

CONTRIBUTIONS FROM THE CUSHMAN  
LABORATORY FOR FORAMINIFERAL RESEARCH

224. NEW OLIGOCENE-MIOCENE FORAMINIFERA  
FROM VENEZUELA

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The present paper includes the description of 42 new species and 12 new varieties of Foraminifera from the Agua Salada Formation of Eastern Falcon (Northern Venezuela). In addition to these new forms, the Formation contains approximately 135 species and varieties already described. The Agua Salada Formation is of Upper Oligocene to Middle (and ?partly Upper) Miocene age, and represents the clay facies of the following synchronous formations of Central Falcon (bottom to top):—

Top part of the Agua Clara Formation

Cerro Pelado Formation

Socorro—Caujarao Formations

Part of the La Vela Formation

The Type section for the Lower Agua Salada Formation is at El Mene de Acosta, and for the Upper Agua Salada Formation at Pozon. The distribution of the smaller Foraminifera enables the lithologically uniform Agua Salada Formation to be subdivided into the following foraminiferal zones (from bottom to top):—

*Lower Agua Salada Formation*

1. Zone of *Marginulina wallacei* (Upper Oligocene)
2. Zone of *Siphogenerina multicostata* and  
*Gaudryina thalmani* (Lowermost Miocene)

*Upper Agua Salada Formation*

3. Zone of *Cibicides kugleri* (Lower to Middle Miocene)
4. Zone of *Marginulina basispinosa* and *Robulus senni*  
(Middle Miocene)

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5. Zone of *Trochammia* sp. (Middle to ?Upper Miocene)
6. Zone of *Textularia panamensis* (?Upper Miocene)
7. Zone of *Rotalia beccarii* and *Elphidium poeyanum* (?Upper Miocene)

On later pages these zones are mentioned by numbers only.

The foraminiferal samples have been collected by geologists of the North Venezuelan Petroleum Co., Ltd., and Tocuyo Oilfields of Venezuela, Ltd. These samples located in detail in the text are stored for reference in the Geological Laboratory of Trinidad Leaseholds, Ltd., Pointe-à-Pierre, Trinidad, B. W. I.

### ACKNOWLEDGMENTS

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We also wish to express our thanks to Dr. C. M. B. Caudri who made the drawings for the plates; to Dr. C. G. Lalicker (University of Oklahoma) who was good enough to examine the Textulariidae of the Agua Salada and to give his opinion on the new species of that family.

#### HAPLOPHRAGMOIDES CARINATUM Cushman and Renz, n. sp. (Pl. 1, fig. 1)

Test of medium size, planispiral, involute, umbilical region depressed, periphery slightly lobulate, acute and slightly carinate; chambers 8-10 in the adult coil, of uniform shape, increasing very gradually in size as added; sutures distinct, slightly curved; wall finely arenaceous with a large proportion of cement, surface smoothly finished; aperture a low opening at the base of the apertural face in the median line. Length of holotype 0.55 mm.; breadth 0.10 mm.

Holotype (Cushman Coll. No. 35893) from Curamichate, 17.6 km. West (281°) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. A. 1142).

*H. carinatum* differs from *H. emaciatum* H. B. Brady in the larger number of chambers and greatly compressed and keeled periphery.

*Stratigraphic occurrence:* Lower and Upper Agua Salada

Formation (Zones 2-5). Lowermost—Middle to ?Upper Miocene.

**TEXTULARIA LEUZINGERI** Cushman and Renz, n. sp. (Pl. 1, fig. 2)

Test of medium size, broadly rounded at the initial end, sides in the adult nearly parallel, strongly compressed toward the periphery which is subacute; chambers numerous, low and broad, the early ones indistinct, later ones with the anterior portions strongly raised, concave posteriorly; sutures indistinct, nearly straight, oblique; wall rather coarsely arenaceous, surface somewhat roughened; aperture a narrow, slightly rounded opening at the base of the apertural face in the median line. Length 0.60-0.90 mm.; breadth 0.45-0.50 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 35916) from Isidro, 34.0 km. East (80° 25') of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 158).

This species differs from *T. warreni* Cushman and Ellisor in the straight sutures and more inflated chambers.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-4). Upper Oligocene—Middle Miocene.

**TEXTULARIA FALCONENSIS** Cushman and Renz, n. sp. (Pl. 1, fig. 3)

Test of medium size, strongly compressed, elongate, averaging about 2½ times as long as wide, somewhat narrower toward the apertural end, periphery subacute; chambers numerous, slightly if at all inflated, gradually increasing in height as added; sutures distinct, slightly limbate, gently curved; wall finely arenaceous with much cement, smoothly finished on the exterior; aperture somewhat rounded in the adult with a slight, broadly rounded lip. Length 0.75-0.85 mm.; breadth 0.25-0.33 mm.; thickness 0.14 mm.

Holotype (Cushman Coll. No. 35919) from Central Falcon, 16.5 km. North (349° 15') of Siquisique, District Urdaneta, State Lara, Venezuela. Coll. Dr. A. Senn.

This species differs from *T. laevigata* d'Orbigny in its higher chambers, more curved and limbate sutures, and rounded aperture.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 2). Lowermost Miocene.

**TEXTULARIA LALICKERI** Cushman and Renz, n. sp. (Pl. 1, figs. 4, 5)

Test of medium size, very strongly compressed, the early portion narrow and slightly tapering, rapidly increasing in breadth in the adult, the greatest breadth at the apertural end, periphery subacute to rounded, lobulate in the adult; chambers of the early portion not inflated, increasing very gradually in size, in the adult increasing rapidly in size, strongly inflated; sutures nearly at right angles to the elongate axis, in the early portion slightly limbate, not depressed, in the adult very strongly depressed; wall finely arenaceous, smoothly finished; aperture rounded, higher than broad, at the base of the apertural face in the median line. Length 0.65-1.20 mm.; breadth 0.55-0.60 mm.; thickness 0.22 mm.

Holotype (Cushman Coll. No. 35917) from Aguide, 2.5 km. South ( $171^{\circ} 25'$ ) of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Core from Aguide Well No. 1 at 237'.

This species differs from *T. gramen* d'Orbigny in the much greater number of chambers, very rapidly expanding in the later portion, and much lower, broader chambers in the adult.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 2). Lowermost Miocene.

**TEXTULARIA POZONENSIS** Cushman and Renz, n. sp. (Pl. 1, fig. 6)

Test of medium size, strongly compressed, sides flattened, periphery broadly rounded, strongly lobulate, generally rhomboid, greatest breadth above the middle; chambers few, increasing gradually in size as added; sutures slightly depressed, strongly oblique, nearly straight; wall very coarsely arenaceous, surface somewhat roughened; aperture much higher than broad, at the base of the last-formed chamber in the median line. Length 0.62-0.95 mm.; breadth 0.45-0.55 mm.; thickness 0.22 mm.

Holotype (Cushman Coll. No. 35918) from Pozon, 21.1 km. Southeast ( $122^{\circ}$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. P. 1693).

This species differs from *T. foliacea* Heron-Allen and Earland, var. *occidentalis* Cushman in the much more lobulate periphery and narrower form.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 4-7). Middle—?Upper Miocene.

**TEXTULARIA ISIDROENSIS** Cushman and Renz, n. sp. (Pl. 1, fig. 7)

Test small, compressed, rhomboid in front view, about as broad as long, tapering, greatest breadth toward the apertural end,

periphery acute; chambers numerous, increasing rapidly in height and breadth as added, but of nearly uniform shape, not inflated; sutures fairly distinct, strongly curved, not depressed, except slightly so in the later portion; wall finely arenaceous, rather smoothly finished; aperture broader than high, at the base of the apertural face in the median line. Length 0.50-0.60 mm.; breadth 0.42-0.50 mm.; thickness 0.26-0.33 mm.

Holotype (Cushman Coll. No. 35915) from Isidro, 33.75 km. East (80°) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 162).

This species differs from *T. gramen* d'Orbigny in its broader lower chambers and acute periphery.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-4). Lowermost—Middle Miocene.

**TEXTULARIA KUGLERI** Cushman and Renz, n. sp. (Pl. 1, figs. 8, 9)

Test of medium size, very strongly compressed, sides flattened or slightly raised along the median line, rhomboid, with the greatest width above the middle, later portion somewhat narrowed, periphery rounded, lobulate; chambers numerous, increasing gradually in breadth and slightly in height as added, very slightly inflated, except along the median line; sutures distinct, strongly oblique, slightly curved, slightly depressed; wall finely arenaceous, smoothly finished; aperture in the median line at the base of the apertural face, semicircular, about as high as broad. Length 0.85-1.15 mm.; breadth 0.55-0.65 mm.; thickness 0.25 mm.

Holotype (Cushman Coll. No. 35920) from Aguide, 12.3 km. South (194° 10') of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. A. 1509).

This species differs from *T. gramen* d'Orbigny in the more rhomboid form, lower and broader chambers in the adult, and much greater compression in the test.

*Stratigraphic occurrence:* Probably Miocene part of the Lower Agua Salada Formation.

**VULVULINA JACURAENSIS** Cushman and Renz, n. sp. (Pl. 1, fig. 10)

Test of medium size, compressed, periphery acute, more or less denticulate, almost entirely uniserial, usually only 1-3 uniserial chambers, slightly longer than broad, initial end broadly rounded; chambers distinct, of rather uniform shape, increasing gradually in size as added, strongly curved in the early portion, becoming

much less so in the adult; sutures distinct, strongly raised and limbate, earlier ones strongly curved, later ones oblique but only slightly curved; wall finely arenaceous with much cement; aperture in the adult becoming terminal, elliptical. Length 1.00-1.30 mm.; breadth 0.75-0.85 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 35921) from Araurima, 11.65 km. Southeast ( $136^{\circ} 45'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. A. 1563).

This species differs from *V. capreolus* (d'Orbigny) in the much less oblique and less thickened sutures, a lessened tendency to develop uniserial chambers, and the broader, less tapering initial end.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

**GAUDRYINA (PSEUDOGAUDRYINA) JACKSONENSIS** Cushman, var. **IRREGULARIS**  
Cushman and Renz, n. var. (Pl. 1, figs. 11, 12)

Variety differing from the typical in the deeply excavated sides, more strongly projecting angles, and deeply depressed sutures.

Holotype (Cushman Coll. No. 35897) from Araurima, 11.6 km. Southeast ( $152^{\circ} 30'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. H. G. Kugler (sample K. 4083).

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 1). Upper Oligocene.

**GAUDRYINA LEUZINGERI** Cushman and Renz, n. sp. (Pl. 1, fig. 13)

Test large, elongate, about  $2\frac{1}{2}$  times as long as broad, rounded in transverse section, early triserial portion rapidly tapering, adult biserial portion of nearly uniform diameter, periphery in the adult lobulate; chambers distinct, inflated, strongly so in the adult, increasing in height as added, in the adult about as high as broad; sutures depressed, strongly so in the adult, nearly at right angles to the elongate axis; wall distinctly arenaceous, but smoothly finished; aperture a low, arched opening in a depression at the base of the apertural face in the median line. Length 2.00-2.30 mm.; breadth 0.90-1.00 mm.; thickness 0.55-0.60 mm.

Holotype (Cushman Coll. No. 35896) from Isidro, 34.9 km. East ( $81^{\circ}$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 149).

This species differs from *G. trinitatensis* Nuttall in the less compressed, more elongate test, with more inflated chambers and more depressed sutures.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-3). Lowermost—Lower to Middle Miocene.

GAUDRYINA THALMANNI Cushman and Renz, n. sp. (Pl. 1, fig. 14)

Test of medium size, usually more than twice as long as broad, gradually tapering throughout, somewhat compressed, periphery rounded, slightly lobulate, triserial stage short; chambers comparatively few, inflated, rapidly increasing in size and height as added, in the adult stage becoming higher than broad; sutures distinct, earlier ones oblique, later nearly at right angles to the elongate axis, straight; wall finely arenaceous, smoothly finished; aperture a high, narrow opening in a depression of the inner face of the last-formed chamber in the median line. Length 0.80-1.00 mm.; breadth 0.45 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 35898) from Pozon, 27.0 km. Southeast (103°) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. E. Buck (sample Bk. A. 57).

