# CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

## 180. FURTHER NEW SPECIES OF FORAMINIFERA FROM THE EOCENE OF CUBA

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Continued study of the rich Eocene faunas of Cuba has resulted in the discovery of more undescribed species. These are here described and figured that they may be available for other workers.

**VERNEUILINA VILLARENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 1, 2)**

Test elongate, 2½ to 3 times as long as broad, very gradually tapering from a somewhat rounded initial end, in transverse section triangular, the sides flattened or slightly convex, the angles sharp, somewhat keeled; chambers numerous, triserial throughout, of rather uniform shape, increasing gradually in size as added; sutures finely distinct, very slightly depressed; wall composed of sand grains of medium size with much cement, rather smoothly finished; aperture semi-circular, becoming nearly terminal in the adult. Length 1.60-1.95 mm.; breadth 0.55-0.65 mm.

Holotype (Cushman Coll. No. 23343) from the Eocene, under R. R. bridge on Central Highway located in Jicotea, Santa Clara Province, Cuba (Bermudez Sta. 92).

This species differs from *V. tricarinata* in the more slender, more tapering test and much stronger keels. In general shape it more closely resembles *Tritaxia ellisorae* Cushman from the Upper Cretaceous of Texas.

**VERNEUILINA PINARENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 3, 4)**

Test slightly less than twice as long as broad, distinctly tapering, greatest breadth at the apertural end, initial end subacute, triangular in transverse section, sides slightly convex in the

middle, concave toward the angles which are bluntly rounded with slight keels; chambers distinct, increasing gradually in size as added, central part of each on the flattened sides somewhat depressed, raised along the edges; sutures oblique, distinct, smooth, raised; wall arenaceous, of rather uniformly sized, fine grains, smoothly finished; aperture small, rounded or elongate, at the edge of the inner margin of the last-formed chamber. Length 1.10-1.25 mm.; diameter 0.60 mm.

Holotype (Cushman Coll. No. 23345) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

CLAVULINOIDES CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 5-7)

Test elongate, 3 to 4 times as long as broad, sides nearly parallel for most of their length, tapering abruptly at either end, triangular in transverse section, sides slightly convex in the middle, concave toward the angles which are acute; chambers of the early triangular portion somewhat indistinct, later uniserial ones distinct, slightly inflated, increasing slightly in height as added; sutures of the later portion distinct, depressed, slightly curved upward toward the aperture in the middle; wall very finely arenaceous with much cement, smooth except for a few short spines on the initial end; aperture terminal, circular with a slight, rounded lip. Length 1.85-2.25 mm.; diameter 0.65 mm.

Holotype (Cushman Coll. No. 23347) from the Eocene, Tejar Consuelo (upper beds), Cerro, Havana, Cuba (Bermudez Sta. 36).

This species differs from *C. jarvisi* Cushman from the Miocene of Trinidad in its more slender form, parallel sides and greater number of uniserial chambers.

CLAVULINOIDES SUBULATUS Cushman and Bermudez, n. sp. (Pl. 1, figs. 8, 9)

Test elongate, about 3 times as long as broad, the earlier third gradually tapering, later two-thirds with sides parallel or even decreasing in diameter toward the apertural end, triangular in section, sides flattened or slightly concave, angles prominent, keeled except toward the apertural end where they are rounded; chambers indistinct, rather low, very slightly inflated in the adult; sutures indistinct; wall rather coarsely arenaceous with a small amount of cement, roughly finished; aperture terminal, rounded, with a slight lip. Length 3.00 mm.; diameter 1.00 mm.

Holotype (Cushman Coll. No. 23349) from the Eocene, under

Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *C. alpini* Cushman in its straighter sides in the adult, more elongate and more slender form, and much larger triserial portion.

CLAVULINOIDES EUCARINATUS Cushman and Bermudez, n. sp. (Pl. 1, figs. 10, 11)

Test elongate, about 2½ times as long as broad, sides for the most part parallel, apertural end truncate, base broadly rounded, early portion rounded, convex without angles, later uniserial portion triserial in section, sides flattened, edges strongly keeled, the keels fusing with the large rounded lip at the apertural end; chambers of the early triserial portion indistinct, later distinct, slightly inflated, few in number; sutures of the early portion indistinct, later slightly depressed; wall arenaceous, smoothly finished; aperture terminal, rounded, with distinct, rounded lip. Length 0.85-1.00 mm.; diameter 0.35-0.40 mm.

Holotype (Cushman Coll. No. 23351) from the Eocene, Avenida de los Presidentes, in street cut between Hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *C. jarvisi* Cushman in the rounded early portion and the prominent keels.

CLAVULINOIDES HAVANENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 12, 13)

Test slightly longer than broad, tapering, greatest breadth toward the apertural end, triangular in section, sides flat, angles acute; chambers rather indistinct, mostly triserial, last-formed one terminal; sutures indistinct; wall finely arenaceous with much cement, smoothly finished; aperture rounded, sub-terminal with a slight lip. Length 1.00 mm.; diameter 0.85 mm.

Holotype (Cushman Coll. No. 23353) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *C. jarvisi* Cushman in the shorter form, larger proportion of triserial chambers, and tapering form throughout.

CLAVULINOIDES EXCURRENS Cushman and Bermudez, n. sp. (Pl. 1, figs. 14, 15)

Test elongate, somewhat fusiform, greatest breadth near the middle, somewhat truncate at the apertural end, gradually tapering to the subacute initial end, triangular in section, sides flat-

tened or slightly concave, angles broadly rounded; chambers indistinct, usually only two uniserial ones in the adult, high; sutures indistinct; wall arenaceous with much cement, smoothly finished; aperture terminal, rounded, with a short neck and distinct lip. Length 1.35-1.50 mm.; diameter 0.55-0.65 mm.

Holotype (Cushman Coll. No. 23355) from the Eocene, under Library of the Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *C. jarvisi* Cushman in the fewer uniserial chambers, fusiform shape, and very broadly rounded angles.

CLAVULINOIDES MARIELINUS Cushman and Bermudez, n. sp. (Pl. 1, figs. 16, 17)

Test elongate, about 2½ times as long as broad, early triserial portion rapidly tapering, later uniserial portion with sides nearly parallel, triangular in transverse section, sides flattened or slightly concave, angles subacute; chambers fairly distinct in the uniserial portion, very indistinct in the early triserial part, 2 or 3 uniserial ones in the adult; sutures of the early portion indistinct, later distinct and slightly depressed; wall finely arenaceous, smoothly finished; aperture terminal, rounded, with a slightly rounded lip. Length 1.50-1.75 mm.; diameter 0.65-0.80 mm.

Holotype (Cushman Coll. No. 23357) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *C. jarvisi* Cushman in the much more inflated early portion, less definite angles in the adult, and smaller aperture.

KARRERIELLA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 18, 19)

Test somewhat longer than broad, compressed, periphery of the early portion subacute, later rounded, almost entirely biserial, early chambers obscure, whole test gradually tapering from the subacute initial end to greatest breadth toward apertural end; chambers distinct, somewhat inflated, especially the last-formed adult pair which rapidly increases in size; sutures distinct, depressed, strongly oblique, straight or slightly curved; wall very finely arenaceous with much cement, smoothly finished; aperture an elongate opening somewhat above the base of the apertural face, with a distinct lip and short neck. Length 0.60 mm.; breadth 0.35-0.40 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 23359) from the Eocene, under the Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *K. chapapotensis* (Cole) in the much greater compression, lower chambers, and more oblique sutures.

KARRERIELLA ARENASENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 20, 21)

Test elongate, about two and one-half times as long as broad, slender, tapering from the subacute initial end to the greatest breadth toward the apertural end, slightly compressed, periphery broadly rounded; chambers except in the early portion distinct, inflated, of uniform shape, increasing rather regularly in size as added; sutures distinct, depressed, straight, at right angles to the elongate axis; wall finely arenaceous, smooth, with much cement; aperture a low broad opening just above the base of the last-formed chamber. Length 0.85-1.00 mm.; breadth 0.40 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 23361) from the Eocene, 1 km. N. of Arroyo Arenas on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *K. chapapotensis* (Cole) in the more slender form with more numerous and longer chambers.

LISTERELLA CUBANA Cushman and Bermudez, n. sp. (Pl. 1, figs. 22, 23)

Test elongate, slender, about three times as long as broad, early triangular portion larger in diameter than the later uniserial part, triangular in section, sides flattened, angles broadly rounded, later portion circular in section; chambers indistinct, 3 or 4 in the uniserial portion; sutures indistinct; wall coarsely arenaceous, roughly finished; aperture small, rounded, terminal. Length 1.00-1.25 mm.; diameter 0.35-0.45 mm.

Holotype (Cushman Coll. No. 23363) from the Eocene, "El Husillo" Quarry, (lower beds) Puentes Grandes, Havana, Cuba (Bermudez Sta. 312).

This species differs from *L. howchini* Cushman in the much rougher surface and more flattened sides in the triserial portion.

LISTERELLA PETROSA Cushman and Bermudez, n. sp. (Pl. 1, figs. 24-26)

Test elongate, slender, of rather uniform diameter throughout, early triserial portion sharply triangular in section, angles rounded, sides flattened; chambers rather indistinct except in the last-formed portion where they are somewhat inflated, 6 or 7 in

the uniserial portion in the adult; sutures indistinct except in the later uniserial portion where they are slightly depressed; wall coarsely arenaceous, roughly finished; aperture terminal, rounded, small, often with a slight neck. Length 1.50-2.25 mm.; diameter 0.40-0.50 mm.

Holotype (Cushman Coll. No. 23365) from the Eocene, Tejar Consuelo (upper beds), Cerro, Havana, Cuba (Bermudez Sta. 36).

This species differs from *L. howchini* Cushman in the much shorter triserial portion, larger number of uniserial chambers, and the much more slender test.

LISTERELLA GRACILLIMA Cushman and Bermudez, n. sp. (Pl. 1, figs. 27, 28)

Test elongate, slender, initial portion triangular, broader than the later uniserial portion, sides flattened, angles rounded, later uniserial portion with few chambers of uniform diameter; chambers of the early triserial portion indistinct, later more distinct, inflated, increasing slightly in size as added; sutures indistinct except between the later chambers where they are slightly depressed; wall rather coarsely arenaceous, somewhat roughly finished; aperture small, terminal. Length 1.50 mm.; diameter 0.45 mm.

Holotype (Cushman Coll. No. 23367) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *L. howchini* Cushman in the much more slender form, smaller proportion of triserial chambers, and higher uniserial ones.

LISTERELLA CARIBAEA Cushman and Bermudez, n. sp. (Pl. 1, figs. 29, 30)

Test elongate, slender, the early triserial portion broader than the remainder of the test, generally rounded, triangular in section, later portion circular and with the sides nearly parallel; chambers indistinct, later uniserial ones four or five in number, *slightly inflated, increasing slightly in height as added; sutures* indistinct except in the later portion where they are slightly depressed; wall coarsely arenaceous, of rounded grains, roughly finished; aperture small, rounded, terminal, without a distinct neck. Length 1.40-1.50 mm.; diameter 0.45-0.50 mm.

Holotype (Cushman Coll. No. 23369) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *L. howchini* Cushman in having the greatest width near the base, the triserial portion being short and rounded, and having a larger number of uniserial chambers.

TRITAXILINA CUBENSIS Cushman and Bermudez, n. sp.

Test elongate, fusiform, about twice as long as broad, greatest breadth at or a little above the middle, apertural end rounded, initial end pointed; chambers fairly distinct, with deep excavation at the base at either side, middle of chambers extending downward; sutures fairly distinct, depressed; wall coarsely arenaceous, rather smoothly finished; aperture small, narrow, at right angles to the inner margin, in a distinct depression. Length up to 1.50 mm.; diameter 0.75 mm.

Holotype (Cushman Coll. No. 23288) from lower beds of "El Husillo" Quarry, Puentes Grandes, Havana, Cuba (Bermudez Sta. 312).

This species differs from *T. hantkeni* Cushman in the very deep depressions at the sides of the base of the chambers, and the depressed sutures.

