENS Cushman (Pl. 23, figs. 2-6)

There are a number of fragmentary specimens, some of which are figured, that resemble the above species in their ornamentation. Known records for the species include the Navarro and Taylor. Our specimens are from the Colon formation.

ELLIPSONODOSARIA cf. STEPHENSONI Cushman, var. SPECIOSA Cushman (Pl. 23, figs. 7, 8)

The very fragmentary specimens from the Colon formation suggest this variety. Little is known of its distribution outside of the type locality in the upper portion of the Navarro.

Family ROTALIIDAE

Genus VALVULINERIA Cushman, 1926

VALVULINERIA ALLOMORPHINOIDES (Reuss) (Pl. 23, fig. 9)

Valvulina allomorphinoides REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 223, pl. 11, figs. 6 *a-c*.

Discorbina allomorphinoides (REUSS) FRANKE, Abhandl. Geol. Pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 91, pl. 8, figs. 11 *a*, *b*; Abhandl. Preuss. Geol. Landes., vol. 111, 1928, p. 189, pl. 18, figs. 7 *a*, *b*.

Discorbis allomorphinoides (REUSS) CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 606, pl. 20, figs. 18, 19; pl. 21, fig. 5.

Valvulineria allomorphinoides (REUSS) CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 43, pl. 6, figs. 2 *a-c*; Bull. 41, Tenn. Geol. Surv., 1931, p. 53, pl. 9, figs. 6 *a-c*.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 46, pl. 15, figs 17 *a-c*. —BROTZEN, Sver. geol. under., ser. C, No. 396, 1936, p. 153, pl. 11, figs. 1 *a-c*; fig. 56 (in text).

This species has a wide range in Europe according to the records. It is best developed in the Taylor of the Gulf Coastal Plain region, and is recorded from the Mendez shale of Mexico and the Cretaceous of Trinidad. Our specimens are from both zones of the Colon formation, but the species is particularly common in the *Pullenia cretacea* zone.

Genus GYROIDINA d'Orbigny, 1826

GYROIDINA DEPRESSA (Alth) (Pl. 23, figs. 11, 12)

Rotalina depressa ALTH, Haidinger's Nat. Abhandl., vol. 3, 1850, p. 266, pl. 13, fig. 21.

Gyroidina depressa (ALTH) CUSHMAN and CHURCH, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 515, pl. 41, figs. 4-6.—CUSHMAN, Journ. Pal., vol. 5, 1931, p. 311, pl. 36, figs. 2 *a-c*; vol. 6, 1932, p. 341.—WICKENDEN, l. c., vol. 6, 1932, p. 206, pl. 29, figs. 9 *a-c*.—LOETTERLE, Bull. Nebraska Geol. Surv., ser. 2, Bull. 12, 1937, p. 42, pl. 6, figs. 7 *a-c*.

Rotalia beccarii (LINNÉ), var. *ripleyensis* W. BERRY (in W. BERRY and KELLEY), Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 15, pl. 3, figs. 10-12.

This from the records is a wide ranging and variable species. It occurs in various parts of the Cretaceous section of Colombia with the best specimens in the lower zone of the Colon formation.

GYROIDINA DEPRESSA (Alth), var. COLOMBIANA Cushman and Hedberg, n. var.

(Pl. 23, fig. 13)

Variety differing from the typical in having a subacute periphery and more open umbilical area.

Holotype of variety (Cushman Coll. No. 38008) from the lower zone of the Colon formation, S-6673, Quebrada La Petrolea, Colombia.

GYROIDINA GLOBOSA (Hagenow) (Pl. 23, fig. 14)

Nonionina globosa HAGENOW, Neues Jahrb. für Min., 1842, p. 574.

Rotalia globosa (HAGENOW) REUSS, Sitz. Akad. Wiss. Wien, vol. 44, 1861 (1862), p. 330, pl. 7, figs. 2 *a, b*.

Gyroidina globosa (HAGENOW) CUSHMAN, Journ. Pal., vol. 5, 1931, p. 510, pl. 35, figs. 19 *a-c*.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 47, pl. 14, figs. 3, 4.

This is a variable species with a wide range. It occurs in the Navarro, Taylor, and Austin, and in the Cretaceous of Mexico and Trinidad. This is one of the characteristic species of the lower zone of the Colon formation.