This species differs from *G. trinitatensis* Nuttall in its more tapering form, less compressed test, more inflated and higher chambers, and more depressed sutures.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 2). Lowermost Miocene.

VALVULINA FLEXILIS Cushman and Renz, n. sp. (Pl. 1, figs. 16, 17)

Test in normal form triserial in the adult, enlarging rapidly from the subacute initial end, greatest breadth formed by the last three chambers, periphery slightly lobulate; chambers normally rounded and inflated, increasing rapidly in size as added; sutures depressed; wall finely arenaceous with much cement, flexible, causing the test to collapse easily under pressure in fossilization; aperture an arched opening at the base of the apertural face with a large, flattened tooth. Length 0.90-1.05 mm.; breadth 0.60-0.75 mm.

Holotype (Cushman Coll. No. 35925) from Aguide, 3.85 km. Southeast (122°) of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 222).

This species differs from *V. oviedoiana* d'Orbigny in the more rounded aperture and the very flexible wall with a large proportion of cement.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

CLAVULINA CARINATA Cushman and Renz, n. sp. (Pl. 1, fig. 18)

Test with the early triserial portion forming nearly half the test in adult specimens, often less, adult uniserial stage comparatively short, early portion triangular in section, the sides concave and angles distinctly carinate; chambers of the triserial stage often indistinct, uniserial chambers two or three in number, circular in section, not inflated; sutures rather indistinct, not depressed; wall of medium coarse sand grains with the surface somewhat roughened; aperture in the adult circular, terminal. Length 0.80-1.10 mm.; diameter 0.25-0.30 mm.

Holotype (Cushman Coll. No. 35884) from Isidro, 33.2 km. East (79° 25') of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

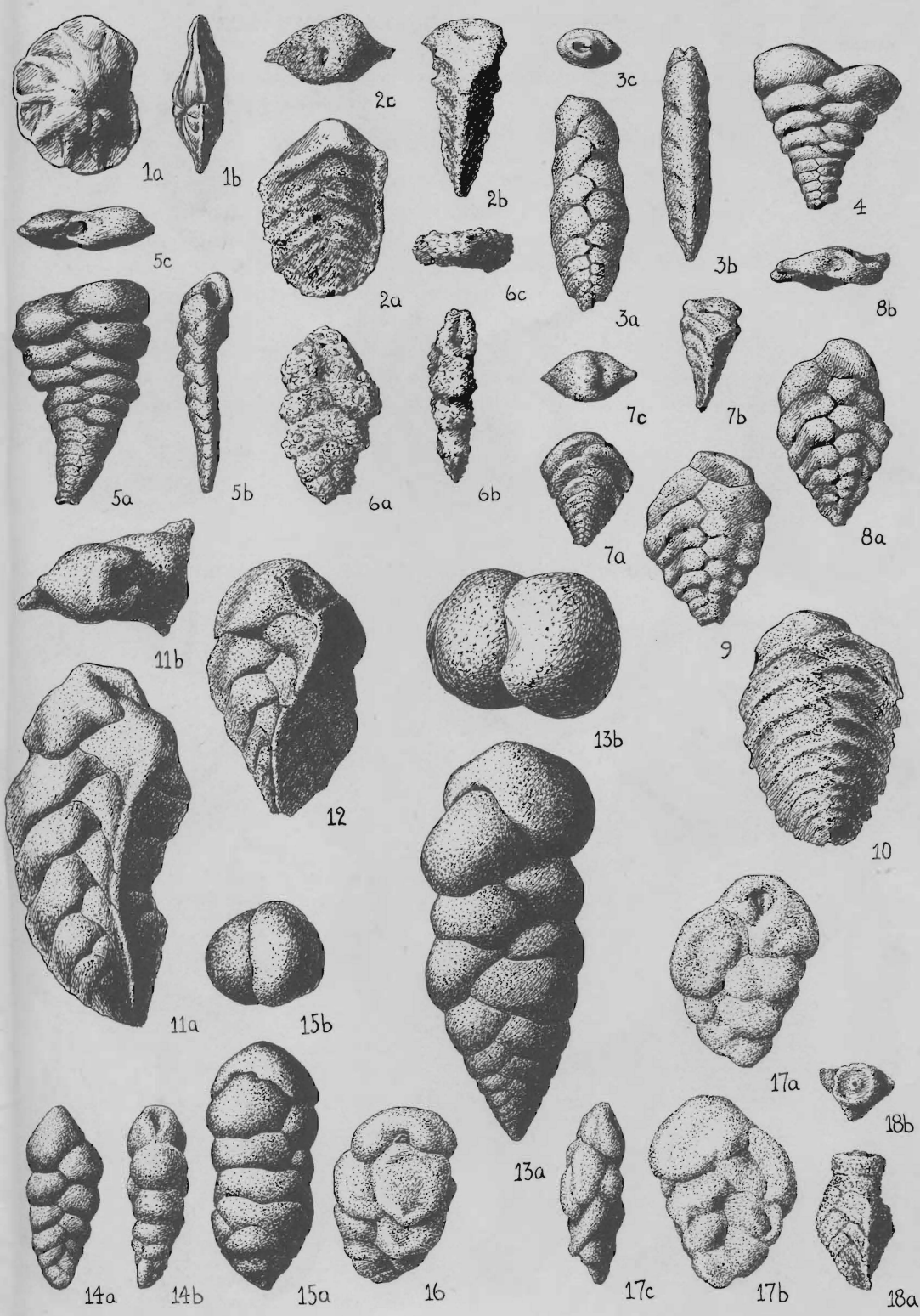
This species differs from *C. tricarinata* d'Orbigny in the longer triserial stage and short uniserial stage, the circular section of the adult chambers, and the straight sutures in the adult portion.

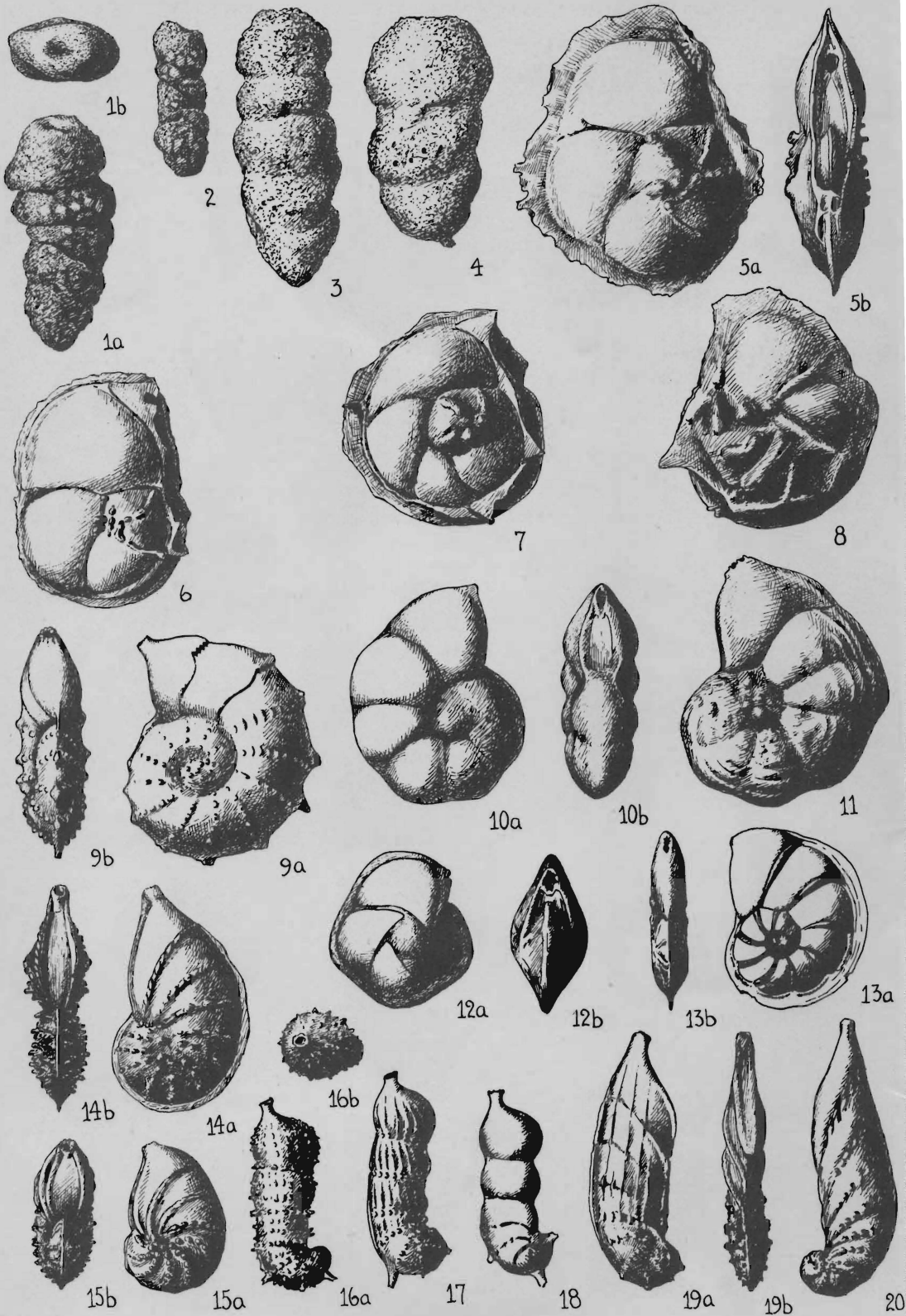
*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-4). Upper Oligocene—Middle Miocene.

#### EXPLANATION OF PLATE 1

FIG. 1. *Haplophragmoides carinatum* Cushman and Renz, n. sp. × 44. *a*, front view; *b*, peripheral view. 2. *Textularia leuzingeri* Cushman and Renz, n. sp. × 44. *a*, front view; *b*, side view; *c*, apertural view. 3. *T. falconensis* Cushman and Renz, n. sp. × 44. *a*, front view; *b*, side view; *c*, apertural view. 4, 5. *T. lalickeri* Cushman and Renz, n. sp. × 30. 4, Paratype. 5, Holotype. *a*, front view; *b*, side view; *c*, apertural view. 6. *T. pozonensis* Cushman and Renz, n. sp. × 30. *a*, front view; *b*, side view; *c*, apertural view. 7. *T. isidroensis* Cushman and Renz, n. sp. × 30. *a*, front view; *b*, side view; *c*, apertural view. 8, 9. *T. kugleri* Cushman and Renz, n. sp. × 30. 8, Holotype. *a*, front view; *b*, apertural view. 9, Paratype. 10. *Vulvulina jacuraensis* Cushman and Renz, n. sp. × 30. 11, 12. *Gaudryina* (*Pseudogaudryina*) *jacksonensis* Cushman, var. *irregularis* Cushman and Renz, n. var. × 30. 11, Holotype. *a*, front view; *b*, apertural view. 12, Paratype. 13. *Gaudryina leuzingeri* Cushman and Renz, n. sp. × 30. *a*, front view; *b*, apertural view. 14. *Gaudryina thalmani* Cushman and Renz, n. sp. × 30. *a*, front view; *b*, side view. 15. *Textulariella miocenica* Cushman, var. *brevis* Cushman and Renz, n. var. × 30. *a*, front view; *b*, apertural view. 16, 17. *Vulvulina flexilis* Cushman and Renz, n. sp. × 30. 16, Paratype. 17, Holotype. *a*, *b*, opposite sides; *c*, edge view. 18. *Clavulina carinata* Cushman and Renz, n. sp. × 30. *a*, front view; *b*, apertural view.







