

REEXAMINATION OF THE UPPER CRETACEOUS PLANKTONIC FORAMINIFERAL GENERA *PLANOGLOBULINA* CUSHMAN AND *VENTILABRELLA* CUSHMAN

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ABSTRACT

Ventilabrella Cushman is considered by many workers to be a junior synonym of *Planoglobulina* Cushman. Careful review of the taxonomic history of both genera has shown conclusively that the two are not synonymous. The name *Ventilabrella* was reinstated by Brown (1969), and in this paper a neotype is selected for *Ventilabrella eggeri* Cushman.

The type-species for *Planoglobulina* Cushman is *Guembelina acervulinoides* Egger. Unfortunately, Cushman selected, as lectotype, a figure of *G. acervulinoides* which differs radically from his generic description. In this paper the genus *Planoglobulina* Cushman is properly redefined by the selection of a neotype for *Planoglobulina acervulinoides* (Egger) which corresponds to Cushman's original description of the genus.

Ventilabrella is characterized by a multiserial, laterally compressed, flabelliform test with fine to medium longitudinal costae or vermicular ornamentation. *Planoglobulina* has a more inflated test, fewer chambers,

and is ornamented with coarse longitudinal costae. Both genera have the following features in common: a multiserial, flabelliform test with chambers arranged in a single plane; depressed sutures; longitudinal ornamentation; merged cameral flanges; and continuous cameral ridges extending over the final series of chambers.

Ventilabrella first appears in the Santonian and is related to *Heterohelix* Cushman and possibly to *Sigalia* Reiss. *Planoglobulina* first appears in the late Maastrichtian and is related to *Pseudotextularia* Rzehak.

The following new species are described: *Ventilabrella browni* Martin, n. sp., *Ventilabrella manuelensis* Martin, n. sp., *Ventilabrella riograndensis* Martin, n. sp., and *Planoglobulina brazoensis* Martin, n. sp. *Ventilabrella alpina* de Klasz, *Ventilabrella decoratissima* de Klasz and *Ventilabrella ornatissima* Cushman and Church are reassigned to *Sigalia* Reiss.

INTRODUCTION

Genera and species of the family Heterohelidae Cushman are among the most common and widespread planktonic foraminifera in Cretaceous marine strata. The family includes the type genus *Heterohelix* Ehrenberg and descendant genera *Pseudoguembelina* Brönnimann and Brown, *Ventilabrella* Cushman, *Sigalia*

Reiss, *Pseudotextularia* Rzehak, *Planoglobulina* Cushman, *Racemiguembelina* Montanaro Gallitelli, and *Gublerina* Kikoin. The writer will follow Brown (1969, p. 31) in excluding from the Heterohelidae: *Guembelitria* Cushman, *Guembelitriella* Tappan, *Gubkinella* Suleymanov, *Chiloguembelina* Loeblich and Tappan, *Woodringina* Loeblich and Tappan, and *Bifarina* Parker and Jones.

Unfortunately, species and genera of this family are commonly misidentified or otherwise misinterpreted,

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and remain poorly studied for two reasons: (1) many genera have nomenclatural problems sufficient to discourage most workers; and (2) certain key genera and species of families such as the Globotruncanidae, Rotaliporidae and Marginotruncanidae are already used quite successfully in systems of Cretaceous foraminiferal zonation; consequently the Heterohelcidae continue to be ignored in lieu of better-known taxa whose stratigraphic significance is well established.

In this study an attempt has been made to unravel the taxonomic problems surrounding *Ventilabrella* Cushman and *Planoglobulina* Cushman. In the process, a neotype was selected for *Ventilabrella eggeri* Cushman and *Planoglobulina acervulinoides* (Egger), and four new species were described.

Over 180 samples were examined during this study from the Mexico, Texas, Arkansas, New Jersey, California, Puerto Rico, Denmark, Upper Bavaria, the Gulf of Mexico, the Blake Bahama Basin (JOIDES Leg I), the Rio Grande Rise (JOIDES Leg III), and Orphan Knoll (JOIDES Leg XII).

ACKNOWLEDGMENTS

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Dr. E. A. Pessagno, Jr., University of Texas at Dallas, suggested the problem, provided most of the Upper Cretaceous samples from the western Gulf Coast area for study, and offered valued advice and council throughout the investigation. Samples were also kindly provided by Dr. William R. Riedel, Curator, Deep Sea Drilling Project, Scripps Institute of Oceanography; Prof. Herbert Hagn, Institut für Paläontologie und historische Geologie der Universität, Munich; Charles C. Smith, University of Texas at Dallas; and B. W. McNeely of Shell Oil Company, Metairie, Louisiana.

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PREVIOUS INVESTIGATIONS

The family Heterohelcidae was first established by Cushman in 1927. He included at that time, among his 7 subfamilies and 17 genera, not only homogeneous genera related to the type genus *Heterohelix* Ehrenberg,

but also a number of questionable forms with transitional or poorly known morphological characters.

Galloway (1933) limited the subfamilies of Heterohelcidae to 3, based on the type of early coiling and degree of compression of the biserial portion of the test. He corrected the positions of *Pseudouvirgerina* Cushman and *Siphogenerinoides* Cushman but otherwise suggested no substantial changes in the general arrangement of the family.