The figures of the type of this species will be found in Contr. Cushman Lab. Foram. Res., vol. 12, pl. 10, figs. 25, 26.

VALVULINA MARTII Cushman and Bermudez, n. sp.

Test elongate, about 1½-2 times as long as broad, triserial, triangular, the early portion with the angles subacute, later more rounded, tapering, greatest breadth toward the apertural end; chambers fairly distinct, the base at each side of the angle deeply excavated; sutures distinct, progressively more depressed toward the apertural end; wall rather coarsely arenaceous but rather smoothly finished; aperture a large opening at the inner margin of the last-formed chamber with a large, elongate, somewhat curved, valvular tooth. Length up to 1.65 mm.; breadth up to 0.95 mm.

Holotype (Cushman Coll. No. 23661) from the Eocene of Cuba (Bermudez Sta. 110).

This species differs from *V. limbata* Terquem in the more rounded periphery in the adult, narrower and more curved tooth, and the very deeply excavated sides of the chambers.

VALVULAMMINA CUBENSIS Cushman and Bermudez, n. sp.

Test subglobular, periphery broadly rounded, early portion with 5 or more chambers in the whorl, the adult with 4, spire low;

## EXPLANATION OF PLATE 1

FIGS.

1, 2. *Verneuilina villarensis* Cushman and Bermudez, n. sp. × 40. 1, Holotype, front view. 2, Paratype, apertural view.

3, 4. *Verneuilina pinarensis* Cushman and Bermudez, n. sp. × 40. 3, Holotype, front view. 4, Paratype, apertural view.

5–7. *Clavulinoides cubensis* Cushman and Bermudez, n. sp. × 22. 5, Holotype, front view. 6, 7, Paratypes; 6, apertural view; 7, front view.

8, 9. *Clavulinoides subulatus* Cushman and Bermudez, n. sp. × 18. 8, Holotype, front view. 9, Paratype, apertural view.

10, 11. *Clavulinoides eucarinatus* Cushman and Bermudez, n. sp. × 18. 10, Holotype, front view. 11, Paratype, apertural view.

12, 13. *Clavulinoides havanensis* Cushman and Bermudez, n. sp. × 35. 12, Holotype, front view. 13, Paratype, apertural view.

14, 15. *Clavulinoides excurrens* Cushman and Bermudez, n. sp. × 40. 14, Holotype, front view. 15, Paratype, apertural view.

16, 17. *Clavulinoides marielinus* Cushman and Bermudez, n. sp. × 24. 16, Holotype, front view. 17, Paratype apertural view.

18, 19. *Karreriella cubensis* Cushman and Bermudez, n. sp. × 45. 18, Holotype, front view. 19, Paratype, front view.

20, 21. *Karreriella arenasensis* Cushman and Bermudez, n. sp. × 45. 20, Holotype, front view. 21, Paratype, apertural view.

22, 23. *Listerella cubana* Cushman and Bermudez, n. sp. × 40. 22, Holotype, front view. 23, Paratype, apertural view.

24–26. *Listerella petrosa* Cushman and Bermudez, n. sp. ×40. 24, Holotype, front view. 25, 26, Paratypes; 25, apertural view; 26, front view.

27, 28. *Listerella gracillima* Cushman and Bermudez, n. sp. × 30. 27, Holotype, front view. 28, Paratype, apertural view.

29, 30. *Listerella caribaea* Cushman and Bermudez, n. sp. × 40. 29, Holotype, front view. 30, Paratype, apertural view.

31, 32. *Marginulina havanensis* Cushman and Bermudez, n. sp. × 35. 31, Holotype. 32, Paratype.

33, 34. *Marginulina laeviuscula* Cushman and Bermudez, n. sp. × 35. 34, Holotype. 33, Paratype.

35. *Saracenaria ornatula* Cushman and Bermudez, n. sp. × 40.

36, 37. *Marginulina palmerae* Cushman and Bermudez, n. sp. × 32. 36, Holotype. 37, Paratype.

38. *Lingulina cubensis* Cushman and Bermudez, n. sp. × 33.

39, 40. *Dentalina havanensis* Cushman and Bermudez, n. sp. × 40. 40, Holotype. 39, Paratype.

41. *Sigmomorphina cubensis* Cushman and Bermudez, n. sp. × 20.

42. *Glandulina cubensis* Cushman and Bermudez, n. sp. × 33.

43. *Bolivinella alata* Cushman and Bermudez, n. sp. × 30.

44, 45. *Spiroplectoides cubensis* Cushman and Bermudez, n. sp. × 40. 44, Holotype. 45, Paratype.

46. *Bolivinella cubensis* Cushman and Bermudez, n. sp. × 33.

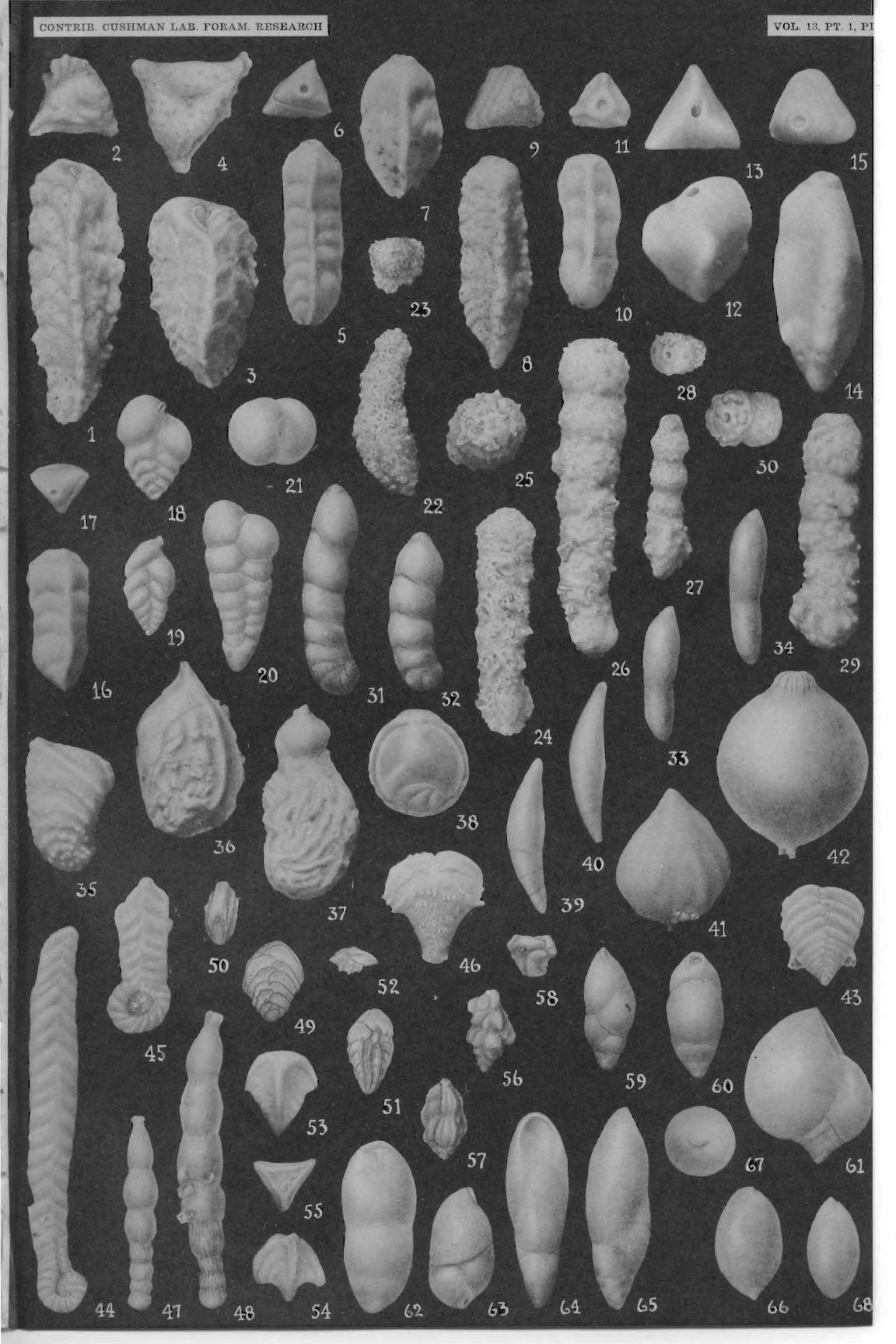
47, 48. *Nodogenerina havanensis* Cushman and Bermudez, n. sp. × 40. 48, Holotype. 47, Paratype.

49, 50. *Bolivina capdevilensis* Cushman and Bermudez, n. sp. × 35. 49, Holotype, front view. 50, Paratype, apertural view.

51, 52. *Bolivina tricosta* Cushman and Bermudez, n. sp. × 40. 51, Holotype, front view. 52, Paratype, apertural view.

53–55. *Chrysalidinella cubana* Cushman and Bermudez, n. sp. × 40. 53, Holotype, front view. 54, 55, Paratypes; 54, front view; 55, apertural view.

56–58. *Angulogerina naranjoensis* Cushman and Bermudez, n. sp. × 40. 56, Holotype, front view. 57, 58, Paratypes; 57, front view; 58, apertural view.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chambers inflated, enlarging rapidly in size as added; sutures distinct, depressed; wall coarsely arenaceous, smoothly finished; aperture large, almost completely covered with an irregularly shaped, valvular tooth. Diameter 1.00 mm.; height 0.65 mm.

Holotype (Cushman Coll. No. 23664) from the Eocene of Cuba (Bermudez Sta. 110).

This species differs from *V. globularis* (d'Orbigny) in the more inflated chambers and very much larger, irregularly shaped, valvular tooth.

**VALVULAMMINA AFFINIS Cushman and Bermudez, n. sp.**

Test subglobular, periphery broadly rounded, spire low, the last-formed whorl making up nearly the entire surface of the test; chambers fairly distinct, slightly inflated, 6 or more in the last-formed whorl, increasing rapidly in size as added; sutures slightly depressed; wall coarsely arenaceous, rather smoothly finished; aperture large with a very broad, valvular tooth. Diameter 0.90 mm.; height 0.85 mm.

Holotype (Cushman Coll. No. 23667) from the Eocene of Cuba (Bermudez Sta. 110).

This species differs from *V. globularis* (d'Orbigny) in the greater number of chambers to the whorl, more involute chambers, and much larger, valvular tooth.

**MARGINULINA HAVANENSIS Cushman and Bermudez, n. sp.** (Pl. 1, figs. 31, 32)

Test elongate, early portion close coiled, much compressed, later becoming uncoiled and nearly circular in section; chambers distinct, those of the uncoiled portion becoming somewhat inflated, and increasing in height as added; sutures distinct, early ones somewhat limbate, later ones becoming progressively more depressed; wall smooth, very finely perforate; aperture terminal,

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59, 60. *Pleurostomella naranjoensis* Cushman and Bermudez, n. sp. × 33. 60, Holotype, front view. 59, Paratype, side view.

61. *Pleurostomella obesa* Cushman and Bermudez, n. sp. × 28.

62, 63. *Pleurostomella rimosa* Cushman and Bermudez, n. sp. × 20. 62, Holotype, front view. 63, Paratype, side view.

64, 65. *Pleurostomella alazanensis* Cushman, var. *cubensis* Cushman and Bermudez, n. var. × 28. 64, Holotype, front view. 65, Paratype, side view.

66–68. *Ellipsoglandulina cubensis* Cushman and Bermudez, n. sp. × 22. 66, Holotype, side view. 67, 68, Paratypes; 67, apertural view; 68, side view.

From photographs retouched by Patricia G. Edwards.

radiate. Length 1.50-1.75 mm.; diameter 0.40 mm.

Holotype (Cushman Coll. No. 23371) from the Eocene, "El Husillo" Quarry (lower beds), Puentes Grandes, Havana, Cuba (Bermudez Sta. 312).

This species differs from *M. jacksonensis* (Cushman and Applin) in the lower and more numerous uniserial chambers, and more inflated later portion.