TEXTULARIELLA MIOCENICA Cushman, var. BREVIS Cushman and Renz, n. var.  
(Pl. 1, fig. 15)

Variety differing from the typical in the relatively shorter, broader form, more inflated chambers, more depressed sutures, and very slight evidence of the interior chamber divisions from the exterior view.

Holotype of variety (Cushman Coll. No. 35895) from Tocuyo, 18.7 km. South ( $202^{\circ} 45'$ ) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. A. 637).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

LIEBUSELLA POZONENSIS Cushman and Renz, n. sp. (Pl. 2, figs. 1, 2)

Test of medium size, subcylindrical, rapidly tapering at the base, the adult with the sides nearly parallel, somewhat lobulate; chambers of the early portion indistinct, the triserial portion usually followed directly by the uniserial stage which consists of 3-4 chambers, interior labyrinthic; sutures of the earlier portion indistinct, in the uniserial portion distinct and depressed; wall finely arenaceous with much cement, somewhat translucent and showing the interior structure; aperture rounded, terminal. Length 0.95-1.30 mm.; diameter 0.35-0.50 mm.

Holotype (Cushman Coll. No. 35902) from Pozon, 17.7 km. Southeast ( $121^{\circ} 30'$ ) of Pueblo Jacura, District Acosta, State

#### EXPLANATION OF PLATE 2

FIGS. 1, 2. *Liebusella pozonensis* Cushman and Renz, n. sp.  $\times 30$ . 1, Holotype. *a*, front view; *b*, apertural view. 2, Paratype. 3, 4. *L. pozonensis* Cushman and Renz, n. sp., var. *crassa* Cushman and Renz, n. var.  $\times 30$ . 3, Holotype. 4, Paratype. 5-8. *Robulus suteri* Cushman and Renz, n. sp.  $\times 17$ . 5, Holotype. *a*, front view; *b*, apertural view. 6-8, Paratypes. 9. *R. hedbergi* Cushman and Renz, n. sp.  $\times 17$ . *a*, front view; *b*, apertural view. 10. *R. nuttalli* Cushman and Renz, n. sp.  $\times 30$ . *a*, front view; *b*, apertural view. 11. *R. nuttalli* Cushman and Renz, n. sp., var. *obliquicostata* Cushman and Renz, n. var.  $\times 30$ . 12. *R. melvilli* Cushman and Renz, n. sp.  $\times 30$ . *a*, front view; *b*, apertural view. 13. *Planularia arbenzi* Cushman and Renz, n. sp.  $\times 44$ . *a*, front view; *b*, apertural view. 14, 15. *Robulus senni* Cushman and Renz, n. sp.  $\times 30$ . 14, Holotype. 15, Paratype. *a*, *a*, front views; *b*, *b*, apertural views. 16-18. *Marginulina basispinosa* Cushman and Renz, n. sp.  $\times 30$ . 16, Holotype. *a*, front view; *b*, apertural view. 17, 18, Paratypes. 19, 20. *M. superba* Cushman and Renz, n. sp.  $\times 30$ . 19, Holotype. *a*, front view; *b*, apertural view. 20, Paratype.

Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 921).

This species differs from *L. jamaicensis* (Cushman and Jarvis) in the less tapering form, fewer and higher chambers, and the thinner walls.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

**LIEBUSELLA POZONENSIS** Cushman and Renz, n. sp., var. **CRASSA** Cushman and Renz, n. var. (Pl. 2, figs. 3, 4)

Variety differing from the typical in the larger size, relatively shorter and less tapering test, and coarser, thicker wall. Length of holotype 1.55 mm.

Holotype of variety (Cushman Coll. No. 35903) from Isidro, 35.7 km. East (84°) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 129).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-4). Lowermost—Middle Miocene.

**ROBULUS SUTERI** Cushman and Renz, n. sp. (Pl. 2, figs. 5-8)

Test comparatively large, close coiled, strongly compressed, slightly evolute, periphery with a wide, thin keel; chambers few, 4 or 5 in the adult coil, rapidly increasing in size as added, of uniform shape, slightly inflated; sutures distinct, curved, limbate and somewhat raised, especially in the earlier portion where they end in a series of raised bosses at the umbonal end; wall smooth except for the ornamentation of the sutures; aperture radiate, with a rounded opening below on the upper end of the apertural face. Diameter 2.10-2.80 mm.

Holotype (Cushman Coll. No. 35885) from Isidro, 33.2 km. East (79° 25') of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

This species differs from *R. americanus* (Cushman) in the fewer chambers, more strongly developed keel, and the ornamented sutures.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-6). Upper Oligocene—?Upper Miocene.

**ROBULUS HEDBERGI** Cushman and Renz, n. sp. (Pl. 2, fig. 9)

Test comparatively large, close coiled, distinctly evolute, compressed, umbilicate, periphery serrate; chambers distinct, numerous, averaging about 12 in the adult coil, of uniform shape and

increasing gradually and regularly in size as added, slightly if at all inflated; sutures distinct, limbate, slightly curved; wall ornamented with a row of raised, rounded bosses over the sutures, wanting in the last portion, and stout, blunt, backwardly pointing spines, at the basal angle of each chamber at the periphery, gradually disappearing in the last portion; aperture radiate, at the outer peripheral angle with the ventral slit enlarged and elongate. Diameter 2.00-2.35 mm.

Holotype (Cushman Coll. No. 35892) from Tocuyo, 18.0 km. South (203° 15') of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Mr. F. R. S. Henson (sample H. P. 57A).

This species differs from *R. americanus* (Cushman), var. *spinus* Cushman in the larger number of chambers, evolute test, and ornamented sutures.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zones 1-2). Upper Oligocene—Lowermost Miocene.

**ROBULUS NUTTALLI** Cushman and Renz, n. sp. (Pl. 2, fig. 10)

Test of medium size, close coiled, partially evolute, somewhat compressed, periphery rounded, entire or very slightly lobulate; chambers in the early portion indistinct, in the last half coil distinct and slightly inflated, averaging 8 in the adult coil, of uniform shape, increasing gradually and uniformly in size as added; sutures of the later portion distinct and slightly depressed, slightly curved, the spiral suture depressed; wall smooth; aperture radiate, at the outer peripheral margin with an elliptical opening below at the upper end of the apertural face. Diameter 0.80-1.20 mm.

Holotype (Cushman Coll. No. 35888) from Isidro, 35.0 km. East (81° 15') of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 148).

This species differs from *R. propinquus* (Hantken) in the larger size, partially evolute test, more inflated and higher chambers, and rounded periphery.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

**ROBULUS NUTTALLI** Cushman and Renz, n. sp., var. **OBLIQUICOSTATA** Cushman and Renz, n. var. (Pl. 2, fig. 11)

Variety differing from the typical in the ornamentation of the

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test, consisting of longitudinal costae, parallel to the periphery, disappearing gradually from the inner portion as growth progresses, and the umbonate region which has a few raised bosses.

Holotype of variety (Cushman Coll. No. 35889) from Tocuyo, 14.2 km. East ( $85^{\circ} 45'$ ) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. P. 1261).

*Stratigraphic occurrence:* Probably Upper Agua Salada Formation (?Transition beds between Zones 3 and 4). ?Middle Miocene.

### ROBULUS MELVILLI Cushman and Renz, n. sp. (Pl. 2, fig. 12)

Test small, close coiled, distinctly umbonate, involute, periphery entire, with a narrow, rounded keel; chambers few, typically 5 in the adult coil, not inflated, of uniform shape and increasing very gradually in size as added; sutures distinct, slightly curved, limbate, but little if at all raised; wall smooth; aperture at the outer peripheral angle, radiate with a rounded opening below on the upper end of the apertural face. Diameter 0.80-1.10 mm.

Holotype (Cushman Coll. No. 35887) from Isidro, 33.5 km. East ( $79^{\circ} 45'$ ) of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 165).

This species differs from *R. americanus* (Cushman) in the fewer chambers and umbonate test, which is more compressed toward the periphery.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 3-4). Lower—Middle Miocene.

### ROBULUS SENNI Cushman and Renz, n. sp. (Pl. 2, figs. 14, 15)

Test of medium size, strongly compressed, depressed in the umbilical region, close coiled, but tending to elongate in the last portion; periphery with a distinct, thin keel except on the last portion which is somewhat rounded; chambers numerous, 9-12 in the final coil, increasing in breadth as added, strongly so in the last portion of the final coil; sutures slightly curved, raised; wall ornamented with a row of raised bosses along the sutures, in the last portion fusing into a raised ridge; aperture with a slight neck at the peripheral angle, the lip marked with teeth and grooves representing the radiate aperture of the earlier chambers. Length 0.80-1.20 mm.; breadth 0.60-0.78 mm.

Holotype (Cushman Coll. No. 35890) from Pozon, 18.9 km.

Southeast (126° 45') of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 857).

This species differs from *R. vauughani* (Cushman) in the greater amount of ornamentation, larger number of chambers in the adult coil, and showing no definitely uncoiled chambers.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 4-6). Middle—?Upper Miocene.

PLANULARIA ARBENZI Cushman and Renz, n. sp. (Pl. 2, fig. 13)

Test almost completely evolute, much compressed, periphery with a thin keel; chambers distinct, slightly inflated, 8-10 in the adult coil, of nearly uniform shape, increasing gradually in size as added; sutures distinct, slightly curved, limbate and raised, thicker toward the periphery; wall smooth except for the raised costae; aperture radiate, at the outer peripheral angle. Length 0.60-0.75 mm.; breadth 0.50-0.60 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 35907) from Pozon, 17.7 km. Southeast (121° 30') of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 921).

This species differs from *P. venezuelana* Hedberg in the larger number of chambers, which are not raised in the middle but which are broader and lower.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

MARGINULINA BASISPINOSA Cushman and Renz, n. sp. (Pl. 2, figs. 16-18)

Test elongate, earliest portion close coiled, later and larger portion uncoiled, early portion somewhat compressed, later portion circular in transverse section, periphery of early portion with a slight keel and spinose; chambers in the later portion becoming somewhat inflated and subglobular, earlier ones compressed; sutures slightly curved in the early portion, limbate, later slightly depressed; wall variously ornamented, the sutures raised and smooth to nodose or even with short rounded spines, periphery at the base with stout spines typically one to a chamber, the face of the chamber in some specimens smooth, in others with longitudinal costae, and in still others with the costae broken into rounded knobs or spines; aperture at the end of a short cylindrical neck at the peripheral edge of the terminal face. Length 0.90-1.40 mm.; diameter 0.40-0.45 mm.

Holotype (Cushman Coll. No. 35886) from Isidro, 33.2 km. East ( $79^{\circ} 25'$ ) of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

This species differs from *M. cooperi* Cushman in the larger number of uncoiled chambers, the straighter, more elongate test, and the wide range of ornamentation.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zone 4). Middle Miocene.

*MARGINULINA SUPERBA* Cushman and Renz, n. sp. (Pl. 2, figs. 19, 20)

Test elongate, much compressed, earliest portion close coiled, later and much the larger portion uncoiled, periphery of both sides slightly keeled, more strongly so on the dorsal side; chambers numerous, rapidly increasing in breadth and then becoming of rather uniform size and shape in the adult portion, little if at all inflated; sutures curved, somewhat raised and ornate; wall along the sutures of the early part at least ornamented with a series of small, rounded knobs, the broad face of the chambers often with longitudinal costae; aperture rounded, with a short cylindrical neck at the peripheral angle. Length 1.40-1.70 mm.; breadth 0.50-0.63 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 35891) from Pozon, 18.4 km. Southeast ( $125^{\circ} 30'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 880).

This species differs from *M. fragaria* (Gümbel), var. *texasensis* (Cushman and Applin) in the more slender test, straighter uncoiled portion, and more definitely cylindrical neck.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zone 4). Middle Miocene.