Glaessner (1936, p. 126) divided the Heterohelcidae into 2 subfamilies, the Heterohelicinae and the Gümbelininae.

Without fundamental change Sigal (1952) and Pokorny (1954) placed the family Gümbelinidae (with *Guembelina*) in the Rotaliidea and the family Heterohelcidae (with *Heterohelix*) in the Buliminidea. *Bolivinita* Cushman, *Bolivinoidea* Cushman and *Bolivinitella* Cushman were still considered members of the Heterohelcidae.

The next major revision of the Heterohelcidae after Glaessner's was that of Montanaro Gallitelli in 1957. She reduced the family to 2 subfamilies and 9 genera; the triserial subfamily Guembelitrinae (including *Guembelitra* Cushman and *Guembelitriella* Tappan); and the biserial subfamily Heterohelicinae (including *Heterohelix* Cushman, *Pseudoguembelina* Brönnimann and Brown, *Tubitextularia* Sulc, *Racemiguembelina* Montanaro Gallitelli, *Gublerina* Kikoiné, *Planoglobulina* Cushman, and *Pseudotextularia* Rzehak). She placed *Bolivinitella* under the family Plectofrondiculariidae, and placed certain other previously mentioned genera under the family Buliminidae (e.g., *Bolivinoidea*, *Bolivinita*, *Eouvirgerina*, and *Siphogenerinoides*).

Montanaro Gallitelli emphasized the necessity of revising all type species and many specimens before proposing a new systematic arrangement for the Heterohelcidae. She used the highest magnification available at the time for the stereobinocular ($\times 216$) for her study, pointing out that (1957, p. 133); "... The previous use solely of low magnifications explains many of the misinterpretations in these extremely small Foraminifera."

Reiss (1963, p. 78) placed the family Heterohelcidae under his superfamily Bilamellida, which included foraminifera with double-layered chamber walls of granular or radial calcite. He retained Montanaro Gallitelli's genera but did not separate them into subfamilies.

Still further emendations were made by Loeblich and Tappan (1964) in the *Treatise on Invertebrate*

Paleontology, in which the family Heterohellicidae was placed in the superfamily Globigerinacea (foraminifera of planktonic habit, with double walls of radial hyaline calcite).

Loeblich and Tappan followed Montanaro Gallitelli for the most part, adding *Gubkinella* Suleymanov and *Woodringina* Loeblich and Tappan to the subfamily Guembelitrinae, and *Bifarina* Parker and Jones and *Chiloguembelina* Loeblich and Tappan to the subfamily Heterohellicinae.

The most recent, and most radical, emendation of the Heterohellicidae was that of Noel K. Brown, Jr. (1969). He discussed the reasons why this group has remained somewhat of an enigma to the micropaleontologist, including the confusing nomenclatural problems, the numerous inter- and intraspecific variations, and the not-readily-apparent chamber arrangement in certain advanced forms.

Brown's emended definition restricts the Heterohellicidae to include only the Cretaceous genera *Heterohelix* Cushman, *Pseudoguembelina* Brönnimann and Brown, *Sigalia* Reiss, *Ventilabrella* Cushman, *Pseudotextularia* Rzehak, and *Gublerina* Kikoin. His definition excludes certain genera commonly placed in the Heterohellicidae: the triserial to trochospiral planktonics *Guembelitra* Cushman, *Guembelitriella* Tappan, and *Gubkinella* Suleymanov; the single-layered Tertiary planktonics *Chiloguembelina* Loeblich and Tappan and *Woodringina* Loeblich and Tappan; and the benthonic *Bifarina* Parker and Jones.

Brown established, for the first time, morphologic terminology which could be applied to biserial and flabelliform taxa. He also described test morphology in heterohellicid genera by using mechanical stress terms, such as "tension" and "compression", as a way for workers to more readily visualize the genetically-caused processes of chamber arrangement.

PROBLEMS OF TAXONOMY

Cushman erected the genus *Planoglobulina* in 1927, listing the "genoholotype" as *Guembelina acervulinoides* Egger. He did not mention, at the time, which of Egger's figures (Egger, 1899, pl. 14, figs. 14-18, 20-22) would be the lectotype.

In 1928 Cushman erected the genus *Ventilabrella*, listing *Ventilabrella eggeri* Cushman as the "genoholotype" (1928, pl. 1, figs. 10-12). Within the discussion which followed, Cushman (*ibid.*, p. 3) also mentioned *Planoglobulina*:

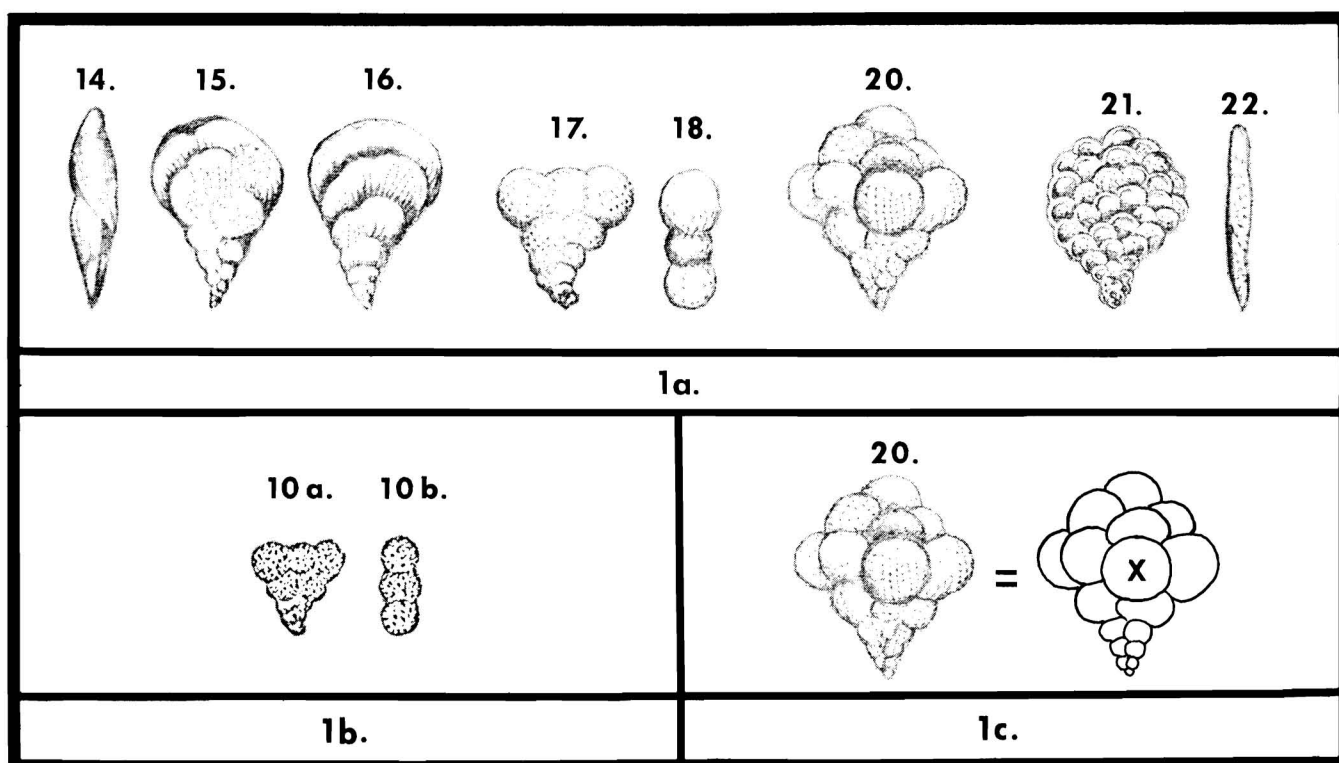
"The species of Egger upon which I based the genus *Planoglobulina*, *Guembelina acervulinoides* Egger, has developed as I stated from a *Pseudotextularia*-like young, the spiral form of the test very apparent in the specimen and not all in one plane, the later chambers finally developing a fan-shaped mass generally in a single plane. The type specimen is here designated as that figured on Pl. xiv, fig. 20 of Egger's work . . ."

It is this last sentence of Cushman's that has led to so much confusion. Cushman was, at that point, discussing the genus *Planoglobulina*, NOT *Ventilabrella eggeri*, and was referring to Egger's figure 20 as his choice of a lectotype for *Planoglobulina acervulinoides* Cushman. Several workers have misinterpreted Cushman's statement and as a consequence have referred to Egger's figure 20 in their synonymies of *Ventilabrella eggeri*; (e.g., Carman, 1929, p. 314; Frizzell, 1954, p. 111; I. Küpper, 1964, p. 636), and, according to Brown (1969, p. 40), even Cushman "... unknowingly became a victim of his own statement. Apparently Cushman, or more likely one of his assistants, in compiling his synonymy cards on the two species, and without perusing pages 2 and 3 of Cushman's text (1928b, pp. 2-3), assumed that the statement referred to *V. eggeri*, not realizing that it had already been included in the synonymy of *Planoglobulina acervulinoides* (Egger), and that if it appeared in the synonymy of one species it must be removed from the synonymy of the other. Thus, Cushman (1938, pp. 23, 25; 1944b, p. 92; 1946, p. 111) cited plate 14, figure 20 of Egger (1899) in his synonymies of both *Planoglobulina acervulinoides* and *Ventilabrella eggeri*."

Montanaro Gallitelli, however, in her revision of the Heterohellicidae (1957, p. 141), did not view this incident as a simple oversight on Cushman's part. After noting (*ibid.*, p. 142) that Cushman had included Egger's figure 20 in his synonymies of both genera, she concluded that "... the type species of *Ventilabrella* (*V. eggeri*) is a junior synonym of the type species of *Planoglobulina* (*P. acervulinoides*), the two genera thus being identical.

"As *Planoglobulina* has priority, and the type species are synonymous, the name *Ventilabrella* must be suppressed as a junior subjective-objective (genotype species are believed to be the same) synonym."