MARGINULINA LAEVIUSCULA Cushman and Bermudez, n. sp. (Pl. 1, figs. 33, 34)

Test elongate, slender, early portion somewhat coiled, very slightly compressed, last-formed chamber circular in section; chambers indistinct except the final one which is inflated and nearly as high as the remainder of the test, earlier chambers elongating rapidly as added; sutures indistinct except that in the base of the last-formed chamber which is slightly depressed; wall smooth, finely perforate; aperture terminal, radiate. Length 1.20-1.30 mm.; diameter 0.30 mm.

Holotype (Cushman Coll. No. 23373) from the Eocene, Avenida de los Presidentes, in road cut between hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *M. subrecta* Franke in the more elongate early chambers and much higher final chamber.

MARGINULINA PALMERAE Cushman and Bermudez, n. sp. (Pl. 1, figs. 36, 37)

Test slightly longer than broad, much compressed, close coiled except the last one or two chambers, periphery sharply keeled, especially on the dorsal side; chambers and sutures largely obscured by the ornamentation of the surface; wall, except for the last-formed chamber in the adult, ornamented by a raised net-work of short, oblique costae, the longer ones representing the line of the sutures with one more prominent costa nearly parallel to the dorsal side; aperture radiate, terminal. Length 1.50 mm.; breadth 0.80-0.85 mm.

Holotype (Cushman Coll. No. 23376) from the Eocene, under R. R. bridge on Central Highway, located in Jicotea, Santa Clara Province, Cuba (Bermudez Sta. 92).

This species differs from *M. fragaria* (Gümbel) in the greater amount of ornamentation forming an irregular net-work rather than a series of parallel lines, and in its shorter and broader form.

SARACENARIA ORNATULA Cushman and Bermudez, n. sp. (Pl. 1, fig. 35)

Test smooth, longer than broad, early portion coiled, later uncoiling, triangular in end view, angles acute, ventral face concave, the other two faces slightly convex; chambers fairly distinct, not inflated, increasing rather rapidly in size as added especially in the later uncoiled ones; sutures fairly distinct, raised, the earlier ones with a series of short, rounded spines, later ones forming raised costae projecting at the ventral margins into short spines; wall smooth except for the ornamentation of the sutures, finely perforate; aperture radiate at the dorsal angle. Length 1.25 mm.; breadth 0.85 mm.

Holotype (Cushman Coll. No. 23375) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *S. schencki* Cushman and Hobson in the ornamentation of the surface and the somewhat greater height of the chambers at the inner margin.

LINGULINA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, fig. 38)

Test nearly circular in front view, moderately compressed, periphery with a distinct, sharp keel; chambers few, in the microspheric form with the earlier ones somewhat coiled, overlapping, the last-formed one making up a large proportion of the test; sutures distinct, very slightly depressed; wall smooth, very finely perforate; aperture terminal, elongate in the line of compression of the test, radiate. Length 0.55 mm.; breadth 0.45 mm.

Holotype (Cushman Coll. No. 23378) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *L. mexicana* Cole in the more circular outline, less developed keel, and larger proportion of the test made up by the final chamber.

DENTALINA HAVANENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 39, 40)

Test elongate fusiform, greatest breadth at about the middle, thence tapering nearly equally toward either end, one side convex, the other slightly concave, initial end bluntly pointed; chambers few, increasing rapidly in size as added, overlapping; sutures fairly distinct, slightly oblique, becoming less so in the later portion; wall smooth, finely perforate; aperture terminal, radiate. Length 0.75 mm.; diameter 0.18 mm.

Holotype (Cushman Coll. No. 23379) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *D. cooperensis* Cushman in the fewer chambers, more fusiform test, and the much longer part of the test occupied by the last-formed chamber.

SIGMOMORPHINA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, fig. 41)

Test compressed, somewhat rhomboid in side view, the basal portion rounded, the upper portion with the sides nearly straight, base with a small spine; chambers rather indistinct, elongate, in alternating series; sutures indistinct, not depressed; wall smooth; aperture terminal, radiate. Length 1.80 mm.; breadth 1.00 mm.

Holotype (Cushman Coll. No. 23381) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *S. vaughani* Cushman and Ozawa in the more compressed test with the rounded basal portion and straight sides above, more elongate chambers, and basal spine.

GLANDULINA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, fig. 42)

Test globular, nearly spherical, initial end with a short, stout spine, apertural end with a distinctly projecting neck; chambers indistinct, those of the earliest portion small, biserial, the last-formed one making up much the larger portion of the test; sutures indistinct, not depressed; wall smooth, except for slightly raised costae radiating from the base of the apertural neck; aperture radiate, with a distinct neck, costate at the sides. Length 1.00 mm.; diameter 0.85 mm.

Holotype (Cushman Coll. No. 22382) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *G. laevigata* d'Orbigny in the more spherical form, radiate costae about the aperture, and the larger apertural neck.

BOLIVINELLA ALATA Cushman and Bermudez, n. sp. (Pl. 1, fig. 43)

Test generally triangular in front view, much compressed, greatest breadth near the apertural end, thence gradually tapering to the acute initial end, apertural end truncate, periphery with a distinct, triangular, somewhat flattened spine toward the

base on each side; chambers low, broad, biserial; sutures distinct, not depressed, slightly curved; wall smooth; aperture small, a low opening at the inner margin of the last-formed chamber. Length 0.55 mm.; breadth 0.45 mm.

Holotype (Cushman Coll. No. 22383) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *B. folia* (Parker and Jones), var. *ornata* Cushman in the broader triangular form, lack of median longitudinal ridge and raised granular sutures, and broader and lower spines.

BOLIVINELLA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, fig. 46)

Test compressed, initial end rounded, truncate, thence increasing to the greatest width at about the middle, later portion of about the same width, apertural end broadly rounded, sides of the early portion concave, later convex; chambers biserial, indistinct, last two pairs greatly increasing in size, each with a slight spine at the posterior angle; sutures marked by a series of raised beads, slightly longer than broad; wall ornamented by the beaded sutures. Length 0.60 mm.; breadth 0.55 mm.

Holotype (Cushman Coll. No. 23386) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *B. folia* (Parker and Jones), var. *ornata* Cushman in the lack of a longitudinal ridge, much broader later portion, and highly beaded sutures.

SPIROPLECTOIDES CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 44, 45)

Test very elongate slender, compressed, early portion planispirally coiled, more or less evolute, later portion biserial, elongate, sides nearly parallel; chambers distinct, of rather uniform size in both the early planispiral and later biserial portions; sutures distinct, slightly depressed, becoming more strongly oblique in the later portion; wall smooth, coarsely perforate. Length 1.60 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. No. 23384) from the Eocene of Alturas de Almendares Quarry in Reparto Kohly, W. side of Almendares River, Havana, Cuba (Bermudez Sta. 18).

This species differs from *S. curta* Cushman in the very slender, elongate test, lower chambers and more evolute early coils,

**BOLIVINA CAPDEVILENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 49, 50)**

Test moderately compressed, generally rhomboid in front view, initial end bluntly pointed, sides truncate in end view, slightly keeled at each side; chambers distinct, not inflated, increasing slightly in height as added; sutures distinct, raised, thin and plate-like, strongly oblique, often slightly undulate near the inner end; wall of the earliest portion spinose, later smooth between the plate-like sutures; aperture a small, low, arched opening at the inner margin of the last-formed chamber. Length 0.30-0.38 mm.; breadth 0.22-0.24 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 22388) from the Eocene, Tejar "Cuba," Arroyo Naranjo (lower beds), Havana Province, Cuba (Bermudez Sta. 235C).

This species differs from *B. jacksonensis* Cushman and Applin in the shorter, broader form, truncate periphery, and very strongly raised sutures.

**BOLIVINA TRICOSTA Cushman and Bermudez, n. sp. (Pl. 1, figs. 51, 52)**

Test compressed, thickest in the middle, thence thinning to the periphery which is sharply keeled, initial end bluntly pointed; chambers distinct, overlapping, last-formed ones nearly as high as broad, basal margin in the adult slightly crenulate; sutures distinct, slightly limbate, curved strongly toward the periphery; wall ornamented by three strongly raised, longitudinal costae, one in the median line, and one at each side of the middle; aperture a low opening in the median line at the base of the last-formed chamber. Length 0.32-0.36 mm.; breadth 0.18-0.20 mm.

Holotype (Cushman Coll. No. 23389) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *B. scalprata* Schwager in the much higher, coarser costae, less obliquely curved costae, and crenulate chamber margin in the adult.

**NODOGENERINA HAVANENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 47, 48)**

Test elongate, slightly tapering toward either end, initial end rounded, apertural end truncate, circular in transverse section; chambers distinct, slightly overlapping, increasing very gradually in diameter but much more rapidly in height as added; sutures distinct, depressed; wall ornamented with numerous, low, longitudinal costae on the earlier chambers, in later ones becoming

obsolescent except over the sutures; aperture rounded, terminal, at the end of a definite neck, the end of which is slightly expanded into a thickened lip. Length 0.85-1.40 mm.; diameter 0.16-0.22 mm.

Holotype (Cushman Coll. No. 23391) from Eocene, Alturas de Almendares Quarry in Reparto Kohly, W. side of Almendares River, Havana, Cuba (Bermudez Sta. 18).

This species differs from *N. cooperensis* Cushman in the less tapering form, higher chambers, elongate neck, and costate wall.

NODOGENERINA LAEVIS Cushman and Bermudez, n. sp. (Pl. 2, fig. 12)

Test elongate fusiform, initial end acute; chambers comparatively few, overlapping, increasing very rapidly in size and length as added; sutures distinct, depressed, especially in the later portion; wall smooth; aperture rounded, at the end of a distinct cylindrical neck, without an expanded lip. Length 1.00 mm.; diameter 0.20 mm.

Holotype (Cushman Coll. No. 23416) from Eocene, from under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *N. cooperensis* Cushman in its fusiform shape, fewer and higher chambers, elongate neck, and smooth wall.

CHRYSALIDINELLA CUBANA Cushman and Bermudez, n. sp. (Pl. 1, figs. 53-55)

Test about as long as broad, triangular in end view, sides concave, initial end pointed, thence increasing gradually in width in the microspheric form, rapidly in the megalospheric, to the greatest breadth at the base of the last-formed whorl of chambers; chambers numerous, increasing rather rapidly in breadth as added, not inflated, earlier ones triserial, later ones uniserial; sutures strongly oblique, not depressed; wall smooth; aperture cribrate, in the terminal face. Length 0.40-0.50 mm.; diameter 0.30-0.40 mm.

Holotype (Cushman Coll. No. 23393) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *C. pulchella* (Cushman) in the relatively shorter, broader test, lower and broader chambers, recurved final chambers, and very tapering test.

ANGULOGERINA NARANJOENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 56-58)

Test somewhat longer than broad, tapering toward either end, generally triangular in end view, angles broadly truncate, sides slightly concave; chambers somewhat inflated, strongly concave at the base, and overhanging previous ones, increasing rapidly in size in the earlier portion; sutures deeply depressed; wall generally smooth; aperture small, circular, terminal, with a short neck and slight lip. Length 0.25-0.30 mm.; diameter 0.15-0.20 mm.

Holotype (Cushman Coll. No. 23395) from the Eocene, Tejar "Cuba," Arroyo Naranjo (lower beds), Havana Province, Cuba (Bermudez Sta. 235C).

This species differs from *A. cooperensis* Cushman in the shorter, broader form, more inflated chambers deeply excavated on the basal portion, and smooth wall.

SIPHOGENERINA TRANSVERSA Cushman, var. CUBENSIS Cushman and Bermudez, n. var. (Pl. 2, figs. 8, 9)

Variety differing from the typical in the higher costae and more fusiform shape. Length 1.00-1.40 mm.; diameter 0.55-0.68 mm.

Holotype of variety (Cushman Coll. No. 23411) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

PLEUROSTOMELLA NARANJOENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 59, 60)

Test fusiform in both front and side views, initial end bluntly pointed, circular in transverse section; chambers distinct, inflated, increasing rapidly in size as added, the last pair making up about two-thirds of the whole test; sutures distinct, slightly depressed; wall smooth; aperture subterminal, with a slight lip. Length 0.55-0.60 mm.; breadth 0.25-0.28 mm.