*LINGULINA GRIMSDALEI* Cushman and Renz, n. sp. (Pl. 3, fig. 1)

Test about  $1\frac{1}{2}$  times as long as broad, slightly compressed, gradually tapering, periphery rounded; chambers few, slightly inflated, increasing rapidly in size as added, slightly overlapping; sutures slightly depressed; wall ornamented by numerous, slightly raised, longitudinal costae; aperture terminal, narrow, elongate, with a slight lip. Length of holotype 2.10 mm.; breadth 1.60 mm.; thickness 1.20 mm.

Holotype (Cushman Coll. No. 35904) from Tocuyo, 17.7 km. South ( $202^{\circ}$ ) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. A. 761).



This species differs from *L. seminuda* Hantken in the finer longitudinal costae which cover the full width of the test, the more tapering form, and the less compressed test.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 1). Upper Oligocene.

**DENTALINA ISIDROENSIS** Cushman and Renz, n. sp. (Pl. 3, figs. 2, 3)

Test elongate, about 5 times as long as broad, of nearly uniform diameter, the early portion in the microspheric form slightly coiled, in the megalospheric form straight throughout; chambers distinct, later ones inflated, of nearly uniform size and shape in the adult; sutures in the early portion indistinct, in the later portion distinct and somewhat depressed; wall ornamented with elongate, often slightly twisted, new costae originating between the earlier ones, initial end of test with a single stout spine; aperture terminal, rounded, with a distinct, cylindrical neck and lip with a row of short teeth at its inner margin. Length 2.50-2.75 mm.; diameter 0.50 mm.

Holotype (Cushman Coll. No. 35894) from Isidro, 34.4 km. East (80° 30') of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 153).

This species differs from *D. vertebralis* (Batsch) in the less tapering form, smaller test, and interpolating new costae which are frequently twisted.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

**NODOSARIA STAINFORTHII** Cushman and Renz, n. sp. (Pl. 3, fig. 4)

Test elongate, uniserial, slender, tapering from the acute initial end to the greatest breadth at the last-formed portion; chambers numerous, rapidly increasing in size as added; sutures distinct, slightly limbate, slightly depressed in the later portion; wall ornamented by six, plate-like, longitudinal costae, continuous throughout the length; aperture radiate, terminal, rounded, without a distinct neck. Length 1.80-2.50 mm.; diameter 0.40-0.45 mm.

Holotype (Cushman Coll. No. 35906) from Isidro, 33.75 km. East (80°) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 162).

This species differs from *N. acuminata* Hantken in its shorter chambers, more inflated in the adult portion, and the thinner,

more plate-like costae.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-4). Upper Oligocene—Middle Miocene.

**PSEUDOGLANDULINA GALLOWAYI** Cushman, var. **PAUCICOSTATA** Cushman and Renz, n. var. (Pl. 3, fig. 5)

Variety differing from the typical in the fewer and higher costae and less tapering form.

Holotype of variety (Cushman Coll. No. 35908) from Isidro, 34.5 km. East (80° 45') of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 152).

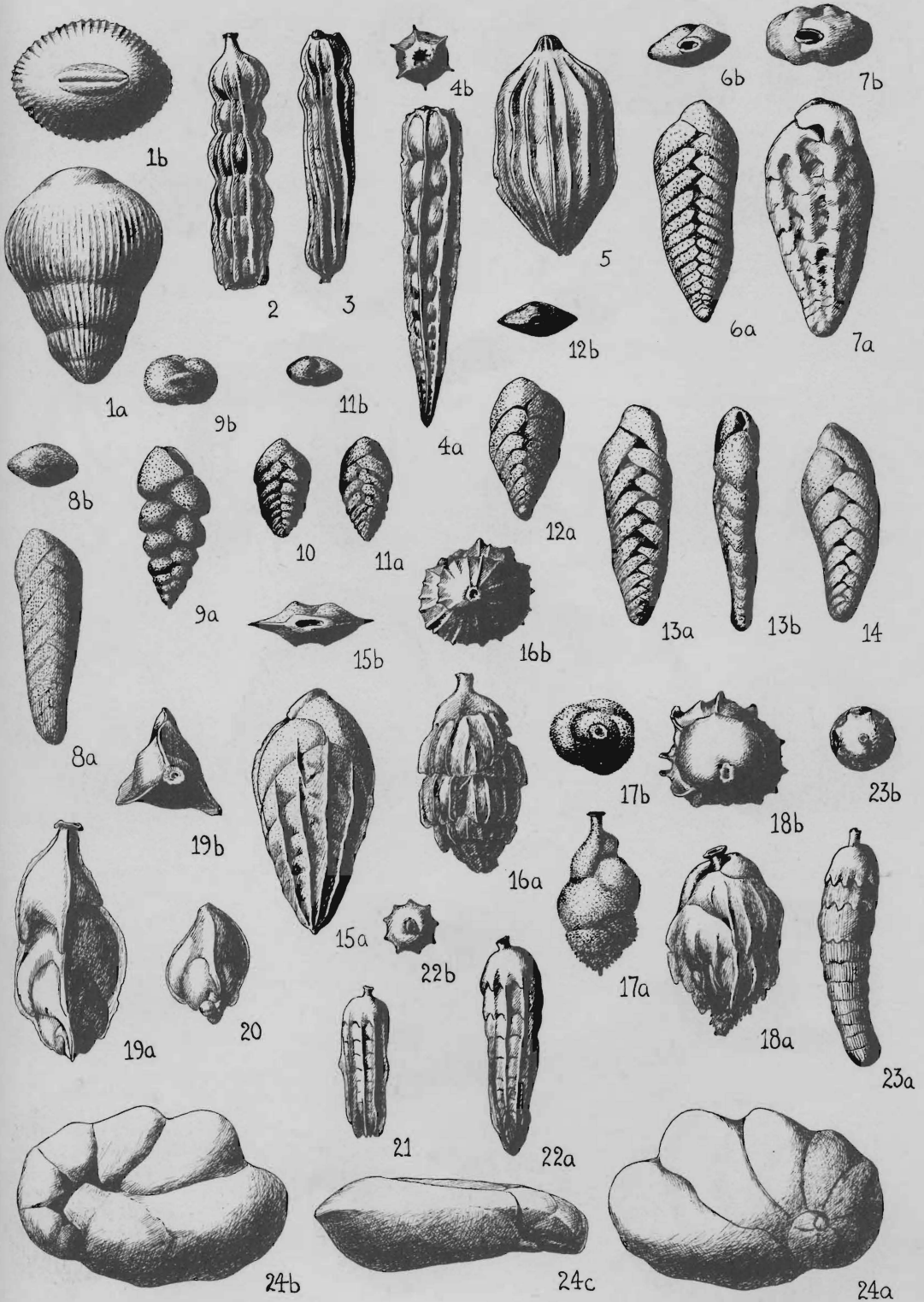
*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-3). Lowermost—Lower to Middle Miocene.

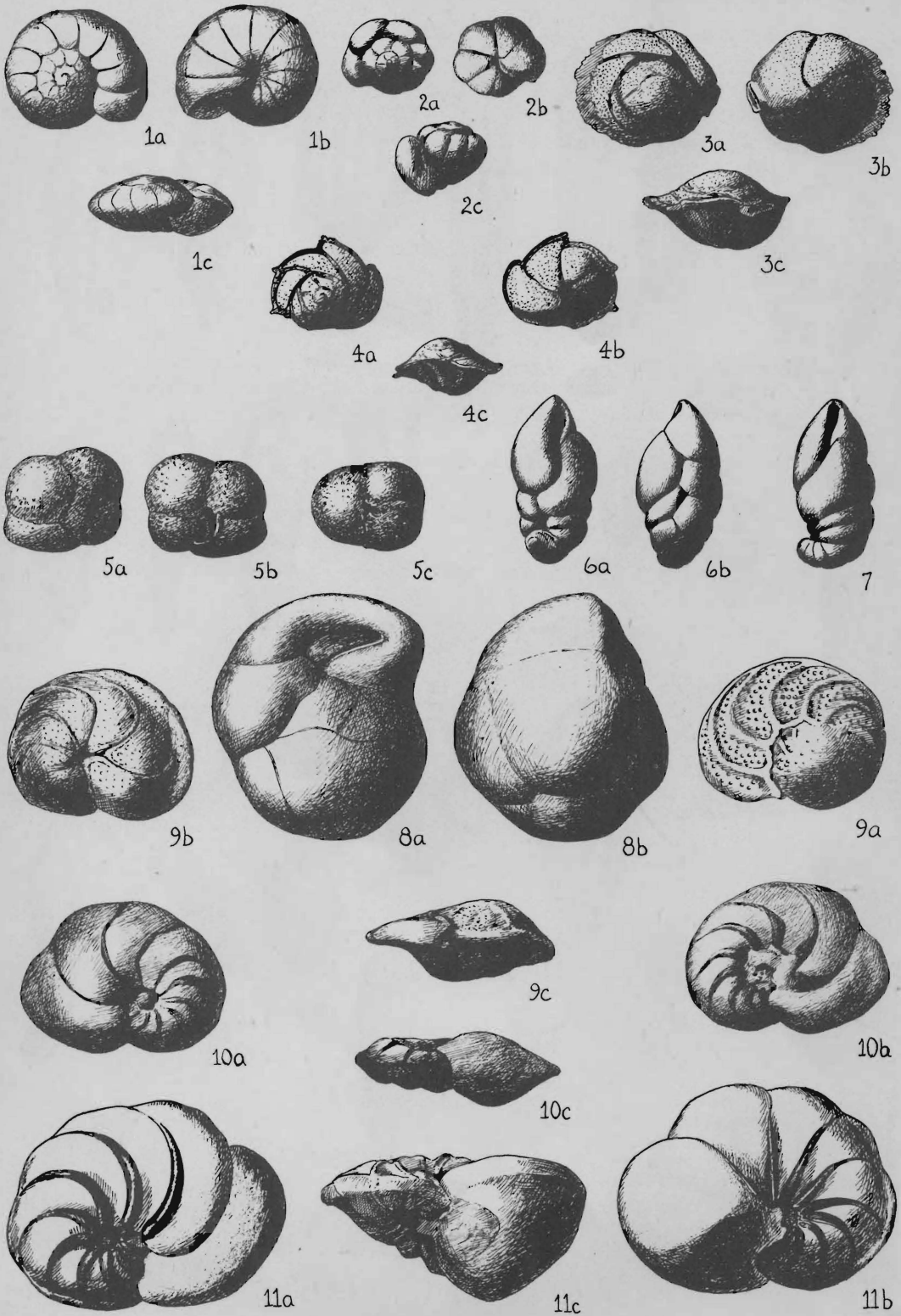
**BOLIVINA POZONENSIS** Cushman and Renz, n. sp. (Pl. 3, fig. 6)

Test elongate,  $2\frac{1}{2}$ -3 times as long as broad, compressed, tapering throughout, greatest breadth formed by the last pair of chambers, periphery rounded; chambers numerous, low and broad, of uniform shape, evenly increasing in size as added;