Genus EPISTOMINA Terquem, 1883

EPISTOMINA cf. CARACOLLA (Roemer) (Pl. 23, fig. 19)

The figured specimen may be partly an internal cast, and not represent the true surface of the test. In some respects it is close to some of the specimens that have been referred to Roemer's species. Specimens occur in both zones of the Colon formation.

Family CHILOSTOMELLIDAE

Genus ALLOMORPHINA Reuss, 1850

ALLOMORPHINA VELASCOENSIS Cushman (Pl. 23, fig. 15)

Allomorphina velascoensis CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 604, pl. 20, figs. 20 *a-c*; Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 72, pl. 13, figs. 2 *a*, *b*.

Specimens from the Colon formation seem to be identical with this species described from the Velasco shale of the Tampico Embayment region of Mexico. Specimens are most abundant in the upper zone of the Colon formation, and less frequent in the lower zone.

Genus CHILOSTOMELLA Reuss, 1850

CHILOSTOMELLA cf. OVOIDEA Reuss (Pl. 23, fig. 16)

Rare specimens possibly belonging to this species occur in the Colon formation. Specimens of this genus are rare in the Upper Cretaceous.

Genus PULLENIA Parker and Jones, 1862

PULLENIA CRETACEA Cushman (Pl. 23, fig. 17)

Pullenia cretacea CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 75, pl. 13, figs. 8 *a*, *b*.

Pullenia quaternaria CUSHMAN, Bull. 41, Tenn. Geol. Surv., 1931, p. 57, pl. 10, figs. 5 *a*, *b*; Journ. Pal., vol. 5, 1931, p. 313, pl. 36, figs. 4 *a*, *b*; l. c., vol. 6, 1932, p. 343.—SANDIDGE, l. c., vol. 6, 1932, p. 284, pl. 44, figs. 16, 17.

Pullenia coryelli LOETTERLE (not WHITE), Bull. Nebraska Geol. Surv., ser. 2, Bull. 12, 1937, p. 63, pl. 11, figs. 3 *a*, *b*.

This species occurs in the lower part of the Navarro and upper part of the Taylor. Typical specimens occur in the lower zone of the Colon formation in Colombia of which it seems to be a characteristic species.

Family GLOBOROTALIIDAE

Genus GLOBOTRUNCANA Cushman, 1927

GLOBOTRUNCANA FORNICATA Plummer (Pl. 23, fig. 18)

Globotruncana fornicata PLUMMER, Univ. Texas Bull. 3101, 1931, p. 198, pl. 13, figs. 4-6.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 285, pl. 44, figs. 12, 13.

Globotruncana convexa SANDIDGE, l. c., p. 285, pl. 44, figs. 9-11.

This species is characteristic of the Navarro and upper part of the Taylor. It occurs in typical form in both zones of the Colon formation.

Family ANOMALINIDAE

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA cf. NELSONI W. Berry (Pl. 23, fig. 20)

This species is widely distributed in the Navarro. Specimens, one of which is figured, occur in the Mito Juan formation, and are close to this species.

ANOMALINA SEMICOMPLANATA Cushman (Pl. 23, fig. 23)

Anomalina complanata CUSHMAN (not REUSS), Bull. 41, Tenn. Geol. Surv., 1931, p. 60, pl. 11, figs. 7 *a-c*.

Anomalina semicomplanata CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 68, pl. 12, fig. 1.

This species occurs in the upper part of the Taylor and the lower part of the Navarro. In the Colombia section this species occurs in both the upper and lower parts of the Colon formation.

Genus PLANULINA d'Orbigny, 1826

PLANULINA SPISSOCOSTATA Cushman (Pl. 23, fig. 24)

Planulina spissocostata CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 69, pl. 12, fig. 4.

This well characterized species is known from the Taylor and the Neylandville marl member of the lower part of the Navarro. In our material it occurs in both zones of the Colon formation.

PLANULINA CORRECTA (Carsey) (Pl. 23, fig. 10)

Discorbis correcta CARSEY, Univ. Texas Bull. 2612, 1926, p. 45, pl. 3, fig. 5.—PLUMMER, l. c., Bull. 3101, 1931, p. 188, pl. 14, figs. 1-4.

This is a very variable species, the microspheric and megalospheric forms often showing considerable differences. The former usually continues the low chambers almost throughout, but in the latter the chambers become much larger in the adult stage as in our figured specimen. It is a characteristic species of the Kemp clay and Corsicana marl members of the Navarro. In our material it occurs commonly in the upper zone of the Colon formation with a few specimens referable to it from the upper part of the lower zone.