The writer disagrees with Montanaro Gallitelli's conclusion and agrees instead with Brown (1969, pp. 40, 41), who discussed at length the status of *Ventilabrella* and *Planoglobulina* and concluded on page 41:



TEXT FIGURE 1

1a. Species figured by Egger in 1899 as *Guembelina acervulinoides*, n. sp.

1b. Cushman figured this specimen as *Ventilabrella eggeri* in 1928. This is probably the same specimen as that figured by Egger in 17, 18 above, and may have been Cushman's intended holotype for *V. eggeri*.

1c. Also in 1928, Cushman selected Egger's figure 20 as lectotype for *Planoglobulina acervulinoides* (Egger). Note circular outline of chamber "X" which does not appear to lie in the same plane with other chambers. (After Brown, 1969).

"Clearly *Ventilabrella eggeri* is in need of a neotype designation . . . Nevertheless, the generic concept of *Ventilabrella* is clear and has never been questioned. The problem was whether it was a junior synonym of *Planoglobulina* or not . . . the latter genus is a junior synonym of *Pseudotextularia* and not a senior synonym of *Ventilabrella*."

Brown's (1969, p. 43) emendation of *Pseudotextularia* Rzehak includes the multiserial forms *Planoglobulina* Cushman and *Racemiguembelina* Montanaro Gallitelli. For this paper, however, the writer will follow Montanaro Gallitelli's (1957, p. 138) emendation of *Pseudotextularia* Rzehak, which limits the genus to biserial forms only.

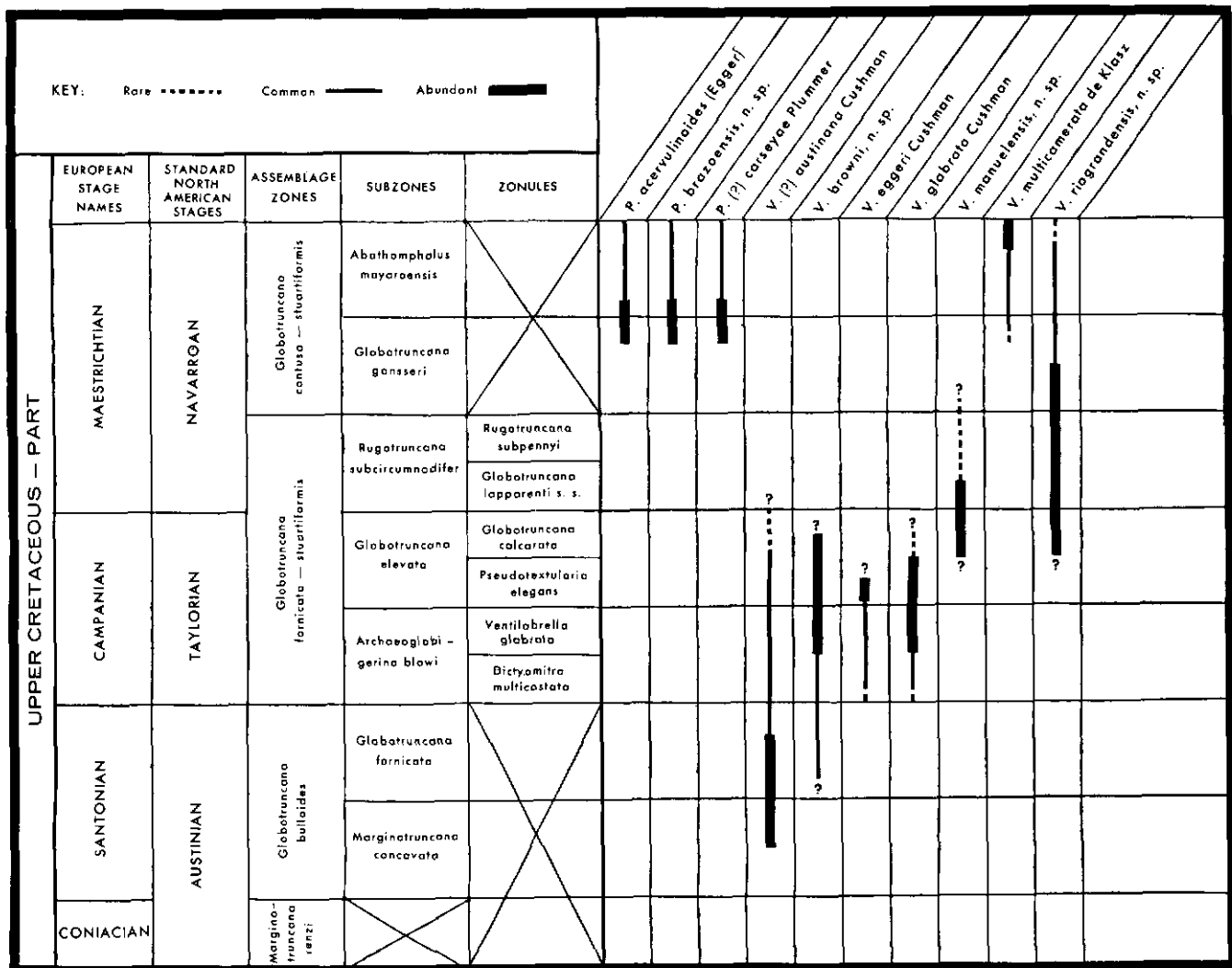
As an aid to this discussion, all specimens originally figured by Egger as *Guembelina acervulinoides* are shown in text figure 1. Among these are Cushman's

intended holotype for *Ventilabrella eggeri*, and his lectotype for *Planoglobulina acervulinoides*.