#### EXPLANATION OF PLATE 3

FIG. 1. *Lingulina grimsdalei* Cushman and Renz, n. sp.  $\times 17$ . a, front view; b, apertural view. 2, 3. *Dentalina isidroensis* Cushman and Renz, n. sp.  $\times 17$ . 2, Holotype. 3, Paratype. 4. *Nodosaria stainforthi* Cushman and Renz, n. sp.  $\times 30$ . a, front view; b, apertural view. 5. *Pseudoglandulina gallowayi* Cushman, var. *paucicostata* Cushman and Renz, n. var.  $\times 30$ . 6. *Bolivina pozonensis* Cushman and Renz, n. sp.  $\times 65$ . a, front view; b, apertural view. 7. *B. floridana* Cushman, var. *regularis* Cushman and Renz, n. var.  $\times 65$ . a, front view; b, apertural view. 8. *B. isidroensis* Cushman and Renz, n. sp.  $\times 65$ . a, front view; b, apertural view. 9. *B. suteri* Cushman and Renz, n. sp.  $\times 65$ . a, front view; b, apertural view. 10, 11. *B. inconspicua* Cushman and Renz, n. sp.  $\times 65$ . 10, Paratype. 11, Holotype. a, front view; b, apertural view. 12. *B. rudderi* Cushman and Renz, n. sp.  $\times 65$ . a, front view; b, apertural view. 13, 14. *B. caudriae* Cushman and Renz, n. sp.  $\times 65$ . 13, Holotype. a, front view; b, side view. 14, Paratype. 15. *B. interjuncta* Cushman, var. *simplex* Cushman and Renz, n. var.  $\times 65$ . a, front view; b, apertural view. 16. *Uvigerina isidroensis* Cushman and Renz, n. sp.  $\times 65$ . a, front view; b, apertural view. 17. *U. auberiana* d'Orbigny, var. *attenuata* Cushman and Renz, n. var.  $\times 65$ . a, front view; b, apertural view. 18. *U. gallowayi* Cushman, var. *basicordata* Cushman and Renz, n. var.  $\times 44$ . a, front view; b, apertural view. 19, 20. *Angulogerina illingi* Cushman and Renz, n. sp.  $\times 65$ . 19, Holotype. a, front view; b, apertural view. 20, Paratype. 21, 22. *Siphogenerina senni* Cushman and Renz, n. sp.  $\times 30$ . 21, Paratype. 22, Holotype. a, front view; b, apertural view. 23. *S. kugleri* Cushman and Renz, n. sp.  $\times 30$ . a, front view; b, apertural view. 24. *Valvulineria inaequalis* d'Orbigny, var. *lobata* Cushman and Renz, n. var.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view.





sutures nearly straight, strongly oblique, distinctly limbate; wall coarsely perforate, with traces of fine longitudinal costae especially on the earlier part; aperture elliptical with a slight lip, tending to become terminal. Length 0.50-0.55 mm.; breadth 0.25 mm.; thickness 0.12 mm.

Holotype (Cushman Coll. No. 35873) from Pozon, 18.35 km. Southeast ( $124^{\circ} 30'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 886).

This species differs from *B. mantaensis* Cushman in the much greater number of lower, broader chambers, straighter and more limbate sutures, and more coarsely perforate wall.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 3-4). Lower—Middle Miocene.

**BOLIVINA FLORIDANA** Cushman, var. **REGULARIS** Cushman and Renz, n. var.  
(Pl. 3, fig. 7)

Variety differing from the typical in the more tapering test and greater development of the longitudinal ridges.

Holotype of variety (Cushman Coll. No. 35870) from Isidro, 33.5 km. East ( $79^{\circ} 45'$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 165).

*Stratigraphic occurrence:* Throughout the Agua Salada Formation. Upper Oligocene—?Upper Miocene.

**BOLIVINA ISIDROENSIS** Cushman and Renz, n. sp. (Pl. 3, fig. 8)

Test elongate, about 3 times as long as broad, evenly tapering, greatest breadth formed by the last pair of chambers, periphery

#### EXPLANATION OF PLATE 4

FIG. 1. *Gyroidina planulata* Cushman and Renz, n. sp.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view. 2. *G. parva* Cushman and Renz, n. sp.  $\times 65$ . a, dorsal view; b, ventral view; c, peripheral view. 3. *Siphonina pozonensis* Cushman and Renz, n. sp.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view. 4. *Pulvinulinella jarvisi* Cushman and Renz, n. sp.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view. 5. *Sphaeroidinella rutschi* Cushman and Renz, n. sp. a, b, Holotype. a, dorsal view; b, ventral view. c, Paratype. 6, 7. *Cassidulinoides erecta* Cushman and Renz, n. sp.  $\times 65$ . 6, Holotype. a, b, opposite sides. 7, Paratype. 8. *Cassidulina subglobosa* H. B. Brady, var. *horizontalis* Cushman and Renz, n. var.  $\times 65$ . a, apertural view; b, side view. 9. *Cibicides floridanus* (Cushman), var. *compressa* Cushman and Renz, n. var.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view. 10. *C. isidroensis* Cushman and Renz, n. sp.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view. 11. *C. kugleri* Cushman and Renz, n. sp.  $\times 44$ . a, dorsal view; b, ventral view; c, peripheral view.

rounded; chambers numerous, low and broad, of nearly uniform shape throughout; sutures very strongly oblique, slightly limbate, not depressed; wall rather coarsely perforate, the earlier half with fine, longitudinal costae; aperture high and narrow, in the median line. Length 0.55-0.65 mm.; breadth 0.18 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 35871) from Isidro, 33.75 km. East (80°) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 162).

This species differs from *B. acerosa* Cushman, which it closely resembles, in the larger size, less slender shape, and more coarsely perforate wall.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 3-5). Lower to Middle—Middle to ?Upper Miocene.

**BOLIVINA SUTERI** Cushman and Renz, n. sp. (Pl. 3, fig. 9)

Test small, about  $2\frac{1}{2}$  times as long as broad, strongly tapering, greatest breadth formed by the last pair of chambers, periphery lobulate, broadly rounded, apical end pointed, often with a short acerose spine; chambers distinct, strongly inflated, rapidly increasing in size as added; sutures distinct, nearly at right angles to the elongate axis, becoming deeply depressed in the later portion; wall coarsely perforate, slightly roughened, especially in the earlier portion; aperture high, rounded, extending from the base of the chamber high up into the apertural face in the median line. Length 0.35-0.40 mm.; breadth 0.15-0.17 mm.; thickness 0.10-0.12 mm.

Holotype (Cushman Coll. No. 35876) from Tocuyo, 15.7 km. East (86° 15') of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. P. 1306).

This species differs from *B. advena* Cushman in the fewer, higher, and more inflated chambers, strongly lobate periphery, and broader aperture.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zones 3-4). Lower—Middle Miocene.

**BOLIVINA INCONSPICUA** Cushman and Renz, n. sp. (Pl. 3, figs. 10, 11)

Test minute, about twice as long as broad, strongly compressed, periphery rounded, sometimes slightly serrate; chambers low and broad, of rather uniform shape throughout, increasing gradually in size as added, slightly inflated; sutures distinct, slightly

depressed, strongly oblique, somewhat curved; wall smooth, rather coarsely perforate; aperture a broad, arched opening at the median line. Length 0.25-0.28 mm.; breadth 0.12-0.14 mm.; thickness 0.05-0.07 mm.

Holotype (Cushman Coll. No. 35875) from Aguide, 2.5 km. South ( $171^{\circ} 25'$ ) of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Core from Aguide Well No. 1 at 1646'.

This species differs from *B. dilatata* Reuss in its much smaller size, relatively larger perforations, and evenly curved sutures.

*Stratigraphic occurrence:* ?Lower Agua Salada Formation.  
?Lowermost Miocene.

**BOLIVINA RUDDERI** Cushman and Renz, n. sp. (Pl. 3, fig. 12)

Test small, about twice as long as broad, strongly tapering, greatest breadth above the middle, compressed, periphery acute but not keeled; chambers distinct, not inflated, low and broad in the early stages, becoming relatively higher in the adult; sutures very strongly curved forward near the inner margin, thence strongly backward to the periphery, the outer part very oblique, slightly limbate; wall smooth; aperture a high, narrow opening at the base of the chamber in the median line. Length 0.35-0.38 mm.; breadth 0.14-0.16 mm.; thickness 0.06-0.08 mm.

Holotype (Cushman Coll. No. 35877) from Pozon, 18.6 km. Southeast ( $126^{\circ} 15'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 869).

This species differs from *B. dilatata* Reuss in the smaller size, more acute periphery, different angle and curvature of the sutures, and the higher chambers.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-4). Lowermost—Middle Miocene.

**BOLIVINA CAUDRIAE** Cushman and Renz, n. sp. (Pl. 3, figs. 13, 14)

Test elongate,  $3-3\frac{1}{2}$  times as long as broad, compressed, periphery rounded, tapering gradually throughout, greatest breadth formed by the last pair of chambers; chambers distinct, of nearly uniform shape throughout, increasing gradually and regularly in size as added; sutures distinct, slightly curved, strongly oblique, with a triangular clear area at the inner end; wall smooth, finely perforate; aperture a high arched opening in the median line at the base of the chamber. Length 0.45-0.50 mm.; breadth 0.15 mm.; thickness 0.09-0.10 mm.

Holotype (Cushman Coll. No. 35874) from Pozon, 27.0 km. East ( $103^\circ$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. E. Buck (sample Bk. A. 57).

This species differs from the closely related *B. arta* Macfadyen in the somewhat smaller size, less compressed test, slightly lower and broader chambers, and slightly curved sutures.

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zones 1-2). Upper Oligocene—Lowermost Miocene.

**BOLIVINA INTERJUNCTA** Cushman, var. **SIMPLEX** Cushman and Renz, n. var.  
(Pl. 3, fig. 15)

Variety differing from the typical in the more regular costae, with the anastomosing intermediate costae greatly reduced or usually absent.

Holotype of variety (Cushman Coll. No. 35872) from Pozon, 21.1 km. Southeast ( $120^\circ 15'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. T. H. Bower (sample T. H. B. 1329).

*Stratigraphic occurrence:* Throughout the Agua Salada Formation. Abundant in the Upper Agua Salada Formation (Zone 4 and higher). Upper Oligocene—?Upper Miocene.

**UVIGERINA ISIDROENSIS** Cushman and Renz, n. sp. (Pl. 3, fig. 16)

Test fusiform, about twice as long as broad, later portion tending to become biserial; chambers distinct, strongly inflated, excavated at the lower edge; sutures depressed throughout; wall ornamented throughout with high, longitudinal costae, those of each chamber independent of those of adjacent ones, projecting backward at the basal end; aperture terminal, rounded, with a short, tubular neck, usually without a distinct lip. Length 0.40-0.50 mm.; diameter 0.25-0.30 mm.

Holotype (Cushman Coll. No. 35922) from Isidro, 33.2 km. East ( $79^\circ 25'$ ) of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

This species differs from *U. altacostata* Cushman and Ellisor in the greater overhang of the chambers, higher and more plate-like costae, and the tendency to assume a biserial condition in the last chambers.

*Stratigraphic occurrence:* Throughout the Agua Salada Formation. Upper Oligocene—?Upper Miocene.



UVIGERINA AUBERIANA d'Orbigny, var. ATTENUATA Cushman and Renz, n. var.  
(Pl. 3, fig. 17)

Variety differing from the typical in having the early chambers more compact and the last-formed ones attenuated, the inner side of the final chamber flattened or concave, the apertural neck long and slender.

Holotype of variety (Cushman Coll. No. 35923) from Isidro, 35.0 km. East ( $81^{\circ} 30'$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 147).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-6). Lowermost to Middle Miocene.

UVIGERINA GALLOWAYI Cushman, var. BASICORDATA Cushman and Renz, n. var.  
(Pl. 3, fig. 18)

Variety differing from the typical in the shorter, broader form and the greater concentration of the ornamentation at the base of the test, extending backward into spinose projections.

Holotype of variety (Cushman Coll. No. 35924) from Tocuyo, 18.7 km. South ( $202^{\circ} 45'$ ) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. A. 637).

*Stratigraphic occurrence:* Lower Agua Salada Formation (Zone 2). Lowermost Miocene.

ANGULOGERINA ILLINGI Cushman and Renz, n. sp. (Pl. 3, figs. 19, 20)

Test fusiform, in the microspheric form tapering to a sharp point, often with a definite spine, triangular in section throughout, periphery strongly keeled at the angles; chambers in the adult portion very distinct, somewhat loosely arranged, slightly inflated and distinctly triangular in section; sutures distinct, strongly depressed in the later portion; wall mostly smooth, but with traces of longitudinal costae in the early portion of occasional specimens; aperture rounded, terminal, with a short cylindrical neck and distinct lip. Length 0.60-0.85 mm.; diameter 0.30-0.40 mm.