Holotype (Cushman Coll. No. 23397) from the Eocene, Tejar "Cuba," Arroyo Naranjo (lower beds), Havana Province, Cuba (Bermudez Sta. 235C).

This species differs from *P. incrassata* Hantken in the shorter form, less inflated and slightly higher chambers, and smaller aperture.

PLEUROSTOMELLA OBESA Cushman and Bermudez, n. sp. (Pl. 1, fig. 61)

Test slightly compressed, initial end subacute, tapering, periphery of adult portion broadly rounded; chambers overlapping, increasing very greatly in size in the adult, the last pair

greatly inflated and making up almost the entire surface of the test; sutures strongly oblique, little if at all depressed; wall smooth; aperture in a broad depression of the apertural face, with a broad, bifid tooth. Length 1.00 mm.; breadth 0.85 mm.

Holotype (Cushman Coll. No. 23401) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *P. rapa* (Gümbel), var. *recens* Dervieux in the greater obliquity of the sutures and much more inflated later chambers.

PLEUROSTOMELLA RIMOSA Cushman and Bermudez, n. sp. (Pl. 1, figs. 62, 63)

Test subcylindrical, initial end bluntly pointed, sides nearly parallel, nearly circular in transverse section; chambers few, slightly inflated, increasing very rapidly in size as added, the last three making up a very large proportion of the whole test, apertural face flattened near the apex; sutures very slightly depressed; wall smooth; aperture subterminal, with a broad tooth and broad central slit, the aperture itself low and broad in front view. Length 0.80-1.10 mm.; diameter 0.40-0.45 mm.

Holotype (Cushman Coll. No. 23402) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *P. incrassata* Hantken in the less inflated chambers, nearly parallel sides, and more narrow aperture.

PLEUROSTOMELLA ALAZANENSIS Cushman, var. CUBENSIS Cushman and Bermudez, n. var. (Pl. 1, figs. 64, 65)

Variety differing from the typical in the somewhat larger size, slightly greater inflation of the chambers, somewhat higher, narrower aperture, and more oblique apertural face. Length 1.30 mm.; diameter 0.40 mm.

Holotype of variety (Cushman Coll. No. 23404) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

ELLIPSOGLANDULINA CUBENSIS Cushman and Bermudez, n. sp. (Pl. 1, figs. 66-68)

Test about twice as long as broad, elliptical in side view, circular in transverse section, initial end subacute; chambers few, earliest ones biserial, last-formed one making up a large part of the test; sutures indistinct; wall smooth; aperture subterminal, slightly curved in end view, very low in front view, the upper rim

forming a hood-like, overhanging lip. Length 0.70-0.90 mm.; diameter 0.35-0.45 mm.

Holotype (Cushman Coll. No. 23407) from the Eocene, Avenida de los Presidentes, in road cut between Hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *E. velascoensis* Cushman in the more narrowly elliptical side view, less tapering initial end, and less pointed apertural end.

ELLIPSOGLANDULINA PRINCIPIENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 1-3)

Test fusiform, once and a half to twice as long as broad, initial end bluntly pointed, circular in transverse section; chambers few, earlier ones biserial, later ones inflated, last-formed one making up about half the test, somewhat overlapping; sutures distinct, earlier ones slightly oblique, later ones slightly depressed; wall smooth; aperture subterminal, low, arched, with a broad, flattened tooth. Length 0.60-0.80 mm.; diameter 0.30-0.50 mm.

Holotype (Cushman Coll. No. 23408) from the Eocene, Avenida de los Presidentes, in road cut between Hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *E. exponens* (H. B. Brady) in the smaller, lower aperture and less depressed sutures.

NODOSARELLA CONSTRICTA Cushman and Bermudez, n. sp. (Pl. 2, figs. 4-7)

Test three to five times as long as broad, circular in transverse section, tapering from the subacute or rounded initial end to the greatest breadth formed by the last chamber; chambers distinct, inflated, particularly the later ones, increasing rapidly in size and height as added, earlier ones much overlapping, later ones less and less so; sutures slightly depressed in the earlier portion, strongly so in the adult; wall smooth; aperture nearly terminal, with a slightly overhanging, hood-like lip and a flattened, bifid tooth. Length 0.60-1.60 mm.; diameter 0.32-0.36 mm.

Holotype (Cushman Coll. No. 23412) from the Eocene, Avenida de los Presidentes, in road cut between Hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *N. subnodosa* (Guppy) in the more rapidly tapering form, more separated and somewhat higher chambers in the adult, and the more pointed initial and apertural ends.

NODOSARELLA ACUS Cushman and Bermudez, n. sp. (Pl. 2, figs. 10, 11)

Test elongate, fusiform, about four times as long as broad, ends subacute, circular in transverse section; chambers few, distinct but not inflated, somewhat overlapping, increasing gradually in size as added; sutures not depressed, usually irregularly oblique; wall smooth; aperture subterminal, very narrow, nearly filled by the flattened tooth. Length 0.68-0.75 mm.; diameter 0.18 mm.

Holotype (Cushman Coll. No. 23414) from Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *N. subnodosa* (Guppy) in the fusiform shape, irregularly oblique and not depressed sutures, and the non-inflated chambers.

NONION HAVANENSE Cushman and Bermudez, n. sp. (Pl. 2, figs. 13, 14)

Test somewhat compressed, slightly depressed in the umbilical regions, completely involute, periphery rounded, 8 to 10 chambers in the adult coil, of uniform shape, increasing very slightly in size as added; sutures distinct, very slightly limbate, not depressed, gently curved; wall smooth; aperture low. Length 0.55 mm.; breadth 0.48 mm.; thickness 0.28 mm.

Holotype (Cushman Coll. No. 23417) from the Eocene, Tejar Consuelo (upper beds), Cerro, Havana, Cuba (Bermudez Sta. 36).

This species differs from *N. advenum* (Cushman) in the depressed umbilical regions without a raised boss, less limbate and not depressed sutures, and less compressed test.

DISCORBIS HAVANENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 15, 16)

Test much compressed, dorsal side slightly convex, ventral side flattened or slightly convex, periphery acute, with a thin keel; chambers very distinct, 4 to 5 in the adult whorl, of uniform shape, increasing regularly in size as added, very slightly inflated; sutures distinct, strongly curved on both sides, slightly depressed on the ventral side; wall smooth, finely perforate; aperture a low opening at the ventral border beneath a distinct, overhanging lip which forms a lobe on the inner portion of the chamber. Length 0.65-0.70 mm.; breadth 0.55 mm.; thickness 0.15-0.18 mm.

Holotype (Cushman Coll. No. 23431) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *D. assulata* Cushman in the fewer

## EXPLANATION OF PLATE 2

FIGS.

1–3. *Ellipsoglandulina principiensis* Cushman and Bermudez, n. sp. × 28. 1, Holotype, side view. 2, 3, Paratypes; 2, side view; 3, apertural view.

4–7. *Nodosarella constricta* Cushman and Bermudez, n. sp. × 35. 4, Holotype, side view. 5-7, Paratypes; 5, 6, side views; 7, apertural view.

8, 9. *Siphogenerina transversa* Cushman, var. *cubensis* Cushman and Bermudez, n. var. × 28. 8, Holotype. 9, Paratype.

10, 11. *Nodosarella acus* Cushman and Bermudez, n. sp. × 30. 10, Holotype. 11, Paratype.

12. *Nodogenerina laevis* Cushman and Bermudez, n. sp. × 30.

13, 14. *Nonion havanense* Cushman and Bermudez, n. sp. × 40. 13, Holotype, side view. 14, Paratype, apertural view.

15, 16. *Discorbis havanensis* Cushman and Bermudez, n. sp. × 28. 15, Holotype, dorsal view. 16, Paratype, ventral view.

17, 18. *Discorbis incrustatus* Cushman and Bermudez, n. sp. × 28. 17, Holotype, dorsal view. 18, Paratype, ventral view.

19, 20. *Siphonina advena* Cushman, var. *cubensis* Cushman and Bermudez, n. var. × 28. 20, Holotype, dorsal view. 19, Paratype, ventral view.

21–23. *Baggina marielina* Cushman and Bermudez, n. sp. × 28. 23, Holotype, ventral view. 21, 22, Paratypes; 21, dorsal view; 22, peripheral view.

24–26. *Lamarckina torrei* Cushman and Bermudez, n. sp. × 30. 25, Holotype, dorsal view. 24, 26, Paratypes; 24, dorsal view; 26, peripheral view.

27–29. *Eponides marielensis* Cushman and Bermudez, n. sp. × 25. 27, Holotype, dorsal view. 28, 29, Paratypes; 28, ventral view; 29, peripheral view.

30–32. *Eponides principiensis* Cushman and Bermudez, n. sp. × 22. 30, Holotype, dorsal view. 31, 32, Paratypes; 31, ventral view; 32, peripheral view.

33–35. *Eponides rutteni* Cushman and Bermudez, n. sp. × 28. 33, Holotype, dorsal view. 34, 35, Paratypes; 34, ventral view; 35, peripheral view.

36–38. *Gyroidina elongata* Cushman and Bermudez, n. sp. × 22. 36, Holotype, peripheral view. 37, 38, Paratypes; 37, dorsal view; 38, ventral view.

39–41. *Gyroidina protea* Cushman and Bermudez, n. sp. × 18. 39, Holotype, ventral view. 40, 41, Paratypes; 40, dorsal view; 41, peripheral view.

42–44. *Gyroidina plummerae* Cushman and Bermudez, n. sp. × 30. 42, Holotype, ventral view. 43, 44, Paratypes, dorsal views.

45–47. *Planulina simplex* Cushman and Bermudez, n. sp. × 35. 46, Holotype, side view. 45, 47, Paratypes; 45, side view; 47, peripheral view.

48–50. *Cancris cubensis* Cushman and Bermudez, n. sp. × 22. 48, Holotype, dorsal view. 49, 50, Paratypes; 49, ventral view; 50, peripheral view.

51–53. *Globorotalia palmerae* Cushman and Bermudez, n. sp. × 40. 52, Holotype, dorsal view. 51, 53, Paratypes; 51, ventral view; 53, peripheral view.

54–56. *Planulina suturata* Cushman and Bermudez, n. sp. × 28. 54, Holotype, dorsal view. 55, 56, Paratypes; 55, ventral view; 56, peripheral view.

57–59. *Anomalina corrugata* Cushman and Bermudez, n. sp. × 20. 57, Holotype, dorsal view. 58, 59, Paratypes; 58, ventral view; 59, peripheral view.

60, 61. *Anomalina almendarensis* Cushman and Bermudez, n. sp. × 28. 60, Holotype, ventral view. 61, Paratype, dorsal view.

62–65. *Globorotalia centralis* Cushman and Bermudez, n. sp. × 28. 65, Holotype, peripheral view. 62-64, Paratypes; 62, ventral view; 63, peripheral view; 64, dorsal view.

From photographs retouched by Patricia G. Edwards.


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chambers, wider keel, and more pronounced lobe above the aperture.

DISCORBIS INCRUSTATUS Cushman and Bermudez, n. sp. (Pl. 2, figs. 17, 18)

Test nearly circular in dorsal view, much compressed, dorsal side with the central portion of the spire convex, then flattening out or even becoming concave toward the periphery, ventral side slightly concave, periphery subacute, not definitely keeled; chambers numerous, about 7 in the adult whorl, distinct, of rather uniform shape, increasing very gradually in size as added, ventrally, chambers somewhat indistinct, the inner end slightly contracted, dorsally the margin raised; sutures on the dorsal side strongly curved and oblique, ventrally depressed, nearly radiate; wall unornamented except for the raised margins on the dorsal side; aperture ventral, low. Diameter 1.00 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 23433) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *D. assulata* Cushman in the very oblique chambers with raised borders on the ventral side, radial sutures on the ventral side, and lack of a definite keel.