The problems surrounding *Planoglobulina* are exceedingly complex. It was stated earlier that when Cushman first described *Planoglobulina*, he listed *Guembelina acervulinoides* Egger (1899, pl. 14, figs. 14–18, 20–22; text fig. 1a in this paper) as "genoholotype" but had not yet selected a lectotype. His description of the genus (1927, p. 77) is as follows:

"Test with the earliest chambers in the microspheric form planospiral, followed by a series arranged biserially and in the adult by a series of globular chambers spread out fan shaped or even partially extending back toward the earlier chambers on either side, the later chambers in a single plane; wall calcareous, perforate."

In the explanation which immediately followed (ibid., p. 77) Cushman contradicted his definition:



TEXT FIGURE 2

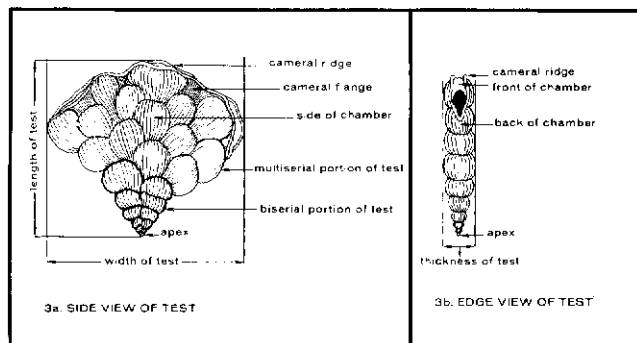
Range zones and relative abundance of species of *Ventilabrella* and *Planoglobulina*.

"This genus represents an end form developed from *Pseudotextularia* Rzehak which in its earlier stages is similar but in the adult has the chambers in a coiling series about the apertural end."

Thus, we have two different concepts of *Planoglobulina* put forth by Cushman: (1) his original definition in which later chambers are arranged in a single plane; and (2) his subsequent explanation in which later chambers are arranged in a coiling series about the apertural end.

In 1928, in a discussion following the definition of his newly erected genus, *Ventilabrella*, Cushman (1928, p. 3) designated Egger's figure 20 as the lecto-

type for *Planoglobulina acervulinoides* (Egger). Figure 20 (shown in text fig. 1), in the writer's opinion, corresponds to Cushman's subsequent explanation of *Planoglobulina*, rather than to his original definition. Observe Brown's (1969, pl. 3, fig. 3) line drawing of figure 20 in text figure 1c; the completely circular outline of the chamber marked "x" would indicate that this chamber certainly does not lie in the same plane with other chambers. Note also that the test has a roughly conical shape, and that the later chambers appear to be circumferentially arranged. Thus, the concept embodied by the lectotype closely corresponds to Cushman's explanation of chambers arranged



TEXT FIGURE 3

Line drawing of idealized *Ventilabrella* illustrating basic morphological terminology referred to in text.

"in a coiling series about the apertural end". In the writer's opinion Egger's figure 20 most likely represents a *Racemiguembelina*.

However, there are late Maestrichtian forms in Europe and America which fit Cushman's original description of *Planoglobulina*, making possible a proper redefinition of the genus by the selection of a neotype for *P. acervulinoides* (Egger).

NATURE OF BIOSTRATIGRAPHIC UNITS

The zonal system and correlation chart outlined by Pessagno (1969a, p. 7, pl. 2) has been utilized in the present study. Range zones and abundance zones of species studied herein are indicated in text figure 2.

MORPHOLOGIC TERMINOLOGY

There is a definite lack of adequate morphologic terminology for describing biserial and multiserial foraminifera. The widely accepted terminology of Bolli, Loeblich and Tappan (1957, p. 9) applies mainly to planispiral, trochospiral and enrolled biserial forms. Brown (1969, p. 22) made the first serious attempt to establish morphologic terminology for the Heteroheliciidae. His terminology will be followed herein with the exception of the terms: (1) *primary chambers* and *primary apertures* (those in the biserial portion of the test); (2) *supplementary chambers* and *supplementary apertures* (those in the multiserial portion of the test); (3) *striae*, and (4) *height* of chambers (the term *length* will be used instead).

To some workers the term *supplementary chamber* might imply that the chamber is not as important as

a "primary chamber". This is probably what Brown intended, because he stated (1969, p. 30) that supplementary chambers were of little taxonomic importance. For this paper, however, genera will be defined on the ultimate shape and form of the adult test, which is determined by the arrangement of "primary" and "supplementary" chambers alike. This is also true of "primary" and "supplementary" apertures. In such a case these terms would be misleading and will therefore not be used.

All morphologic terminology applicable to *Ventilabrella* (and *Planoglobulina* as well) is illustrated in text figure 3. Terms not mentioned by Brown (1969, p. 21, 22) are discussed below.