Genus CIBICIDES Montfort, 1808

CIBICIDES COONENSIS (W. Berry) (Pl. 23, fig. 21)

Anomalina coonensis W. BERRY (in W. BERRY and KELLEY), Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 14, pl. 2, figs. 22-24.

Anomalina pseudopapillosa CUSHMAN (not CARSEY), Bull. 41, Tenn. Geol. Surv., 1931, p. 61, pl. 12, figs. 4 *a-c*.

The records for this species give its range through most of the Navarro and Taylor. The figured specimen is from the "Orocue" formation of Quebrada La Petrolea, Colombia.

CIBICIDES sp. (Pl. 23, fig. 22)

The peculiar specimen figured is from the lower zone of the Colon formation. It is evidently a *Cibicides*, but the final chamber is broken away, if not more, and its complete characters cannot be determined.

233. *CUNEOLINELLA*, A NEW GENUS FROM THE MIOCENE*

By JOSEPH A. CUSHMAN and PEDRO J. BERMUDEZ

In the general West Indian region and Florida there are numerous large arenaceous foraminifera in various parts of the Tertiary and living representatives of large size are still living in the waters of this area. Among the largest fossil forms is *Gunteria*, known from the Eocene of Florida and Cuba. Of almost equal size is a species of *Cuneolina* known from the Miocene of Jamaica and Santo Domingo and still living in waters of the West Indian region. Certain species of *Textulariella* of nearly as large size are known from the Miocene of the same regions and also still living. It is of interest therefore to record other large forms from this same region in the Miocene, which belong to an undescribed but allied genus. Thanks are expressed to Mr. John Whitney Lewis for the interest and assistance extended to Dr. Bermudez in this work.

Genus CUNEOLINELLA Cushman and Bermudez, n. gen.

Genoholotype, *Cuneolinella lewisi* Cushman and Bermudez

Test large, much compressed so that the zig-zag lines between the chambers are on the narrow sides of the test, in the earliest stages conical, then compressed and in the adult with the angles extending backward towards the initial end; chambers in the earliest stages with as many as five chambers in the first whorl, becoming reduced to two, interior labyrinthic; wall arenaceous, with much cement, exterior with a thin imperforate layer; aperture in the adult consisting of a series of elongate openings at the base of the inner margin of the last-formed chamber. Miocene.

This genus is related to *Textulariella* and *Cuneolina*, differing from the former in the strong compression of the test and the complex aperture, and from the latter in the apertural characters. The genus is a specialized one, and evidently derived from *Cuneolina* or *Textulariella*.

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CUNEOLINELLA LEWISI Cushman and Bermudez, n. sp. (Pl. 24, figs. 1-3).

Test large, compressed, triangular or lunate in front view, earliest whorl with four or five chambers, soon becoming biserial; chambers labyrinthic, distinct, rapidly increasing in breadth as added but with little increase in height; sutures fairly distinct, occasionally somewhat raised; wall arenaceous, with a smooth outer layer; aperture in the adult consisting of a series of elongate openings at the base of the inner margin of the last-formed chamber. Diameter 7.00-8.00 mm.; thickness 1.30-1.60 mm.

Holotype (Cushman Coll. No. 38139) from the Miocene, Moncion-Mao road, Santiago Province, Dominican Republic. The species is named in honor of Mr. John Whitney Lewis.

CUNEOLINELLA LEWISI Cushman and Bermudez, n. sp., var. INTERMEDIA Cushman and Bermudez, n. var. (Pl. 24, figs. 4-6)

Variety differing from the typical in the less strongly compressed test and less produced peripheral angles and fewer apertural openings.