LAMARCKINA TORREI Cushman and Bermudez, n. sp. (Pl. 2, figs. 24-26)

Test plano-convex, dorsal side with a low, rounded spire, ventral side flattened, slightly umbilicate, periphery subacute, with a rounded keel; chambers 5 or 6 in the adult whorl increasing rather rapidly in size as added, but of uniform shape, periphery on the dorsal side strongly raised, ventrally ending in a point at the inner end; sutures strongly curved dorsally, ventrally straight and radiate, slightly depressed; wall of the dorsal side with the periphery and sutures strongly raised, and in the central umbo further thickened to obscure the earlier chambers; aperture a low opening at the ventral border of the last-formed chamber. Length 1.30-1.65 mm.; width 1.10-1.45 mm.; thickness 0.60-0.75 mm.

Holotype (Cushman Coll. No. 23439) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *L. jacksonensis* Cushman in the more strongly developed ornamentation of the dorsal side, straight and radial sutures of the ventral side, and more convex dorsal side.

GYROIDINA ELONGATA Cushman and Bermudez, n. sp. (Pl. 2, figs. 33-35)

Test strongly plano-convex, dorsal side flattened or even slightly concave, ventrally very strongly convex, the growing edge convex, the opposite side concave in peripheral view, not truly umbilicate, periphery subacute, with a thickened border; chambers fairly distinct, 7 or 8 in the adult whorl, increasing rather rapidly in size as added; sutures indistinct, those of the dorsal side nearly radiate, straight; wall smooth; aperture a low, narrow, arched opening about midway of the ventral margin of the last-formed chamber. Diameter 1.15-1.20 mm.; thickness 0.85 mm.

Holotype (Cushman Coll. No. 23447) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *G. orbicularis* d'Orbigny, var. *planata* Cushman in the much more convex ventral side and more pointed form in peripheral view, more strongly developed peripheral margin and less well developed umbilicus.

GYROIDINA PROTEA Cushman and Bermudez, n. sp. (Pl. 2, figs. 39-41)

Test plano-convex, dorsal side flattened or slightly concave, ventral side convex, periphery subacute without a keel, umbilicus not strongly developed; chambers on the dorsal side triangular, increasing very gradually in size as added, ventrally indistinct, 12 to 14 in the adult whorl; sutures of the dorsal side fairly distinct, straight, tangential, slightly depressed, those of the ventral side radial, very strongly limbate and broad, very slightly raised and rounded; wall smooth; aperture a low, narrow opening at the margin of the ventral side of the last-formed chamber, somewhat nearer the umbilical than the peripheral end.

Holotype (Cushman Coll. No. 23449) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *G. orbicularis* d'Orbigny, var. *planata* Cushman in the depressed sutures of the dorsal side, the slightly raised, very broadly limbate sutures of the ventral side, and the much greater number of chambers.

GYROIDINA PLUMMERAE Cushman and Bermudez, n. sp. (Pl. 2, figs. 42-44)

Test strongly plano-convex, dorsal side flattened or even somewhat concave, ventral side very strongly convex, periphery broadly rounded, umbilicate; chambers much inflated, 5 in the adult

whorl, of uniform shape, increasing regularly in size as added, slightly involute on the dorsal side; sutures slightly depressed; wall smooth; aperture a low opening near the umbilical end of the ventral border of the last-formed chamber. Diameter 0.60-0.70 mm.; thickness 0.55 mm.

Holotype (Cushman Coll. No. 23451) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *G. soldanii* d'Orbigny, var. *octocamerata* Cushman and G. D. Hanna in the fewer chambers to the whorl, more involute on the dorsal side, and more convex ventral side.

EPONIDES MARIELENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 27-29)

Test biconvex, dorsal side strongly convex, ventral side much less so, periphery bluntly angled, umbilical region filled with a solid mass of translucent, secondary shell material; chambers about 10 in the adult whorl, of uniform shape, increasing very gradually and regularly in size as added, slightly if at all inflated; sutures on the dorsal side strongly oblique, slightly curved, strongly limbate and slightly raised, ventrally nearly radiate, very slightly depressed; wall smooth; aperture a low elongate opening at the margin of the ventral side of the last-formed chamber. Length 1.20 mm.; breadth 1.05 mm.; thickness 0.70 mm.

Holotype (Cushman Coll. No. 23443) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *E. jacksonensis* (Cushman and Applin) in the larger number of chambers, more limbate and raised sutures, and larger umbilical mass of secondary shell material.

EPONIDES PRINCIPIENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 30-32)

Test plano-convex, dorsal side very strongly convex in a high spire, ventrally flattened, periphery with a rounded, keel-like border, subacute; chambers 5 or 6 in the adult whorl, somewhat obscure on the dorsal side, ventrally very distinct and triangular, increasing very slowly in size as added, the inner end slightly tumid and thickened; sutures of the dorsal side strongly oblique, somewhat limbate and very slightly raised, ventrally nearly radiate, slightly depressed; wall smooth; aperture a low opening on

the ventral side beneath the slightly lobed inner end of the last-formed chamber. Diameter 0.80 mm.; thickness 0.55 mm.

Holotype (Cushman Coll. No. 23441) from the Eocene, Avenida de los Presidentes, in road cut between Hospital "Calixto Garcia" and Havana University, Havana, Cuba (Bermudez Sta. 20).

This species differs from *E. jacksonensis* (Cushman and Applin) in the small size, much higher spire and convex dorsal side, fewer chambers in the whorl, and more expanded inner end of the chambers on the ventral side.

**EPONIDES RUTTENI Cushman and Bermudez, n. sp. (Pl. 2, figs. 33-35)**

Test biconvex, dorsal side very slightly convex, ventral side very strongly so, periphery rounded; chambers 6 or 7 in the adult whorl, of uniform shape and increasing very gradually in size as added, very little if at all inflated; sutures distinct, dorsally nearly straight, very oblique, very slightly depressed, ventrally nearly radiate, slightly curved, very slightly limbate; wall smooth; aperture fairly large, running from near the umbilicus nearly to the periphery along the ventral border of the last-formed chamber which forms a sort of thickened lip. Diameter 0.80-0.90 mm.; thickness 0.65 mm.

Holotype (Cushman Coll. No. 23445) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *E. jacksonensis* (Cushman and Applin) in the lower dorsal and much more convex ventral side, more rounded periphery, and more definitely thickened lip.

**SIPHONINA ADVENA Cushman, var. CUBENSIS Cushman and Bermudez, n. var. (Pl. 2, figs. 19, 20)**

Variety differing from the typical in the fimbriate periphery and more highly developed apertural neck and lip. Length 0.55 mm.; breadth 0.50 mm.; thickness 0.28 mm.

Holotype of variety (Cushman Coll. No. 23435) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

In some respects this variety resembles *S. jacksonensis* Cushman and Applin, but the shape of the chambers and general characters are more like *S. advena* Cushman.

CANCRIS CUBENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 48-50)

Test nearly equally biconvex, periphery acute, with a slight keel; chambers few, five in the final whorl, overlapping, of rather uniform shape but increasing very rapidly in size as added; the last chamber making up nearly half the surface of the test, slightly inflated; sutures slightly depressed, on the dorsal side gently curved, ventrally nearly radial; wall smooth; aperture ventral, a low, elongate opening, near the umbilical end of the last-formed chamber. Length 0.75 mm.; breadth 0.55 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 23453) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *C. brongniartii* (d'Orbigny) in the fewer, more overlapping chambers, larger proportion of the test made up by the final chamber and acute, keeled periphery.

BAGGINA MARIELINA Cushman and Bermudez, n. sp. (Pl. 2, figs. 21-23)

Test only slightly compressed, dorsal side somewhat flattened, ventral side strongly convex and somewhat umbilicate, periphery broadly rounded, spire depressed and covered by the last whorl; chambers few, about 4 or 5 in the final whorl, much inflated, increasingly rapidly in size as added, becoming involute on the dorsal side, ventrally ending in a truncate lobe at the inner end; sutures of the dorsal side slightly depressed, nearly straight, strongly oblique, ventrally strongly depressed, slightly curved, nearly radial; wall smooth; aperture an elongate opening in the umbilical region of the ventral side. Length 0.75 mm.; breadth 0.65 mm.; thickness 0.60 mm.

Holotype (Cushman Coll. No. 23437) from the Eocene, 4.5 kms. W. of Guanajay on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *B. californica* Cushman in the more inflated chambers on the ventral side, more largely covered spire dorsally, and the lobular character of the ventral ends of the chambers.

GLOBIGERINA DISSIMILIS Cushman and Bermudez, n. sp. (Pl. 3, figs. 4-6)

Test subglobular, spire low, periphery broadly rounded; chambers few, four in the adult whorl, inflated, subglobular, ventrally with the last-formed chamber smaller, nearly covering the um-

bilicus, quadrangular in side view; sutures strongly depressed; wall coarsely cancellated except that of the peculiar last chamber which is much smoother; aperture rounded, opening into the umbilical area below the last chamber. Diameter 0.50-0.55 mm.; thickness 0.45 mm.

Holotype (Cushman Coll. No. 23430) from the Eocene, 1 km. N. of Arroyo Arenas on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *G. eocaena* Gümbel in the more compact form, less lobulate periphery, and the peculiarly shaped and smoother last chamber.

GLOBOROTALIA PALMERAE Cushman and Bermudez, n. sp. (Pl. 2, figs. 51-53)

Test about equally plano-convex, compressed, periphery with prominent, slightly flattened spines, and slightly keeled; chambers six or seven in the adult whorl, increasing rather evenly in size as added, inflated, the periphery of each in the adult usually ending in a somewhat tangentially pointing spine; sutures distinct, particularly on the dorsal side, slightly curved, ventrally nearly radial, strongly depressed; wall smooth, rather coarsely perforate, especially on the ventral side; aperture a low opening near the umbilical end of the ventral margin of the last-formed chamber. Length with spines 0.40-0.60 mm., without spines 0.28-0.35 mm.; breadth with spines 0.36-0.46 mm., without spines 0.24-0.30 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 23423) from the Eocene, Tejar "Cuba," Arroyo Naranjo (lower beds), Havana Province, Cuba (Bermudez Sta. 235C).

This species differs from *G. lehneri* Cushman and Jarvis in the smoother surface, less inflated chambers, and the periphery with a single large spine on each chamber instead of several small spines.

GLOBOROTALIA CENTRALIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 62-65)

Test unequally biconvex, dorsal side only slightly so, ventrally very strongly convex, periphery rounded; chambers few, about 4 in the adult whorl, inflated, increasingly rapidly in size as added; sutures distinct, depressed, on the dorsal side strongly oblique, gently curved or nearly straight, ventrally radial; wall smooth, distinctly perforate; aperture an elongate, low, arched opening

about midway of the ventral side from periphery to umbilicus. Diameter 0.45-0.55 mm.; thickness 0.35-0.45 mm.

Holotype (Cushman Coll. No. 23425) from the Eocene, under R. R. bridge on Central Highway located in Jicotea, Santa Clara Province, Cuba (Bermudez Sta. 92).

This species differs from *G. cocoaensis* Cushman in the more inflated form, more convex ventral side, and more rounded periphery.

ANOMALINA CORRUGATA Cushman and Bermudez, n. sp. (Pl. 2, figs. 57-59)

Test plano-convex, dorsal side flattened to even somewhat concave, ventral side strongly convex, periphery in the early portion subacute, in the later portion broadly rounded; chambers 6 or 7 in the last-formed whorl, inflated on the ventral side throughout, last ones on the dorsal side strongly inflated, increasing rapidly in size as added, the last two making up nearly half the surface of the test; sutures somewhat indistinct, slightly depressed, ventrally nearly radial, dorsally somewhat curved; wall very coarsely pitted; aperture an arched opening at the base of the last-formed chamber at the periphery. Diameter 0.80-1.25 mm.; thickness 0.40-0.85 mm.

Holotype (Cushman Coll. No. 23419) from the Eocene, 4.5 kms. W. of Guanajay, on road to Mariel, Pinar del Rio Province, Cuba (Bermudez Sta. 337A).

This species differs from *Anomalina cocoaensis* Cushman in the fewer chambers, which are much more inflated, lack of central umbo, non-limbate chambers, and coarsely pitted surface.