APEX OF TEST

The tip of the biserial portion of the test is termed *apex*.

CAMERAL FLANGE

In the final series of chambers, each chamber develops perforate lateral extensions on either side of the aperture, called *cameral flanges*. Flanges merge together, filling in open space between two adjacent chambers.

CAMERAL RIDGE

Each cameral flange has an imperforate rim which extends beyond the flange onto the top of adjacent chambers, ultimately forming a thin, continuous *cameral ridge* extending along the final series of chambers.

To the writer's knowledge, cameral flanges and ridges have not been described previously. They are present not only in *Ventilabrella* and *Planoglobulina*, but in *Sigalia* and *Gublerina* as well. As the test takes on a more flabelliform shape, chambers in the latter portion of the test tend to become more widely separated. Cameral flanges form connections between chambers, and cameral ridges may serve either as a reinforcement for the final series of chambers, or as a foundation upon which to build subsequent chambers. Cameral flanges and ridges seem to have taxonomic significance in multiserial genera of the Heteroheliciidae, but further study is needed to substantiate this.

CRITERIA FOR CLASSIFICATION

Many classificatory schemes have been devised for planktonic foraminifera, but most are used as a basis for recognizing the more thoroughly studied planispiral

	Montanaro Gallitelli (1957)	Brown (1969)	Martin (1971)
Family Level	wall composition and structure; chamber shape; type of early coiling; position and shape of aperture(s).	wall composition and structure; presence, however slight, of longitudinally disposed ornamentation; arrangement of primary chambers; type and position of apertures; type of stresses exerted on test (e.g., compression, tension, etc.).	wall composition and structure; chamber arrangement, including early portion; type and position of apertures.
Generic Level	type of coiling (early and adult); chamber shape (proliferations or reductions); surface ornamentation; position and shape of aperture.	relative shapes and positions of primary chambers as produced by stresses; number of chambers in biserial portion; nature of sutures.	chamber arrangement (e.g., biserial, multiserial in one plane, conical, etc.); nature of sutures (e.g., raised, depressed, etc.); position and shape of apertures; presence or absence of apertural flaps; type of longitudinal ornamentation, if any; degree of lateral inflation or compression of test; presence or absence of cameral flanges and ridges.
Specific Level	not given	not given	geometry of test; number and shape of chambers; type of ornamentation; (e.g., longitudinal costae, pore patterns, vermicular texture, etc.).

TEXT FIGURE 4

Criteria for classification of the Heterohellicidae.

and trochospiral taxa, such as the Planomaliniidae, Globotruncanidae and Rotaliporidae.

Text figure 4 compares criteria for classification of the Heterohellicidae by Montanaro Gallitelli (1957), Brown (1969), and the writer. Loeblich and Tappan (1964, p. C652) placed the Heterohellicidae in the superfamily Globigerinacea due to planktonic habit, but followed Montanaro Gallitelli at all other levels of classification.

Brown (1969, p. 30) classified genera of the Heterohellicidae on the basis of positions and shapes of chambers, in the biserial portion of the test only, as produced by stresses (e.g., tension, compression, etc.). Brown (ibid., p. 67) pointed out that these "stresses" are not external forces; that chamber shapes are determined by inherent causes in the genetics of the organism, and that these causes are referred to as "stresses" as a convenient way to visualize and describe processes of chamber arrangement.

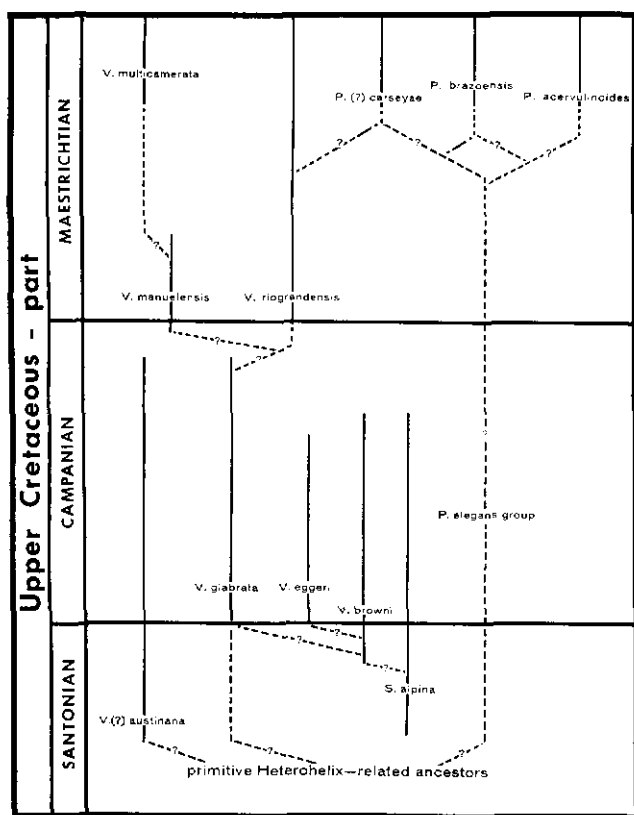
The following criteria for classification at the generic level were used for *Ventilabrella* and *Planoglobulina*: (1) chamber arrangement; (2) nature of sutures; (3) degree of inflation or compression of test; (4) position of apertures; (5) strength of longitudinal ornamentation; and (6) presence of cameral flanges and ridges.