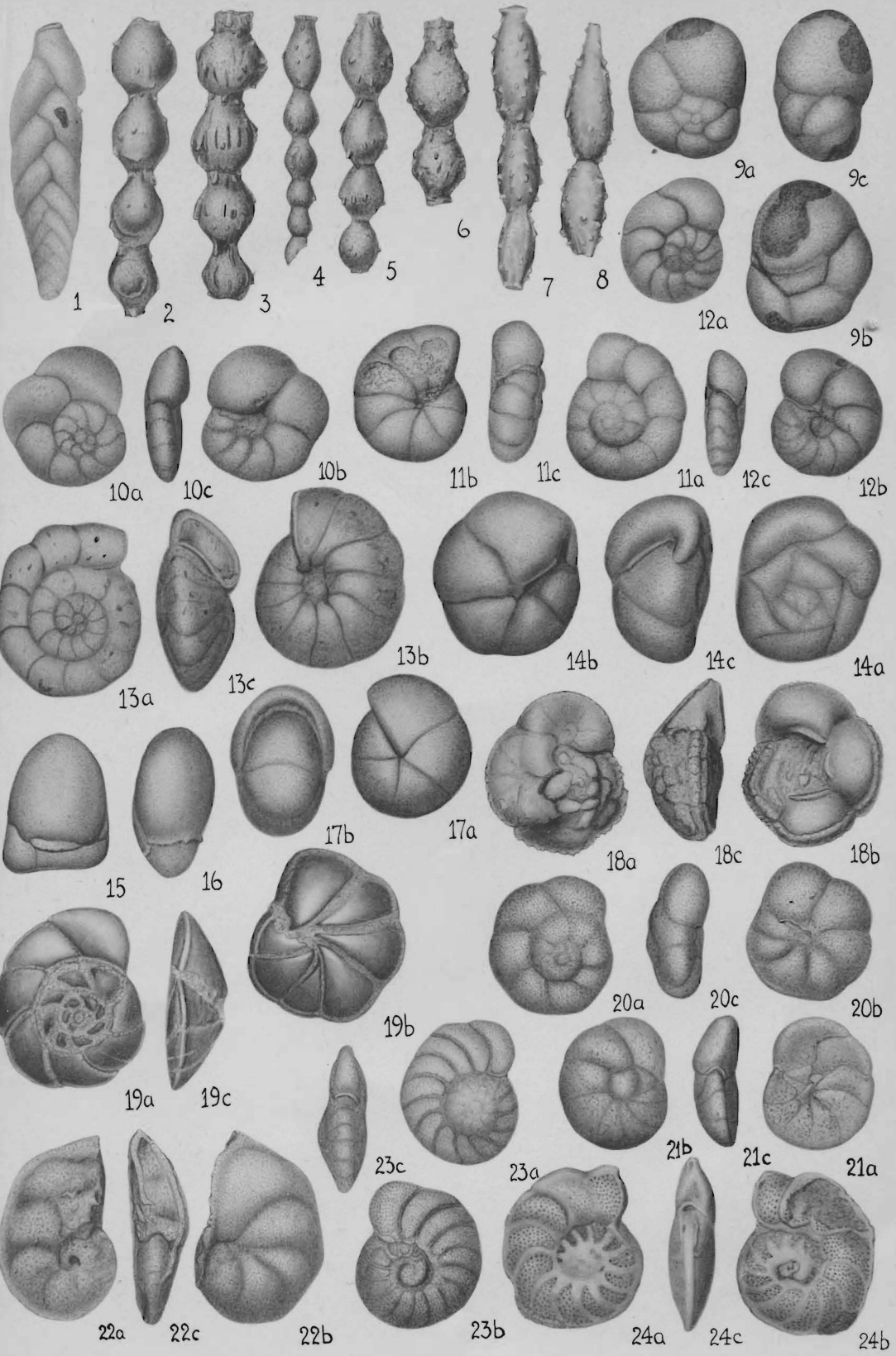
Holotype of variety (Cushman Coll. No. 38142) from the Miocene, Rio Mao, Santiago Province, Dominican Republic.

For comparison, specimens of a less compressed form with simple apertures are figured. They probably belong to *Cuneolina angusta* Cushman (Pl. 24, figs. 7-9), and are also from the Miocene of the Dominican Republic.