ANOMALINA ALMENDARENSIS Cushman and Bermudez, n. sp. (Pl. 2, figs. 60, 61)

Test plano-convex, dorsal side gently convex, ventral side flattened or slightly concave; periphery subacute, with a rounded keel; chambers about 7 in the adult whorl, rather rapidly increasing in size as added, slightly inflated; sutures strongly curved, limbate, raised; wall of dorsal side distinctly perforate, ventral side more coarsely so, with numerous, irregularly scattered, rounded, or elongate, raised bosses; aperture at the periphery, small, arched, slightly extending to the ventral side. Diameter 0.90-0.95 mm.; thickness 0.45 mm.

Holotype (Cushman Coll. No. 23421) from the Eocene, Alturas de Almendares Quarry in Reparto Kohly, W. side of Almendares River, Havana, Cuba (Bermudez Sta. 18).

This species differs from *A. bilateralis* Cushman in the fewer and higher chambers, flatter ventral side, more strongly curved sutures, and ornamentation of the surface.

CIBICIDES HAVANENSIS Cushman and Bermudez, n. sp. (Pl. 3, figs. 1-3)

Test biconvex, dorsal side more strongly convex than the ventral, periphery subacute, with a bluntly-angled keel, umbilical region filled with a mass of secondary material; chambers numerous, about 12 in the adult whorl, of uniform shape, increasing very gradually in size as added, those of the earlier whorls on the dorsal side nearly obscured by secondary shell growth; sutures on the dorsal side, strongly oblique, nearly straight, limbate, ventrally gently curved, not depressed; wall smooth, except for the secondary layer over the spire; aperture, a small opening at the peripheral margin, extending to the dorsal side under a peculiar, projecting lobe of the chamber border. Diameter 0.65-0.75 mm.; thickness 0.40 mm.

Holotype (Cushman Coll. No. 23427) from the Eocene, Tejar "Cuba," Arroyo Naranjo (lower beds), Havana Province, Cuba (Bermudez Sta. 235C).

This species differs from *C. pseudoungerianus* (Cushman) in the high spire, strongly convex dorsal side, larger number of chambers, and strongly lobed final chamber.

PLANULINA SIMPLEX Cushman and Bermudez, n. sp. (Pl. 2, figs. 45-47)

Test small, much compressed, biconvex, highest in the middle, thence sloping to the subacute, somewhat carinate periphery, involute on both sides; chambers very distinct, strongly overlapping, of uniform shape, increasing very gradually in size as added; sutures very much curved, strongly limbate, slightly raised; wall smooth; aperture at the base of the apertural face, extending over onto the dorsal side, with a somewhat overhanging extension at the base of the last-formed chamber. Diameter 0.30-0.35 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 23457) from the Eocene, under Library of Havana University, Havana, Cuba (Bermudez Sta. 257).

This species differs from *P. cocoaensis* Cushman in the much smaller size, completely involute final whorl, and more strongly curved and limbate sutures.

PLANULINA SUTURATA Cushman and Bermudez, n. sp. (Pl. 2, figs. 54-56)

Test much compressed, dorsal side very slightly convex, ventral side slightly concave, umbilicate, periphery with a distinct, rounded keel; chambers 6 or 7 in the adult whorl, of uniform shape, increasing regularly in size as added, slightly inflated, on the ventral side with a distinct lobe at the umbilical end; sutures distinct, depressed, curved, more strongly so on the ventral side, limbate dorsally; wall smooth, coarsely perforate; aperture extending from the periphery slightly to the ventral side. Length 0.60-0.85 mm.; breadth 0.50-0.60 mm.; thickness 0.15-0.25 mm.

Holotype (Cushman Coll. No. 23455) from the Eocene, 1 km. N. of Arroyo Arenas, on road to Jaimanitas (water well), Havana Province, Cuba (Bermudez Sta. 31).

This species differs from *P. cocoaensis* Cushman in the fewer chambers, more evolute test, open umbilical region, and less compressed form.

## 181. ASTRONONION, A NEW GENUS OF THE FORAMINIFERA, AND ITS SPECIES

By JOSEPH A. CUSHMAN and PATRICIA G. EDWARDS

A study of material usually referred to *"Nonionina stelligera* d'Orbigny," both fossil and recent, from various parts of the world, has revealed very interesting structures. There are at least two distinct lines of development which apparently have definite relationships. In all the specimens there are developed supplementary chambers, alternating with the main chambers of the test in the region toward the umbilicus. In one, and apparently the earliest development, these supplementary chambers are in the form of narrow, tubular structures, reaching from the umbilicus, along the sutures, part way to the periphery, where they open to the surface. In the second group, the earliest chambers are of the same general form as already noted, but this is followed by more or less rhomboid chambers, occupying the same relative position, but with the opening at the outer posterior side. In addition, there are, apparently in certain species, supple-

mentary tubular openings extending forward, and appearing as rounded openings on the surface of the main chamber itself, toward the inner end, and adjacent to the supplementary chamber (Pl. 3, figs. 13, 20). These structures seem to have a definite significance, and are of sufficient importance to warrant the erection of a new genus for those species which develop them.

**Genus ASTRONONION Cushman and Edwards, n. gen.**

Genotype, *Nonionina stelligera* d'Orbigny

*Nonionina* and *Nonion* (part) of authors.

Test free, planispiral, coiled, bilaterally symmetrical or nearly so, periphery broadly rounded; chambers numerous, distinct, usually somewhat inflated, with supplementary tubular or rhomboid chambers on both sides, alternating with the primary chambers; wall calcareous, perforate; aperture of the main series of chambers at the base of the last-formed chamber in the median line, a low arched opening, which in some species may be somewhat subdivided, the supplementary chambers with either rounded openings at the peripheral end, or, in those species with distinctly rhomboid supplementary chambers, with the aperture elongate along the peripheral posterior margin.—Eocene (?) Oligocene—Recent.

Stellate forms referred to "Nonionina" have been recorded as early as the Eocene of Europe. We have found specimens in our material from the Eocene of Biarritz, France, the locality from which Halkyard recorded the species, which probably belong to this genus, but in the specimens studied, the structures are not clear enough to warrant description. They are extremely rare, and more material must be studied. In the Oligocene of Australia there are very definite specimens, some of which are here figured, and in the young, the early stages of the supplementary chambers seem to be of the narrow tubular type, followed in the later stages by the broader, more definitely rhomboid shape. The peculiar tubular structures, which seem to open in the lateral face of the larger chambers, and connect with the previous supplementary chamber, are here suggested as worthy of further study. The various species are figured on our plate, and while specimens show a certain amount of variation, those selected seem to be typical of their species.

ASTRONONION STELLIGERUM (d'Orbigny) (Pl. 3, figs. 7 a, b)

*Nonionina stelligera* D'ORBIGNY, in Barker-Webb and Berthelot, Hist. Nat. Iles Canaries, 1839, vol. 2, pt. 2, "Foraminifères," p. 128, pl. 3, figs. 1, 2.

Test strongly compressed, umbilical region slightly depressed, periphery rounded; chambers of the primary coil distinct, of rather uniform shape, increasing regularly in size as added, slightly if at all inflated, apertural face much higher than broad, supplementary chambers elongate, narrow, very irregularly rhomboid, with a very sharp, distinct angle toward the umbilical end, pointing posteriorly; sutures distinct, rather strongly curved, little if at all depressed, those between the supplementary chambers very distinct; wall smooth, finely perforate; aperture low, arched, opening at the base of the apertural face at the median line. Diameter 0.35-0.50 mm.; thickness 0.15-0.20 mm.

The types of this species were from shallow water off the Island of Teneriffe, Canary Islands, where d'Orbigny recorded it as very rare. There have been many records referred to this species, both fossil and recent, by many authors from various parts of the world. A study of these figures seems to show that none of them are identical with the species figured and described by d'Orbigny. We have been unable to study any material from the type locality, but d'Orbigny's description coincides well with his figure, and we are, therefore, to believe that they are reasonably accurate. We have given new names to the other species which we have found and figured. The group has proved to be a difficult one to figure in its complete details, and as a result, the earlier figures of various authors should be carefully compared with the original specimens.

ASTRONONION SIDEBOTTOMI Cushman and Edwards, n. sp. (Pl. 3, figs. 8 a, b)

*Nonionina stelligera* SIDEBOTTOM (not D'ORBIGNY), Mem. Proc. Manchester Lit. Philos. Soc., vol. 53, No. 21, 1909, p. 13, pl. 4, fig. 9.

Test somewhat compressed, umbilical region very slightly depressed, periphery rounded, lobulate, apertural face about as high as broad, usually somewhat oblique; chambers 9 or 10 in the primary coil, distinct, much inflated, supplementary chambers elongate, the later ones triangular rather than rhomboid, earlier ones rhomboid; sutures distinct, slightly curved, depressed; wall smooth, distinctly perforate; aperture a low, arched opening at the base of the apertural face, apertures of supplementary cham-

bers at the posterior side, in the earlier ones toward the periphery, in the adult running all the way from the umbilicus to the outer point. Diameter 1.25 mm.; thickness 0.55 mm.

Holotype (Cushman Coll. No. 12848) from the Bay of Naples.

This species differs from *A. stelligerum* (d'Orbigny) in the much thicker test, broader and triangular supplementary chambers, and lobulate periphery. The species is evidently that recorded by Sidebottom from off the Island of Delos and from the Bay of Palermo. It has occurred in material kindly sent us by Mr. Sidebottom from Delos, and we have specimens also from off Ville Franche, France, and from the Bay of Naples.

ASTRONONION STELLATUM Cushman and Edwards, n. sp. (Pl. 3, figs. 9-11)

Test somewhat compressed, umbilical region slightly depressed, periphery broadly rounded, lobulate, apertural face about as high as broad; chambers 7 or 8 in the adult, strongly inflated, supplementary chambers strongly rhomboid, the outer end in adult very tapering; sutures depressed, strongly curved; wall smooth, distinctly but finely perforate; aperture a low, arched slit at the base of the last-formed chamber, sometimes slightly subdivided, in the supplementary chambers a long, low opening at the posterior peripheral margin. Diameter 0.60-0.95 mm.; thickness 0.25-0.45 mm.

Holotype (Cushman Coll. No. 10399) from off southern Iceland.

This species differs from *A. stelligerum* (d'Orbigny) in the very rounded apertural face, less compressed test, fewer chambers, and broader supplementary chambers. This species is apparently well distributed in the northern portion of the North Atlantic, from around the British Isles northward, where it has probably been recorded as *"Nonionina stelligera."* It differs from the Mediterranean species in the more definitely rhomboid supplementary chambers, and fewer primary chambers.

ASTRONONION VIRAGOENSE Cushman and Edwards, n. sp. (Pl. 3, figs. 12 a, b)

Test somewhat compressed, strongly umbilicate, periphery very broadly rounded, apertural face broader than high, periphery somewhat lobulate; chambers about 7 in the adult, increasing rather rapidly in size as added, very strongly inflated, supplementary chambers very broadly rhomboid, somewhat fused; sutures depressed, strongly curved in the earlier stages, slightly so in the adult, strongly depressed; wall smooth, finely perforate;

aperture at the base of the apertural face, subdivided into numerous, small openings, those of the supplementary chambers low, at the posterior peripheral side. Diameter 0.60 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 23645) from Virago Sound, British Columbia.

This species differs from *A. stelligerum* (d'Orbigny) in the fewer chambers, which are strongly inflated, the very broad supplementary chambers, and the subdivided aperture. It differs from the two species previously described, in the fewer chambers, very broad apertural face, and the subdivided aperture.

ASTRONONION TUMIDUM Cushman and Edwards, n. sp. (Pl. 3, fig. 17)

*Nonionina stelligera* (part) H. B. BRADY (not d'Orbigny), Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 728, pl. 109, fig. 5.

Test somewhat depressed, periphery broadly rounded, lobulate, umbilical regions depressed; chambers of the primary coil few, 6 or 7, inflated, of uniform shape, increasing gradually in size as added, supplementary chambers elongate, rhomboid, the outer ends elongate, tapering; sutures distinct, depressed, slightly curved; wall smooth, finely perforate; aperture of the supplementary chambers, along the posterior peripheral margin. Diameter 0.60 mm.