EVOLUTIONARY TRENDS

Evolutionary trends in the Heterohellicidae as a whole include: (1) the strengthening of costae in *Pseudoguembelina* and *Pseudotextularia*; and (2) an increase in the number of chambers, through time, in successive species of *Ventilabrella*, *Sigalia*, *Racemiguembelina*, and *Gublerina*.

Two evolutionary trends can be observed in *Ventilabrella*: (1) the number of chambers in the multiserial portion of the test tends to increase through time; and (2) earlier species are costate throughout, whereas later, more advanced species exhibit a combination of longitudinal costae and vermicular ornamentation. No distinctive evolutionary trends were observed in the short-ranging genus *Planoglobulina*.

For example, *V. browni* Martin, n. sp. (pl. 1, figs. 3, 4) of the early Campanian, has about 18 chambers and is costate throughout. *V. riograndensis* Martin, n. sp. (pl. 2, figs. 1-4) of the late Campanian and early Maestrichtian has about 26 chambers; early chambers are beginning to exhibit vermicular ornamentation, yet fine costae are still visible over much of the test. Finally, *V. multicamerata* de Klasz (pl. 3, figs. 1-3) of the late Maestrichtian, has 44 or more chambers; heavy, vermicular ornamentation charac-



TEXT FIGURE 5

Phylogenetic relationships of *Ventilabrella* and *Planoglobulina* at species level.

terizes the test, with fine costae visible only on the final series of chambers.

With a paucity of transitional forms to draw from, it is difficult to establish, with any degree of certainty,

a phylogenetic sequence of species in *Ventilabrella* and *Planoglobulina*. Tentatively, however, the proposed sequence is shown in text figure 5.

SYSTEMATIC DESCRIPTIONS

Superfamily GLOBIGERINACEA

Family HETEROHELICIDAE Cushman, 1927

Type-genus: **Heterohelix** Ehrenberg, 1843

Remarks: The lengthy emended description of Brown (1969, p. 31) is adopted herein, with the following reservations: (1) It has never been conclusively shown that Heterohelidae have double-layered wall structure; (2) Brown's description contains morphologic terminology which is only partially accepted by the writer; and (3) Longitudinally disposed ornamentation over the entire test is not the rule for all Heterohelidae. For example, *H. glabrans* (Cushman) (Maestrichtian) lacks costae altogether. Species such as *Ventilabrella manusiensis* Martin, n. sp., and *V. multicamerata* de Klasz exhibit costae only on the final series of chambers.

Range: Cretaceous.

Occurrence: World-wide.