EXPLANATION OF PLATE 23

FIG. 1. *Loxostoma plaitum* (Carsey). × 80. 2-6. *Ellipsonodosaria* cf. *horridens* Cushman. × 55. 7, 8. *E.* cf. *stephensoni* Cushman, var. *speciosa* Cushman. × 60. 9. *Valvulineria allomorphinoides* (Reuss). × 40. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 10. *Planulina correcta* (Carsey). × 50. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 11, 12. *Gyroidina depressa* (Alth). 11, × 50. 12, × 45. *a*, *a*, dorsal views; *b*, *b*, ventral views; *c*, *c*, peripheral views. 13. *G. depressa* (Alth), var. *colombiana* Cushman and Hedberg, n. var. × 75. *a*, dorsal view; *b*, ventral view; *c*, apertural view. 14. *G. globosa* (Hagenow). × 80. *a*, dorsal view; *b*, ventral view; *c*, apertural view. 15. *Allomorphina velascoensis* Cushman. × 55. 16. *Chilostomella* cf. *ovoidea* Reuss. × 50. 17. *Pullenia cretacea* Cushman. × 75. *a*, side view; *b*, peripheral view. 18. *Globotruncana fornicata* Plummer. × 40. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 19. *Epistomina* cf. *caracolla* (Roemer). × 60. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 20. *Anomalina* cf. *nelsoni* W. Berry. × 60. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 21. *Cibicides coonensis* (W. Berry). × 75. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 22. *C.* sp. × 38. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 23. *Anomalina semicomplanata* Cushman. × 55. *a*, dorsal view; *b*, ventral view; *c*, peripheral view. 24. *Planulina crassocostata* Cushman. × 55. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

Figures drawn by Ann Shepard Green.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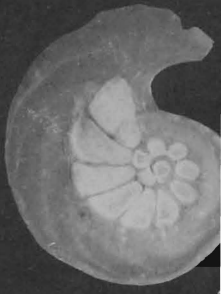


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234. THE STRUCTURE AND DEVELOPMENT OF *LATICARININA PAUPERATA* (PARKER AND JONES)*

By JOSEPH A. CUSHMAN and RUTH TODD

The genus *Laticarinina* has as its genoholotype *Pulvinulina repanda* Fichtel and Moll, var. *menardii* d'Orbigny, subvar. *pauperata* Parker and Jones. The structure and development of *Laticarinina* have been puzzling. It is evident that the form designated as *pauperata* is not generically related to the variety and species to which it was originally assigned. In 1927 Galloway and Wissler proposed the generic name *Carinina* with *Pulvinulina repanda*, var. *menardii*, subvar. *pauperata* as the genoholotype, but as the generic name was preoccupied, they later proposed the name *Laticarinina*, a name which now stands. Their original description is as follows:

"Test free or attached to plants, planispiral, biconvex or planoconvex, depressed, consisting of one or two whorls of inflated chambers which are loosely appressed, visible on both sides of the test, and surrounded on the periphery by a very wide flange or carina; wall very finely perforate, smooth; aperture a small, distorted opening at the outer side of the septal face near the periphery of the test."

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EXPLANATION OF PLATE 24

FIGS. 1-3. *Cuneolinella lewisi* Cushman and Bermudez, n. sp. 1, apertural view, × 5; 2, front view, × 5; 3, apical view, × 9. 2, Holotype; 1, 3, Paratypes. 4-6. *Cuneolinella lewisi* Cushman and Bermudez, n. sp., var. *intermedia* Cushman and Bermudez, n. var. 4, apertural view, × 10; 5, front view, × 7; 6, apical view, × 12. 5, Holotype; 4, 6, Paratypes. 7-9. *Cuneolina angusta* Cushman. 7, apertural view, × 10; 8, front view, × 14; 9, side view, × 14. 10-12. *Laticarinina pauperata* (Parker and Jones). × 30. *a*, *a*, *a*, dorsal views; *b*, *b*, *b*, ventral views. 10, 11, Sta. 25, Johnson-Smithsonian Expedition, lat. 18° 32′ 15″ N., long. 66° 22′ 10″ W. 240-300 fathoms. 12, *Albatross* D2150, lat. 13° 34′ 45″ N., long. 81° 21′ 10″ W. 382 fathoms. *s*, Sinus in plate separating dorsal and ventral portions of chambers.

A study of several hundred specimens from widely scattered areas shows some entirely unrecorded structures which it seems worth while to give in some detail as they are rather unique in the foraminifera. Recent specimens are most abundant in our material from deep water in the Caribbean and from *Globigerina* oozes in many parts of the oceans. The habitat of this particular species, so far as we know, is obscure, although Galloway and Wissler mention it as "free or attached to plants." Certain of the structures, as will be noted later, might indicate that it perhaps could be attached to floating seaweeds; and its most closely related genus, *Cibicides*, is frequently attached. It has not been recorded as a pelagic species. The following details of structure and development have been derived from a study of a large suite of specimens.