Holotype (Cushman Coll. No. 35869) from Tocuyo, 16.9 km. South ( $193^{\circ} 45'$ ) of San Juan de Los Cayos, District Acosta, State Falcon, Venezuela. Coll. Dr. H. G. Kugler (sample K. P. 290).

This species differs from *A. cooperensis* Cushman in the more angled test with strong keels, deeply depressed sutures, and almost entire absence of ornamentation.

*Stratigraphic occurrence:* ?Lower and Upper Agua Salada

Formation (Zones 1[?]-4). Upper Oligocene (?)—Middle Miocene.

SIPHOGENERINA SENNI Cushman and Renz, n. sp. (Pl. 8, figs. 21, 22)

Test elongate,  $3\frac{1}{2}$ -4 times as long as broad, tapering in the microspheric form, nearly cylindrical in the megalospheric, rounded in transverse section; chambers distinct except in the earliest portion, little if at all inflated, of uniform size and shape in the adult, slightly overlapping; sutures distinct in the later portion, slightly if at all depressed; wall ornamented with 8-10 longitudinal, plate-like costae, continuous from the initial end to the base of the last-formed chamber which is smooth, often projecting at the base of the test; aperture terminal, rounded, with a tubular neck and slight lip. Length 0.80-1.10 mm.; diameter 0.25-0.30 mm.

Holotype (Cushman Coll. No. 35912) from Isidro, 34.9 km. East ( $81^\circ$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 149).

This species differs from *S. spinosa* Bagg in the more evenly developed costae, more nearly cylindrical test, and lack of spines at the base.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

SIPHOGENERINA KUGLERI Cushman and Renz, n. sp. (Pl. 8, fig. 23)

Test elongate, slender, about 4 times as long as broad, very gradually tapering from the broadly rounded initial end, often slightly curved; chambers distinct, increasing very gradually in size as added, the last few with the base crenulated; sutures distinct, slightly depressed in the later portion; wall ornamented in the earlier portion with very numerous, fine, somewhat anastomosing, longitudinal costae independent of the sutures, later portion becoming nearly smooth; aperture rounded, terminal, with a slender, cylindrical neck and slight lip. Length 1.00-1.25 mm.; diameter 0.25-0.30 mm.

Holotype (Cushman Coll. No. 35911) from Pozon, 20.2 km. Southeast ( $118^\circ 15'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. T. H. Bower (sample T. H. B. 2204).

This species differs from *S. multicosata* Cushman and Jarvis in the more slender form, higher chambers, broadly rounded

initial end, and finer, more numerous costae with the base of the chambers crenulate in the adult.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-3). Lowermost—Lower to Middle Miocene.

VALVULINERIA INAEQUALIS d'Orbigny, var. LOBATA Cushman and Renz, n. var.  
(Pl. 3, fig. 24)

Variety differing from the typical in the more inflated chambers and strongly lobate periphery.

Holotype of variety (Cushman Coll. No. 35878) from Pozon, 20.3 km. Southeast ( $118^{\circ} 30'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. H. H. Suter (sample Su. A. 2196).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-3). Lowermost—Lower to Middle Miocene.

GYROIDINA PLANULATA Cushman and Renz, n. sp. (Pl. 4, fig. 1)

Test trochoid, strongly compressed, biconvex, distinctly umbilicate on the ventral side, periphery rounded; chambers typically about 12 in the adult whorl, of uniform shape, increasing very gradually in size as added, not inflated; sutures distinct, slightly curved, more strongly so on the dorsal side, not depressed; wall smooth; aperture a low, elongate opening on the ventral side from near the periphery to the umbilicus. Diameter 0.35-0.50 mm.; height 0.18-0.20 mm.

Holotype (Cushman Coll. No. 35900) from Mirimire, 6.75 km. East ( $81^{\circ} 15'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. A. 953).

This species differs from *G. laevis* d'Orbigny in its biconvex test, distinct umbilicus, and umbonate dorsal side. Our species has undoubtedly been recorded as *G. laevis* d'Orbigny but is distinct.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

GYROIDINA PARVA Cushman and Renz, n. sp. (Pl. 4, fig. 2)

Test minute, trochoid, ventral side strongly convex, dorsal side rounded, the last whorl below the previous one at the margin, umbilical area depressed, periphery broadly rounded; chambers distinct, inflated, typically six in the adult whorl, of uniform shape, increasing gradually in size as added; sutures distinct,

depressed, dorsally oblique, slightly curved, ventrally nearly radial; wall smooth; aperture elongate, low, with a distinct lip. Diameter 0.20-0.25 mm.; height 0.20 mm.

Holotype (Cushman Coll. No. 35899) from Pozon, 18.5 km. Southeast ( $125^{\circ} 45'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. H. S. Rogers (sample H. S. R. 876).

This species differs from *G. danvillensis* Howe and Wallace in the oblique, somewhat curved sutures on the dorsal side, higher test, fewer chambers, and the last-formed whorl depressed below the previous one.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-4). Upper Oligocene—Middle Miocene.

SIPHONINA POZONENSIS Cushman and Renz, n. sp. (Pl. 4, fig. 3)

Test unequally biconvex, dorsal side less strongly so than the ventral, periphery strongly keeled except on the later portion, slightly lobulate; chambers few, about five in the adult whorl, slightly if at all inflated; sutures very oblique on the dorsal side, curved on the ventral, not depressed, slightly limbate; wall smooth, coarsely perforate; aperture just ventral to the periphery, elliptical, somewhat contracted in the middle, with a short neck and slight lip. Diameter 0.55-0.60 mm.; height 0.35 mm.

Holotype (Cushman Coll. No. 35913) from Isidro, 33.2 km. East ( $79^{\circ} 25'$ ) of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

This species differs from *S. tenuicarinata* Cushman in the more convex test, less developed keel, and more strongly curved sutures.

*Stratigraphic occurrence:* Throughout the Agua Salada Formation. Upper Oligocene—?Upper Miocene.

PULVINULINELLA JARVISI Cushman and Renz, n. sp. (Pl. 4, fig. 4)

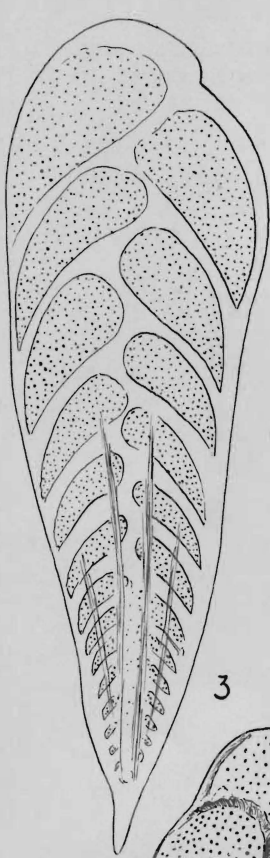
Test about equally biconvex, periphery slightly keeled with a distinct angular projection at the peripheral margin of the base of each chamber, occasionally almost spinose; chambers 5 or 6 in

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EXPLANATION OF PLATE 5

All figures  $\times 120$

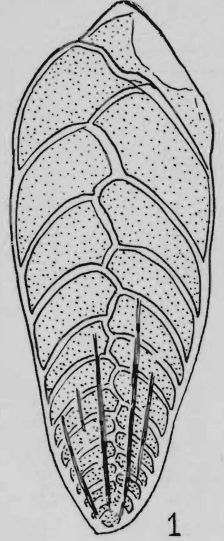
FIG. 1. *Bolivina aenariensis* (Costa). Pliocene, Italy. 2-6. *B. sub-aenariensis* Cushman. 2, 3, Albatross D 2262. 2, Megalospheric form. 3, Microspheric form. 4-6, Off Carna-veral, Florida. 4, Average specimen. 5, Megalospheric form. 6, Microspheric form.