Brady's figured specimen is from *Challenger* Station No. 344, in 420 fathoms, off Ascension Island in the South Atlantic.

This species has fewer and more tumid chambers than *A. stelligerum* (d'Orbigny), and its supplementary chambers are much more regularly rhomboid, and larger. It differs from *A. viragoense*, which it most closely resembles, in the much more tapering supplementary chambers.

ASTRONONION AUSTRALE Cushman and Edwards, n. sp. (Pl. 3, figs. 13, 14)

Test compressed, periphery broadly rounded, slightly lobulate, the apertural face slightly higher than broad, umbilical region slightly depressed; chambers distinct, usually arched in the adult, somewhat inflated, increasing rather regularly in size as added, supplementary chambers in the adult irregularly rhomboid, in early stages somewhat tubular; wall smooth, distinctly perforate; aperture, a low opening at the base of the apertural face, in the supplementary chambers forming a narrow, semi-elliptical open-

ing, placed obliquely at the posterior side, near the periphery. Diameter 0.90-1.10 mm.; thickness 0.25-0.40 mm.

Holotype (Cushman Coll. No. 6653) from the Oligocene, Balcombian of Muddy Creek, Victoria, Australia.

This species differs from *A. stelligerum* (d'Orbigny) in the more lobulate periphery, broader apertural face, and the completely covered umbilical region. It differs from most of the other species already described, in the more tubular supplementary chambers of the earlier stages, and the more arched aperture. This species occurs also in the Miocene of Filter Quarries, Victoria, and in the lower Pliocene of Beaumaris, near Melbourne, Victoria, Australia. In some respects this resembles d'Orbigny's figure of *A. stelligerum* more than do most of the other species which had been referred to his, but there are many points of difference between the two.

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## EXPLANATION OF PLATE 3

FIGS.

1–3. *Cibicides havanensis* Cushman and Bermudez, n. sp. × 33. 3, Holotype, dorsal view. 1, 2, Paratypes; 1, ventral view; 2, peripheral view.

4–6. *Globigerina dissimilis* Cushman and Bermudez, n. sp. × 33. 4, Holotype, ventral view. 5, 6, Paratypes; 5, side view; 6, dorsal view.

7. *Astrononion stelligerum* (d'Orbigny). (After d'Orbigny.)

8. *Astrononion sidebottomi* Cushman and Edwards, n. sp. × 25. Holotype.

9–11. *Astrononion stellatum* Cushman and Edwards, n. sp. 9, Holotype, off Iceland. × 30. 10, 11, *Porcupine* Sta. 8. 10, × 30. 11, × 40.

12. *Astrononion viragoense* Cushman and Edwards, n. sp. × 50. Holotype.

13, 14. *Astrononion australe* Cushman and Edwards, n. sp. 14, Holotype, × 33. Oligocene, Muddy Creek, Victoria. 13, × 27, Pliocene, Beaumaris, Victoria.

15, 16. *Astrononion fijiense* Cushman and Edwards, n. sp. (After H. B. Brady). × 40. Recent, Fiji. 15, Holotype. 16, Paratype.

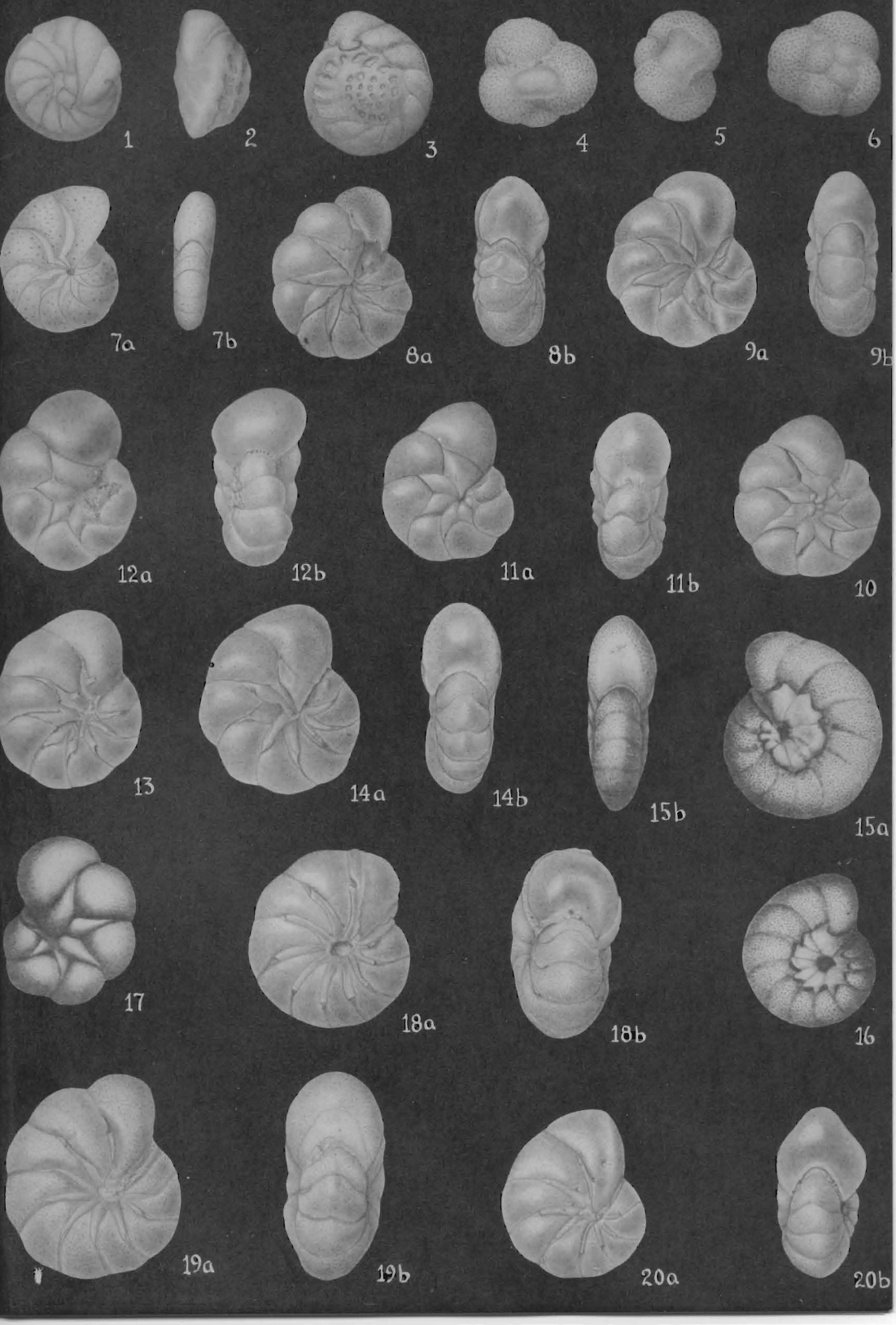
17. *Astrononion tumidum* Cushman and Edwards, n. sp. × 40. Recent, off Ascension Island.

18. *Astrononion novo-zealandicum* Cushman and Edwards, n. sp. × 27. Recent, off New Zealand.

19, 20. *Astrononion italicum* Cushman and Edwards, n. sp. 19, Holotype; × 27. 20, Paratype, × 33.

In all figures: *a*, side view; *b*, peripheral view.

From retouched photographs and drawings by Patricia G. Edwards.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ASTRONONION FIJIENSE Cushman and Edwards, n. sp. (Pl. 3, figs. 15, 16)

*Nonionina asterizans* H. B. BRADY (not FICHTEL and MOLL), Rep. Voy. *Challenger*, Zool., vol. 9, 1884, pl. 109, figs. 1, 2.

Test much compressed, umbilical regions flattened or slightly depressed, periphery rounded; chambers of the primary coil numerous, about 12 in the adult coil, of uniform shape, increasing very gradually in size as added, supplementary chambers small, roughly rhomboid, alternating with the primary ones; sutures distinct, slightly curved in the primary coil, slightly depressed and somewhat limbate, those of the supplementary chambers less distinct; wall coarsely perforate; aperture a low opening in the median line at the base of the apertural face, in the supplementary chambers at the posterior peripheral side. Diameter 0.80 mm.; thickness 0.35 mm.

This species differs from *A. stelligerum* (d'Orbigny) in the greater number of chambers, very short, and somewhat fused supplementary chambers, and the very coarsely perforate wall. Brady's *Challenger* specimens were from off Fiji.

ASTRONONION NOVO-ZEALANDICUM Cushman and Edwards, n. sp. (Pl. 3, figs. 18 a, b)

Test slightly compressed, umbilicate, periphery nearly entire, very slightly umbilicate, in later portion broadly rounded, apertural face somewhat broader than high; chambers distinct, about 10 in the adult coil, slightly if at all inflated, increasing very gradually in size as added, supplementary chambers elongate, tubular, of rather uniform diameter throughout; sutures very slightly if at all depressed; wall smooth, coarsely perforate; aperture at the base of the apertural face, low, arched, those of the supplementary chambers semicircular at the outer end. Diameter 1.10 mm.; thickness 0.60 mm.

Holotype (Cushman Coll. No. 23639) from off New Zealand.

This species differs from *A. stelligerum* (d'Orbigny) in the much less compressed form, and in the tubular secondary chambers.

ASTRONONION ITALICUM Cushman and Edwards, n. sp. (Pl. 3, figs. 19, 20)

Test somewhat compressed, umbilicate, periphery somewhat lobulate, broadly rounded, apertural face about as broad as high; chambers distinct, 10 to 12, increasing very gradually in size as added, slightly if at all inflated, supplementary chambers elongate, generally tubular, but more or less tapering toward the

outer end; sutures distinct, slightly limbate, very slightly depressed, gently curved; wall thick, coarsely perforate; aperture at the base of the apertural face, low, sometimes slightly divided, in the supplementary chambers elongate, very oblique, at the posterior side at the peripheral end. Diameter up to 1.25 mm.; thickness 0.60 mm.

Holotype (Cushman Coll. No. 23642) from the Pliocene clays of Coroncina, near Siena, Italy.

This species differs from *A. stelligerum* (d'Orbigny) in the larger number of chambers and very narrow, tubular, supplementary chambers, with oblique apertures.

In some of the specimens of this species there are apparently supplementary apertures in the face of the primary chambers, connecting with the supplementary chambers by a tubular canal. Somewhat similar structures were noted in *A. australe* Cushman and Edwards, n. sp.

## 182. NOTES ON SOME OLIGOCENE SPECIES OF BULIMINA AND BULIMINELLA

By JOSEPH A. CUSHMAN and FRANCES L. PARKER

In a study of the known Oligocene species of *Bulimina* and *Buliminella*, topotypes or specimens from nearby localities were obtained. Representative specimens are here figured and described, together with several new species and varieties.

**BULIMINA SOCIALIS** Bornemann (Pl. 4, figs. 1 a-c)

*Bulimina socialis* BORNEMANN, Zeitschr. deutsch. geol. Ges., vol. 7, 1855, p. 342, pl. 16, fig. 10.

Test medium, about 1½ times as long as broad, somewhat oval in shape, with the widest part at about the middle; chambers few, distinct, the last whorl forming the larger part of the test, slightly inflated; sutures distinct, depressed; wall thin, perforate; aperture elongate, loop-shaped, with a slight lip, extending from the margin of the last-formed chamber, well above the suture joining

the second and third chambers. Length 0.47 mm.; breadth 0.30 mm.

A single, very poor specimen was found in our material from the middle Oligocene of Hermsdorf, the type locality. Good specimens, however, were found in middle Oligocene material from Ratingen, Dusseldorf, Germany, one of which is here figured.

BULIMINA COPROLITHOIDES Andreae (Pl. 4, figs. 2 a-c)

*Bulimina coprolithoides* ANDREAE, Abhandl. geol. Special-Karte Elsass-Lothringen, vol. 2, pt. 3, 1884, p. 213, pl. 6, figs. 4 *a-d*.