Test plano-convex, slightly trochoid, composed of two or two and a half whorls in the adult, the dorsal side flattened or slightly concave as development proceeds, the ventral side convex, especially in the young. One of the striking features is the thin, broad, usually transparent keel. This is built in sections with the addition of each chamber, and in the early stages has a deep re-entrant at its proximal margin. Definite growth lines appear in the keel in many specimens. In some specimens the keel is opaque and sometimes thickened and filled with rounded cavities and slender tubes.

In the specimens we examined the chambers range in number from 12 or 13 in a megalospheric form to 22 chambers in a microspheric adult. The chambers in the young are more or less spherical, in the adult on the ventral side becoming cuneiform, and on the dorsal side reniform. A peculiarity of *Laticarinina* differing from allied genera is the fact that the chambers are in two portions: a larger ventral portion which on the proximal side extends back over the keel of the previous whorl, and a smaller dorsal portion flattened and extending back only to the periphery of the previous keel. The two portions are separated from one another by a thin plate representing a continuation of the keel but having an elongate sinus extending backward from about the middle of the chamber as shown at *s* in fig. 12 *a*. The dorsal part of each chamber seems to be about half a chamber anterior to the ventral part. Sometimes supplementary chambers are present at the outer edges of the later chambers, but their position and occurrence seem haphazard.

The sutures on the ventral side in the adult are nearly radial, but on the dorsal side the chambers are so separated that there are no distinct sutures. In the young stages the chambers are more or less globular and separated, being held together by the keel and the tubular connections between the chambers.

The wall is smooth and very finely perforate. The earlier chambers have a thin inner wall of chitin that remains when the outer calcareous wall is dissolved in weak acid. This often gives an orange brown color to these chambers.

The aperture in the adult is on the dorsal side on the inner margin of the last-formed chamber, low and elongate, similar to that in many species of *Cibicides*. The chambers are connected on the ventral side by tubular necks. The aperture is difficult to see, but is most easily demonstrated by wetting a specimen and observing the escaping air bubbles from the interior.

The development and structure of this species seem to show very definitely that it is closely allied to and derived from the genus *Cibicides*. It would be interesting to know more of its life habits: whether attached or free, and whether or not it is pelagic.

RECENT LITERATURE ON THE FORAMINIFERA

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

Phleger, Fred B. Jr. Foraminifera of Submarine Cores from the Continental Slope.—Bull. Geol. Soc. Amer., vol. 50, 1939, pp. 1395-1422, 3 pls., 4 text figs.—Numerous species figured and detailed distributions given.

Ishizaki, Kazuhiko. A List of Japanese Neogene, Pleistocene and Recent Foraminifera, Excluding Orbitoididae, Recorded up to 1938.—Taiwan Tigaku Kizi, vol. X, 1939, Appendix pp. 1-48; vol. XI, 1940, Appendix pp. 49-182.—A compilation of the literature, species and varieties, and their occurrences.

On the Foraminifera of the so-called Upper Marine Fossil Beds in the Vicinity of Kwansai, Sintiku Prefecture, Taiwan.—L. c., vol. X, No. 4, December 1939, pp. 103-124, 2 pls., 4 text figs.—In Japanese with an abstract in English. 6 new species described (in Japanese).

Fossils from Hôtosaku, Rinkô-syô, Sinsyô-gun, Taihoku Prefecture, Taiwan.—L. c., vol. XI, No. 1, March 1940, pp. 13-24 (in Japanese).

On *Streblus schroeterianus* (Parker and Jones) and Allied Species.—L. c., vol. XI, No. 2, June 1940, pp. 49-61, pls. III, IV.—In Japanese, with a resumé in English.

Cole, W. Storrs. Stratigraphic and Paleontologic Studies of Wells in Florida.—Florida Geol. Survey Bull. 19, 1941, pp. 1-91, pls. 1-18, 4 text figs.—Numerous species and varieties described and figured, 9 new, and 2 new genera: *Pseudochrysalidinella* (genoholotype, *P. floridana* Cole, n. sp.) family Buliminidae, and *Discorinopsis* (genoholotype, *D. gunteri* Cole, n. sp.) family Rotaliidae.

LeRoy, L. W. Small Foraminifera from the Late Tertiary of the Nederlands East Indies.—Colorado School of Mines Quarterly, vol. 36, No. 1, January 1941, pp. 11-132, 13 pls., 12 text figs.—Many species and varieties are described and figured, including 19 new species and 5 new varieties.