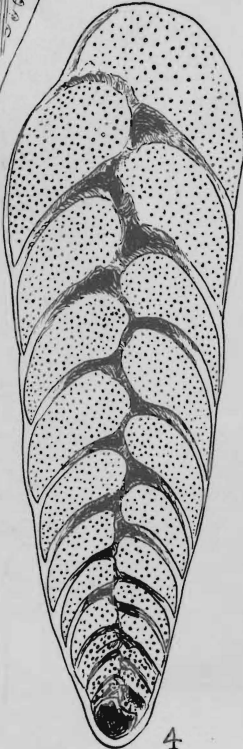
3



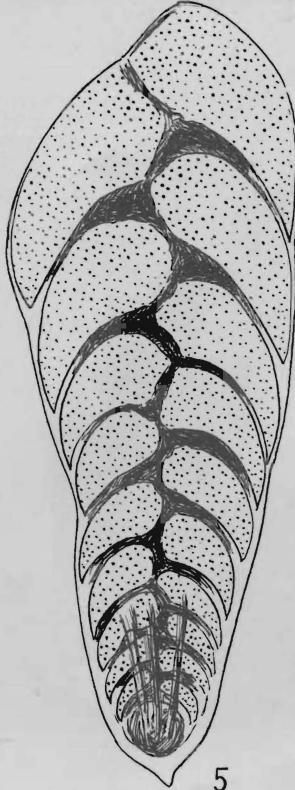
2



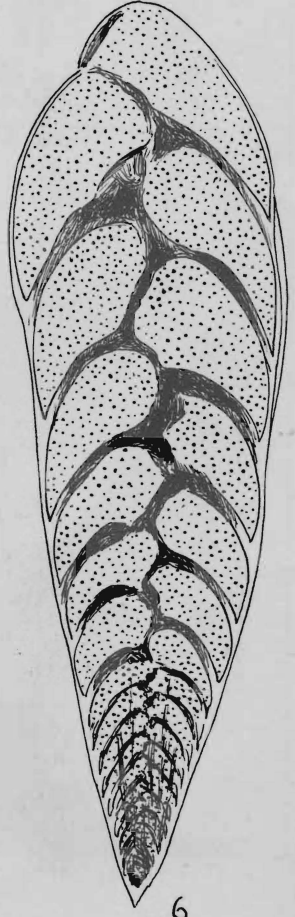
1



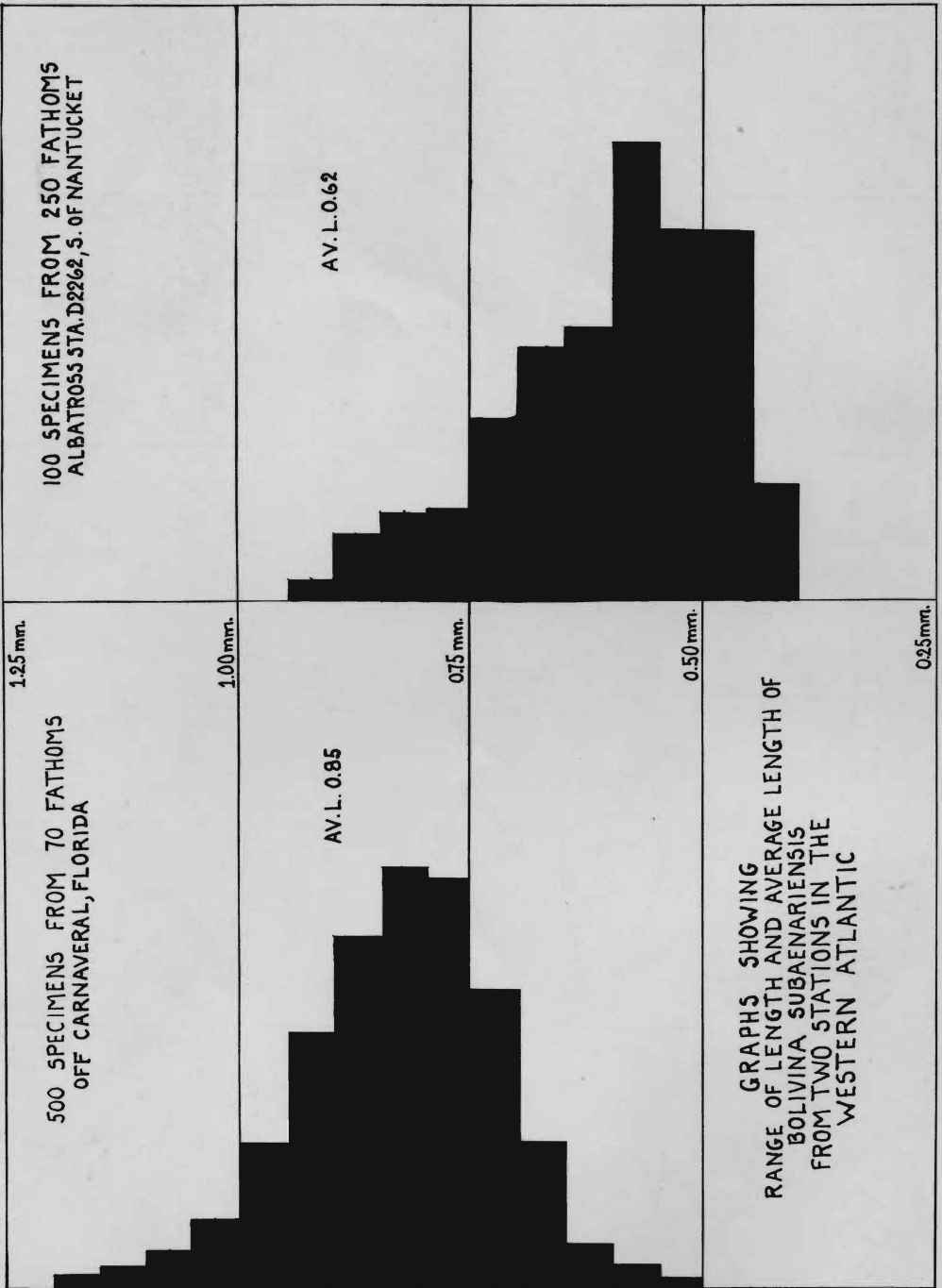
4



5



6



FLORIDA



Av. L. 0.41  
Av. B. 0.17



Av. L. 0.41  
Av. B. 0.16

LOWER ECPHORA ZONE  
UPPER MIOCENE



Av. L. 0.44  
Av. B. 0.20



Av. L. 0.44  
Av. B. 0.21

ARCA ZONE-UPPER PART  
UPPER MIDDLE MIOCENE



Av. L. 0.46  
Av. B. 0.21



Av. L. 0.48  
Av. B. 0.21

ARCA ZONE-LOWER PART  
UPPER MIDDLE MIOCENE

CALIFORNIA



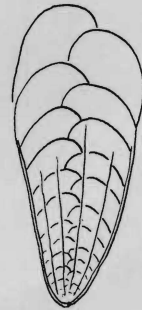
Av. L. 0.56  
Av. B. 0.24

MIOCENE  
TEMBLOR  
VALVULINERIA  
ZONE

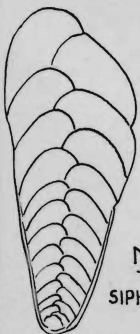


Av. L. 0.52  
Av. B. 0.22

YOLDIA ZONE  
UPPER MIDDLE MIOCENE

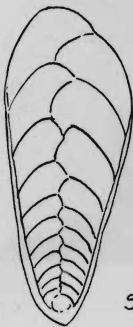


Av. L. 0.59  
Av. B. 0.24



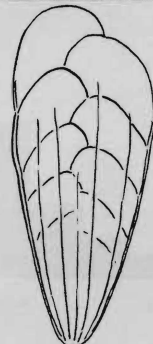
Av. L. 0.61  
Av. B. 0.25

MIOCENE  
TEMBLOR  
SIPHOGENERINA  
ZONE

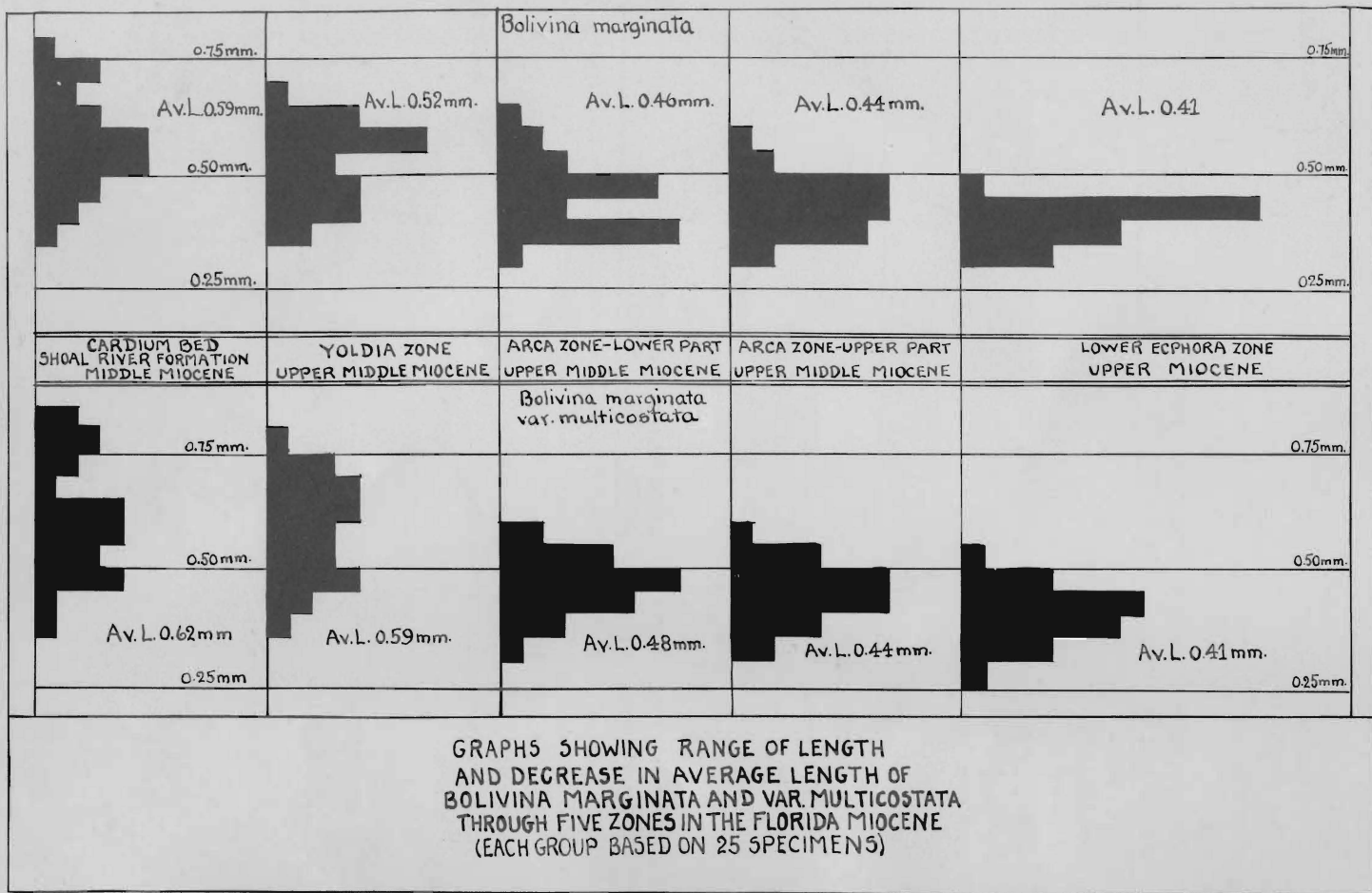


Av. L. 0.59  
Av. B. 0.24

CARDIUM BED  
SHOAL RIVER FORMATION  
MIDDLE MIOCENE



Av. L. 0.62  
Av. B. 0.26





the adult whorl, of uniform shape, increasing rather regularly in size as added, slightly inflated on the ventral side; sutures distinct, slightly limbate on the dorsal side, slightly if at all raised, slightly curved, strongly oblique, ventrally somewhat depressed, slightly curved, not limbate; wall smooth; aperture elongate, on the ventral side nearly parallel to the periphery. Diameter 0.40-0.50 mm.; thickness 0.20-0.25 mm.

Holotype (Cushman Coll. No. 35909) from Aguide, 2.5 km. South ( $171^{\circ} 25'$ ) of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Core from Aguide Well No. 1 at 2177'.

This species differs from *P. interrupta* Cushman in the slightly fewer chambers in the whorl, more equally biconvex test, and more spinose projections at the periphery.

*Stratigraphic occurrence:* Lower Agua Salada Formation (probably Zone 2). ?Lowermost Miocene.

**SPHAERODINELLA RUTSCHI** Cushman and Renz, n. sp. (Pl. 4, fig. 5)

Test trochoid, subglobular, dorsal side with the spire depressed, periphery broadly rounded, slightly lobate; chambers strongly inflated, 3 or 4 making up the adult whorl; sutures slightly if at all depressed; wall smooth, very coarsely perforate; aperture in a deep depression between the two last-formed chambers, the periphery slightly raised and lip-like. Diameter 0.40-0.45 mm.

Holotype (Cushman Coll. No. 35914) from Isidro, 33.5 km. East ( $79^{\circ} 45'$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 165).

This species differs from *S. dehiscens* (Parker and Jones) in its smaller size, more globular form, and the failure to develop deep grooves along the sutures.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 2-4). Lowermost—Middle Miocene.

**CASSIDULINOIDES ERECTA** Cushman and Renz, n. sp. (Pl. 4, figs. 6, 7)

Test elongate, only slightly compressed, the earliest portion

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EXPLANATION OF PLATE 7

All figures  $\times 75$

Simplified camera lucida drawings of *Bolivina marginata* Cushman and var. *multicostata* Cushman showing average specimens from five zones of the Florida Miocene and two zones in the California Miocene.

close coiled, later portion in an uncoiled biserial arrangement, periphery rounded, apertural end acute; chambers distinct, inflated, increasing rapidly in size in the adult; sutures distinctly depressed; wall smooth; aperture high and narrow in the axis of the uncoiled portion in a depression of the apertural face. Length 0.40-0.45 mm.; diameter 0.22-0.25 mm.

Holotype (Cushman Coll. No. 35880) from Aguide, 2.5 km. South ( $171^{\circ} 25'$ ) of Pueblo Aguide, District Acosta, State Falcon, Venezuela. Core from Aguide Well No. 1 at 111'.

This species differs from *C. bradyi* (Norman) in the very slightly compressed test, much larger uncoiled portion, inflated chambers, and depressed sutures.

*Stratigraphic occurrence:* ?Base of Upper Agua Salada Formation. ?Lower to Middle Miocene.

CASSIDULINA SUBGLOBOSA H. B. Brady, var. HORIZONTALIS Cushman and Renz,  
n. var. (Pl. 4, fig. 8)

Variety differing from the typical in the later portion in which the chambers are added at an angle to the general axis, and the aperture elongate and at an angle of nearly  $90^{\circ}$  from the axis.

Holotype of variety (Cushman Coll. No. 35879) from Isidro, 35.7 km. East ( $83^{\circ} 30'$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 133).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-3). Upper Oligocene—Lower to Middle Miocene.

CIBICIDES FLORIDANUS (Cushman), var. COMPRESSA Cushman and Renz, n. var.  
(Pl. 4, fig. 9)

Variety differing from the typical in the much compressed test, somewhat umbilicate ventral side, and more strongly curved and narrower chambers.

Holotype of variety (Cushman Coll. No. 35882) from Isidro, 33.2 km. East ( $79^{\circ} 25'$ ) of Pueblo Piritu, District Zamura, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-7). Upper Oligocene—?Upper Miocene.