Test small, somewhat longer than broad, very slightly tapering, somewhat twisted; chambers few, about three whorls, the last-formed whorl composing about three-fourths of the test, distinct, inflated; sutures distinct, depressed; wall polished, translucent, perforate; aperture broad, loop-shaped, deep-set, with a slight lip, placed just above the junction of the second and third chambers. Length 0.22 mm.; breadth 0.16 mm.

Specimens closely resembling Andreae's description and figures were found in Stampian material from Ormoy, Seine-et-Oise, France, and one of them is here figured.

BULIMINA SCULPTILIS Cushman (Pl. 4, figs. 3 a-c)

*Bulimina sculptilis* CUSHMAN, U. S. Geol. Surv., Prof. Paper 133, 1923, p. 23, pl. 3, fig. 3.

Test elongate, at least twice as long as broad, tapering, subacute at the initial end; chambers numerous, distinct; sutures slightly depressed, distinct; wall finely perforate, ornamented with about 10, thin, low, longitudinal costae, extending from halfway down the last-formed whorl to the base of the test, without a break, but with slight depressions at the sutures, giving a somewhat scalloped effect; aperture long, comma-shaped, with a well developed lip, placed somewhat above the junction of the second and third chambers. Length 0.77 mm.; breadth 0.40 mm.

There has been some confusion between this species and *Bulimina jacksonensis* Cushman. *B. sculptilis* has more numerous and more distinct chambers of a somewhat more angled character, lower and more regular costae, and is much less tapering, having a more uniform width throughout. The specimen here figured is from U. S. G. S. Sta. 8752, Red Bluff clay, Red Bluff, Hiwanee, Mississippi.

BULIMINA SCULPTILIS Cushman, var. LACINIATA Cushman and Parker, n. var. (Pl. 4, figs. 4 a-c)

*Bulimina sculptilis* CUSHMAN and SCHENCK (not CUSHMAN), Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 17, 1928, p. 311, pl. 43, fig. 16.

Variety differing from the typical in the more tapered test, usually terminating in a blunt spine, somewhat inflated chambers, especially those of the last whorl, and more jagged costae. Length 0.56-0.80 mm.; breadth 0.40-0.44 mm.

Holotype of variety (Cushman Coll. No. 23646) from the Bassendorf shale, U. C. Loc. 4198 and A. 198, Waldfort, Oregon.

BULIMINA JUGOSA Cushman and Parker, n. sp. (Pl. 4, figs. 5 a-c)

Test small, rapidly tapering, about 1½ times as long as broad; chambers very indistinct, 3-4 whorls; sutures indistinct, slightly depressed; wall coarsely perforate, sometimes slightly translucent, ornamented by numerous longitudinal, low, rounded costae; aperture somewhat deepset, loop-shaped, with a very slight lip, just above the junction of the second and third chambers. Length 0.30-0.48 mm.; breadth 0.20-0.30 mm.

Holotype (Cushman Coll. No. 23653) from the Punta Blanca shales, Sea Cliff near village of Rio Seco, 1° 10′ S. of Equator, 9.25 kms. SW. of Manta, Ecuador.

This species belongs to the same general group as *Bulimina*

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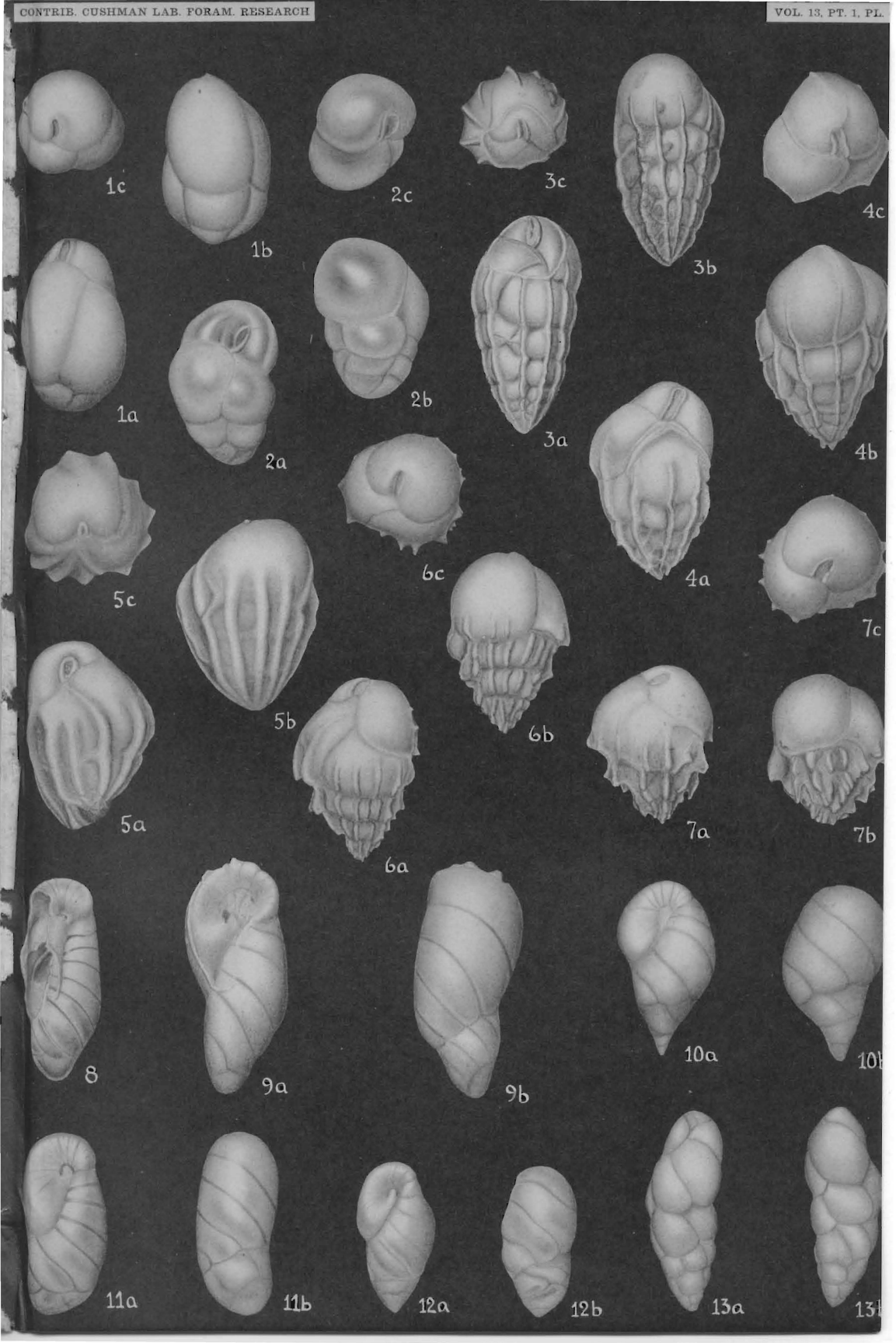
EXPLANATION OF PLATE 4

FIGS.

1. *Bulimina socialis* Bornemann. × 60.
2. *Bulimina coprolithoides* Andreae. × 120.
3. *Bulimina sculptilis* Cushman. × 47.
4. *Bulimina sculptilis* Cushman, var. *laciniata* Cushman and Parker, n. var. × 47.
5. *Bulimina jugosa* Cushman and Parker, n. sp. × 87.
6, 7. *Bulimina alsatica* Cushman and Parker, n. sp. × 80. 6, Holotype. 7, Paratype.
8, 9. *Buliminella obtusata* Cushman. × 87. 8, Holotype, front view. 9, Topotype.
10. *Buliminella apiculata* (Chapman). × 60.
11, 12. *Buliminella apiculata* (Chapman), var. *hebetata* Cushman and Parker, n. var. × 60. 11, Holotype. 12, Paratype.
13. *Buliminella bassendorfensis* Cushman and Parker, n. sp. × 60.

In all figures: *a*, front view; *b*, rear view; *c*, apertural view.

Figures drawn by Ann Shepard.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*alazanensis* Cushman, but differs from it in having a much broader test, which reaches its greatest width nearly at the top, heavier, and more rounded costae, and a blunt initial end.

BULIMINA ALSATICA Cushman and Parker, n. sp. (Pl. 4, figs. 6, 7)

Test small, about 1½ times as long as broad, tapering, the initial end of the test having one or more short spines; chambers indistinct except for those of the last whorl, undercut at the base, somewhat inflated, especially those in the last whorl; sutures indistinct, depressed; wall of most of the last whorl smooth, the rest of the test with plate-like costae ending in plate-like spines, bent downward, giving a hooked appearance, the costae usually not crossing the sutures; aperture loop-shaped, with a well defined lip, well above the junction of the second and third chambers. Length 0.34-0.57 mm.; breadth 0.22-0.44 mm.

Holotype (Cushman Coll. No. 23650) from the Oligocene of Hartmannsweiler, in Alsace.

This species somewhat resembles *Bulimina cooperensis* Cushman, but differs in being larger and broader in proportion to its length, with better developed costae, and in the hooked character of many of the spines. Specimens were found at several localities in the Oligocene of Germany, in addition to the type locality in Alsace.

BULIMINELLA OBTUSATA Cushman (Pl. 4, figs. 8, 9)

*Buliminella obtusata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, 1929, p. 42, pl. 7, figs. 8 *a*, *b*.

Test elongate, between 2 and 3 times as long as broad, usually not more than 2 whorls; chambers numerous, 7 or more in the last whorl; sutures distinct, flush with the surface, except for the spiral suture, which may be depressed; wall smooth, polished, finely perforate; aperture in a slight depression of the apertural face, which is large and concave, gradually depressed to its deepest at the aperture. Length up to 0.46 mm.; breadth up to 0.20 mm.

Our figured specimens are from the lower Oligocene, Byram marl, Byram, Mississippi.

BULIMINELLA APICULATA (Chapman) (Pl. 4, figs. 10 a, b)

*Bulimina elegantissima* D'ORBIGNY, var. *apiculata* CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1907, p. 31, pl. 4, fig. 77.

Test of 2 or 3 whorls, small, tapering, terminated by a stout

spine; chambers fairly numerous, 6-8 in the adult whorl, distinct; sutures distinct, somewhat limbate, flush with the surface; wall smooth, polished, finely perforate; aperture rounded, sometimes with a tooth-like projection extending up over it, near the top of the apertural face, which is convex around the outside and depressed toward the aperture. Length 0.40-0.72 mm.; breadth 0.24-0.38 mm.

This species is obviously a *Buliminella,* and does not seem to be sufficiently close to *B. elegantissima* to be called a variety of it. It seems best, therefore, to make it an independent species. An interesting fact to note in connection with this form is its great variation in size. Our specimens all came from Balcombian material at various localities in Victoria, Australia. The figured specimen is from Balcombe Bay, Mornington, Victoria, Australia.

**BULIMINELLA APICULATA (Chapman), var. HEBETATA Cushman and Parker, n. var.** (Pl. 4, figs. 11, 12)

Variety differing from the typical in its smaller size, and in having a blunt initial end without a spine.

Holotype of variety (Cushman Coll. No. 23656) from the Balcombian, Muddy Creek, Victoria, Australia.

This form occurs with *Buliminella apiculata* (Chapman) at many localities, but the absence of the basal spine makes the two forms easy to separate. Our specimens all come from the Balcombian of Victoria, Australia.

**BULIMINELLA BASSENDORFENSIS Cushman and Parker, n. sp.** (Pl. 4, figs. 13 a, b)

Test of about 5 whorls, elongate, very gradually tapering, 2½ to 3 times as long as broad; chambers about 4 to a whorl, distinct, somewhat inflated; sutures distinct, depressed; wall smooth, polished, finely perforate, sometimes with very fine, small spines on the early portion of the test; aperture, a rounded loop-shaped opening near the top of the very short and narrow apertural face. Length 0.55 mm.; breadth 0.20 mm.

Holotype (Cushman Coll. No. 23659) from Bassendorf shale, U. C. Loc. 4198 and A. 198, Waldfort, Oregon.

This species resembles *Buliminella subfusiformis* Cushman, but differs from it in having fewer whorls, longer, less inflated chambers, and is more rapidly coiling. Our species shows very little variation in size.