Crespin, Irene. Palaeontological Review of the Holland's Landing Bore, Gippsland.—Mining and Geological Journal, vol. 2, No. 4, March 1941, pp. 252-256.—Mentions the occurrence of many foraminifera in different formations of the core.

Macfadyen, W. A. Foraminifera from the Green Ammonite Beds, Lower Lias, of Dorset.—Phil. Trans. Roy. Soc. London, ser. B, Biol. Sciences, No. 576, vol. 231, May 22, 1941, pp. 1-73, pls. 1-4, text figs. 1-6.—55 species are described and figured, a few new: Genus *Carixia*, n. gen. (genotype, *C. langi*, n. sp.); *Lingulina terquemi* nom. nov.; genus *Tristix*, n. gen. (genotype, *Rhabdogonium liasinum* Berthelin); *Lagena davoei*, n. sp.

Thompson, M. L. and **Harold W. Scott.** Fusulinids from the type section of the lower Pennsylvanian Quadrant formation.—Journ. Pal., vol. 15, No. 4, July 1941, pp. 349-353, pl. 48, 1 text fig.—A few species figured and described, none new.

Tappan, Helen. New arenaceous Foraminifera from the Woodbine sand of northern Texas.—L. c., pp. 359-361, pl. 51.—New species described and figured: *Reophax woodbinensis, Flabellammina brachylocula, F. denisonensis.*

Stewart, Grace A. and **Richard R. Priddy.** Arenaceous Foraminifera from the Niagaran Rocks of Ohio and Indiana.—L. c., pp. 366-375, pl. 54.—21 species described and figured, 10 new.

Mornhinveg, A. R. The Foraminifera of Red Bluff.—L. c., pp. 431-435.—Gives a check list of the foraminifera of Red Bluff, Wayne Co., Mississippi.

Hanna, G. Dallas and **Leo George Hertlein.** Characteristic Fossils of California.—State of California, Division of Mines, Bull. 118, pt. II, August 1941, pp. 165-182, i-iii, figures [plates] 60-67.—"Fig. 67," a plate with 49 figures, is of foraminifera, the others of other groups of fossils.

Church, C. C. Descriptions of Foraminifera.—L. c., p. 182, fig. [plate] 67, figures 37 and 47.—5 new species described, 2 figured, the others figured previously but not described: *Plectofrondicularia jenkensi, Planularia markleyana, Pullenia lillisi, Robulus welchi,* and *Siphogenerinoides whitei.*

Laiming, Boris. Eocene Foraminiferal Correlations in California.—L. c., pp. 193-198, i-iii, fig. [plate] 83, figures 1-7.—Characteristic foraminifera are listed, and 7 species figured.

Goudkoff, Paul P. Correlation of Oil Field Formations on West Side of San Joaquin Valley.—L. c., pp. 247-252, i-iii, fig. [plate] 101, figures 1-5.—Notes occurrence of index foraminifera for different horizons, and figures 5 species.

Toulmin, Lyman D. Eocene smaller Foraminifera from the Salt Mountain limestone of Alabama.—Journ. Pal., vol. 15, No. 6, Nov. 1941, pp. 567-611, pls. 78-82, 4 text figs.—There are 97 species and varieties figured and described, 15 new species and 1 new variey, with 2 new genera, *Eggerina* (genotype, *E. cylindrica* n. sp.) belonging to the Valvulinidae, and *Alabamina* (genotype, *A. wilcoxensis* n. sp.) belonging to the Rotaliidae.

LeRoy, L. W. A new species of *Cibicides* from the lower Pliocene (Repetto formation) of southern California.—L. c., pp. 622, 623, pl. 84.—*Cibicides repettoensis* n. sp.

Vieaux, Don G. New Foraminifera from the Denton formation in northern Texas.—L. c., pp. 624-628, pl. 85.—Ten species from the Lower Cretaceous are described and figured, 9 new: *Reophax eckernex, Marginulina cyprina, Nodosaria harrisi, N. barkeri, Frondicularia lalickeri, Dentalinopsis gigantea, D. quadrata, Epistomina charlottae, Discorbis minima.*

Thalmann, Hans E. Bibliography and index to new genera, species, and varieties of Foraminifera for the years 1937 and 1938.—L. c., pp. 629-690.

J. A. C.