CIBICIDES ISIDROENSIS Cushman and Renz, n. sp. (Pl. 4, fig. 10)

Test about equally biconvex, depressed in the middle of both sides, periphery subacute, with a very slight keel; chambers distinct, 8 or 9 in the adult whorl, of rather uniform shape, in-

creasing rapidly in size as added, slightly inflated, the inner end on the dorsal side with a definite proximal portion; sutures distinct, strongly curved, limbate on the ventral side, much thickened toward the inner end and raised except in the last portion where they are depressed slightly, on the dorsal side more strongly curved and thickened in the middle; wall smooth except for the sutures; aperture on the dorsal side near the periphery, a low, arched opening. Diameter 0.65-0.90 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll. No. 35881) from Isidro, 33.2 km. East ( $79^{\circ} 25'$ ) of Pueblo Piritu, District Zamora, State Falcon, Venezuela. Coll. Dr. P. Leuzinger (sample L. P. 167).

This species differs from *C. concentricus* (Cushman) in the more acute periphery, more strongly curved and limbate sutures, and a lesser development of the proximal portions of the chambers on the dorsal side.

*Stratigraphic occurrence:* Lower and Upper Agua Salada Formation (Zones 1-6). Lowermost—?Upper Miocene.

**CIBICIDES KUGLERI** Cushman and Renz, n. sp. (Pl. 4, fig. 11)

Test plano-convex, the dorsal side nearly flat, ventral side becoming strongly convex, periphery slightly lobulate, subacute, slightly keeled; chambers distinct, 8 or 9 in the adult whorl, increasing very rapidly in size and especially thickness in the adult; sutures distinct, strongly limbate and raised, particularly toward the inner end; wall smooth except for the raised sutures; aperture at the periphery and extending to both the dorsal and ventral sides. Length 0.85-1.00 mm.; breadth 0.75-0.85 mm.; thickness 0.50 mm.

Holotype (Cushman Coll. No. 35883) from Pozon, 20.8 km. Southeast ( $119^{\circ} 15'$ ) of Pueblo Jacura, District Acosta, State Falcon, Venezuela. Coll. Mr. T. H. Bower (sample T. H. B. 1359).

This species differs from *C. mississippiensis* (Cushman) in its much larger size, larger number of chambers, keeled periphery, and strongly limbate, raised sutures. In some respects our species resembles the genus *Valvulineria*.

*Stratigraphic occurrence:* Upper Agua Salada Formation (Zone 3). Lower to Middle Miocene.

225. NOTE ON AGUAYOINA ASTEROSTOMATA  
BERMUDEZ

By PEDRO J. BERMUDEZ

Museo Poey, Universidad de la Habana, Cuba

*Aguyaina asterostomata* BERMUDEZ, Memorias, Soc. Cubana Hist. Nat., 1938, vol. 12, No. 5, pp. 385-8, pl. 29; CUSHMAN, 1940, Foraminifera, Their Classification and Economic Use, p. 82, pl. 42, figs. 11, 12; PLUMMER, 1940, American Midland Naturalist, vol. 24, No. 1, pp. 261-70; ELLIS & MESSINA, 1940, Catalogue of Foraminifera, vol. 1.

This new genus was described as a member of the foraminiferal family Saccamminidae. The specimens were found on the shells of *Xenophora longleyi* which had been dredged from a depth of 100 to 200 fathoms in Cochinos Bay on the south coast of Cuba by the First Harvard-Habana Expedition of the "*Atlantis*" in 1938.

Shortly after the publication of the description Mr. Arthur Earland of Watford, England, called my attention to some facts indicating that the new genus was more probably a coelenterate than a foraminifer. The form had not been discovered until all the specimens were dried and the animal remained unknown.

Fortunately, the Second Harvard-Habana Expedition of the "*Atlantis*" in 1939 offered another opportunity to collect from the type locality. Abundant specimens were obtained and careful examination showed that they did possess some characters of the Coelenterata.

At the suggestion of Mr. Earland the preserved material was submitted to the late Dr. Sydney J. Hickson, Prof. of Zoology at Cambridge University, England. He in turn asked the opinion of Dr. Stanley Gardner of the same institution. The verdict of these authorities on the Coelenterata was that *Aguyaina* is a new genus, apparently a member of the Coelenterata but not a madreporarian. They suggested that it probably belongs to the Order *Zoanthidae*; the animals of this group are known to use sand grains and alcyonarian and sponge spicules in their tests, as does *Aguyaina*. It is hoped that future studies will clarify the relationships of this interesting but strange genus.

The generous assistance of Mr. Earland and Drs. Hickson and Gardner is gratefully acknowledged.

## NO. 226. STATISTICAL STUDIES OF SOME BOLIVINAS

By J. A. CUSHMAN and RUTH TODD

This study is a preliminary one of a series, the ultimate purpose of which is to evaluate the physical characters of foraminifera which may be useful in stratigraphic correlation and those which may be significant of certain ecologic conditions. It has been evident for some time that a fairly long-ranging species shows somewhat different characters in different parts of its range. This was brought out in a paper in 1927: Cushman and Harris, these Contributions, vol. 2, pt. 4, pp. 92-94. Part of the present paper is an attempt to evaluate these differences so that they might possibly be used for stratigraphic purposes.

The present paper comprises first, a study of the differences between the same species as it occurs in two different localities and environments at the present time; and second, a study of the changes which occurred in a species and its accompanying variety as they developed and died out in one locality throughout several successive zones in the Miocene.

One hundred specimens of *Bolivina subaenariensis* Cushman from the type locality, Albatross D 2262, Lat. 39° 54' 45" N., Long. 69° 29' 45" W., 250 fathoms, South of Nantucket, were measured in length and breadth. Five hundred specimens of the same species from off Carnaveral, Florida, 70 fathoms, were likewise measured in length and breadth. Specimens from the type locality range from 0.92-0.43 mm. in length and from 0.35-0.18 mm. in breadth; the average being 0.62 mm. long and 0.26 mm. broad. Specimens from off Florida range from 1.20-0.52 mm. in length and from 0.37-0.20 mm. in breadth; the average being 0.85 mm. long and 0.28 broad. Specimens from the two localities differ in external appearance; those from off Florida are translucent with clear sutures, while those from the type locality are opaque and have entirely opaque sutures. The percentage of microspheric individuals differs; off Florida it is 7%, while at the type locality it is 25%. Most of the specimens show a basal spine, more conspicuous in the forms from the type locality, but it is variable in size and not always present. In spite of all these differences, the two groups are considered to

belong to the same species because the fundamental structures, such as shape of chambers, and curvature of the sutures, are the same. This can be seen by superimposing camera lucida drawings of the two over one another. It would be interesting to have specimens from additional areas to see what effect depth, temperature, and other factors have on the size characters, and it is hoped that this can be carried further at a later date.

The few available specimens of *Bolivina aenariensis* (Costa) from the Pliocene of Coroncina, Italy, were measured and a characteristic one drawn. Some time ago it was evident that these Pliocene ones of Italy were different from the Western Atlantic Recent ones. They differ in the angle of suture as well as smaller size.

In order to test out the possibility of using these average size characters in correlation, a study was made of *Bolivina marginata* Cushman and its accompanying variety, *multicostata* Cushman, in the Florida Miocene.

Twenty-five perfect specimens of both the species and the variety were picked out from each of the five zones of the Florida Miocene given on our chart, Plate 7. (See also Table 1, Bull. 9, Florida Geol. Survey, 1932.) The specimens were measured and averages figured, and to our surprise it was found that the length and breadth decreases as the species becomes older, or progressively in younger formations. On Plate 8 the decrease is shown in graphic form, both for the typical form and the variety. There is a tendency for the specimens to become relatively narrower with a more rounded, less noticeably keeled, periphery in the later development of the species. This is shown on Plate 7 which gives simplified drawings of average specimens from each of the five zones. At the same time the varietal form is usually slightly larger than the typical form, but decreases in nearly the same ratio, and the costae become much less well defined and cover less of the surface as the variety continues to persist with the typical form. At the earliest occurrence of *Bolivina marginata* and its variety *multicostata* in any considerable numbers, the number of individuals of the variety is more than twice that of the number of individuals of the species. At their latest occurrence the proportion is reversed; there are almost twice as many individuals of the species as of the variety. Thus the variety appears to die out by becoming rarer as well as smaller with the costae less well developed.

In the five zones of the Florida Miocene studied, the *Bolivinas* suggest a longer break between the lower part of the *Arca* zone and the *Yoldia* zone than between the other zones. The difference in length and strength of development of the costae on the varietal form is quite marked between these two zones, and the difference in average length is greater here than between the other zones.

For purposes of comparison, an equal number of specimens of *Bolivina marginata* from two samples in the California Miocene were measured. These seem to compare well with the specimens in the lowest formation of the Florida series, and, if other factors were left out, these California specimens from the two zones of the Temblor would seem to be the equivalents of the lower part of the Florida section.

While this is only a preliminary study, enough has been found to suggest the possibility that average measurements of a fair number of specimens may be useful as an indicator of relative age, and may perhaps be used in correlation not only in core samples but in surface samples as well, where the range of a species is relatively long and studies can be made of the entire series. There seems to be no difficulty in the Florida section in fitting an unknown set of these specimens in its proper stratigraphic position. A large enough number must be available in order to eliminate extreme forms.

We have not by any means neglected the possibility that environmental conditions in fossil series may also have more or less influence on size characters. This is a line of study that is now being pursued with the anticipation that something definite may soon be published along this line.

We do not wish to suggest as yet, from the small amount of evidence involved in this study, that long-distance correlation may be made on the basis of average size, but rather the possibility of finer divisions in one locality. The above results are presented more as a suggestive line of work, rather than as a definite proof of such changes being present in all species, until more is known of its possibilities.

## RECENT LITERATURE ON THE FORAMINIFERA

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

**Natland, M. L.** New genus of Foraminifera from the later Tertiary of California.—*Journ. Pal.*, vol. 14, No. 6, Nov., 1940, pp. 568-571, pl. 69, 2 text figs.—A new genus, *Cassidulinella*, with two new species, *C. renulinaformis* and *C. pliocenica*.

**Schenck, Hubert G. and M. L. Thompson.** *Misella* and *Brevaxina*, new Permian fusulinid Foraminifera.—A synopsis of the subfamily Verbeekiniinae is given, the generic name *Misella* taking the place of the preoccupied *Doliolina*, with a new subgenus *Brevaxina*.

**Laiming, Boris.** Foraminiferal Correlations in Eocene of San Joaquin Valley, California.—*Bull. Amer. Assoc. Petr. Geol.*, vol. 24, No. 11, Nov., 1940, pp. 1923-1939, 9 text figs. (charts and map).—A detailed study with charts showing the value of the smaller foraminifera in correlation.

**Cushman, Joseph A. and Irene McCulloch.** Some Nonionidae in the Collections of the Allan Hancock Foundation.—*Allan Hancock Pacific Expeditions*, vol. 6, No. 3, 1940, pp. 145-178, pls. 17-20.—There are 27 species and varieties described and figured, 10 new as follows: *Nonion hancocki*; *Nonionella japonica*, var. *mexicana*, *N. decora*, *N. basiloba*; *Cushmanella primitiva*; *Elphidium incertum*, var. *lene*, *E. spinatum*, var. *magnificum*, *E. stimulum*, *E. crispum*, var. *subcrispum*, *E. pustulosum*.

**Crickmay, G. W., H. S. Ladd and J. E. Hoffmeister.** Shallow-water Globigerina Sediments.—*Bull. Geol. Soc. Amer.*, vol. 52, Jan. 1, 1941, pp. 79-106, 2 pls., 4 text figs.—An interesting study of sediments containing *Globigerina*.

**Senn, Alfred.** Paleogene of Barbados and Its Bearing on History and Structure of Antillean-Caribbean Region.—*Bull. Amer. Assoc. Petr. Geol.*, vol. 24, No. 9, Sept., 1940, pp. 1548-1610, chart.

**Schenck, Hubert G.** Applied Paleontology.—*L. c.*, No. 10, Oct., 1940, pp. 1752-1778, 2 pls., 5 text figs.

J. A. C.