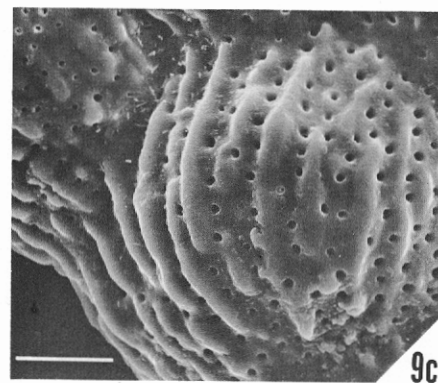
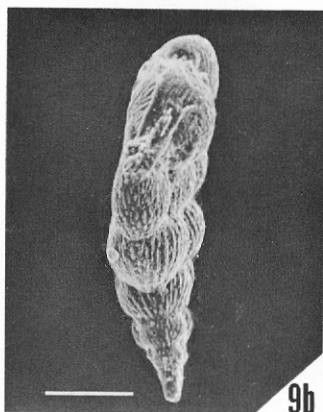
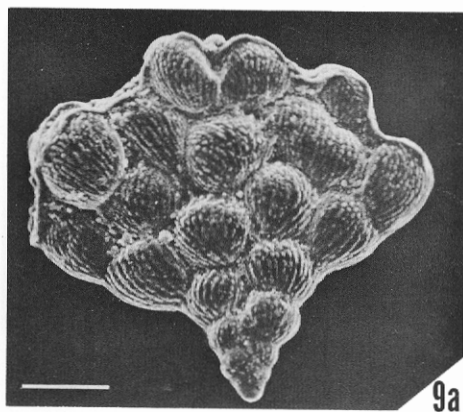
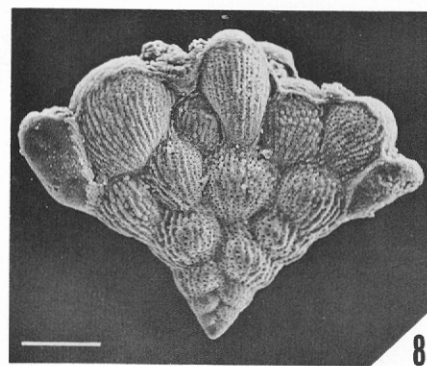
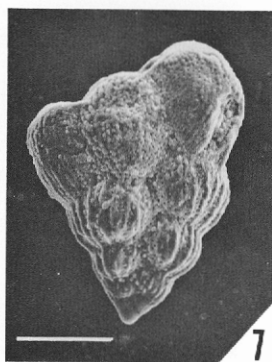
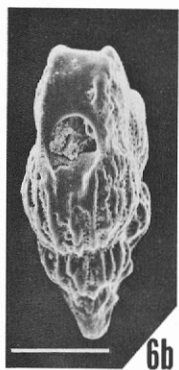
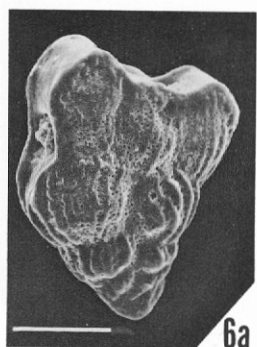
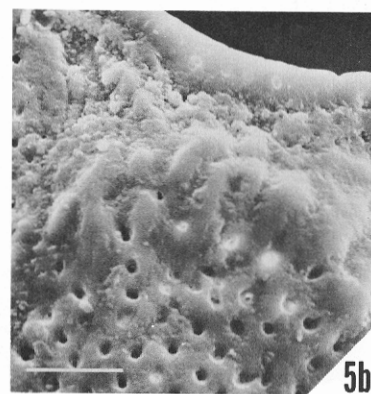
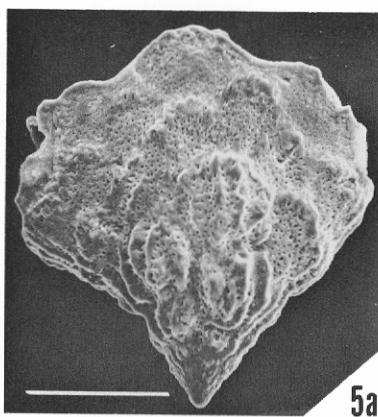
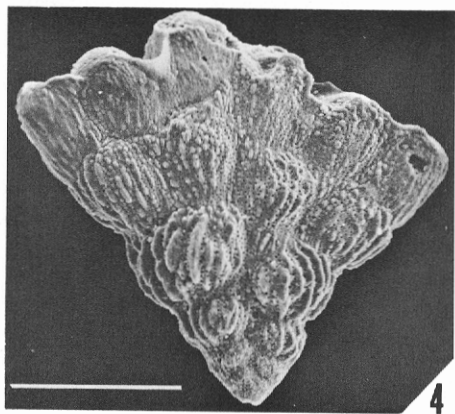
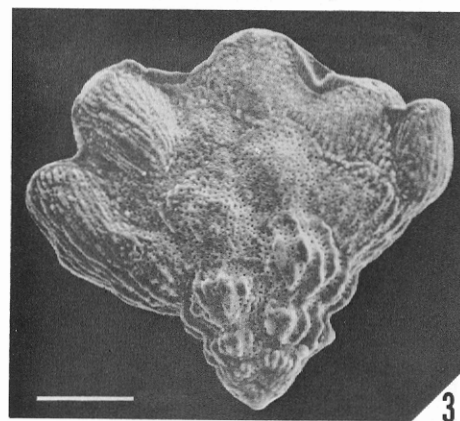
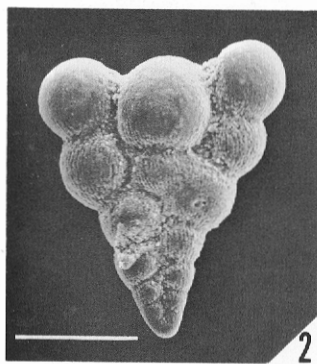
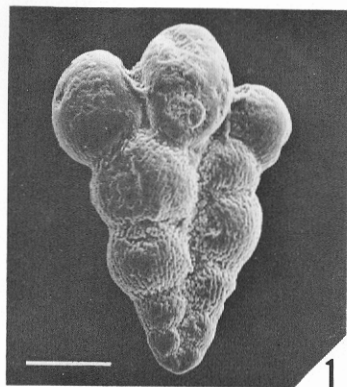
Genus *Planoglobulina* Cushman, 1927, emended

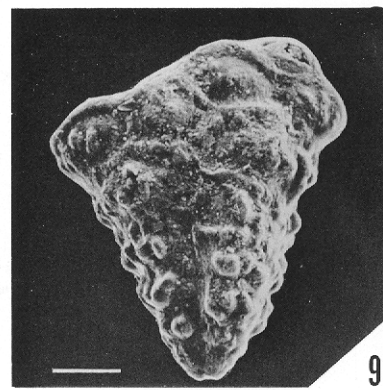
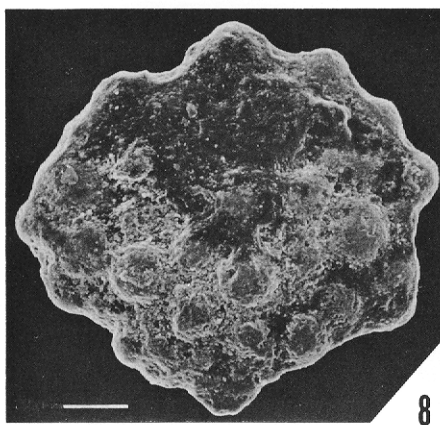
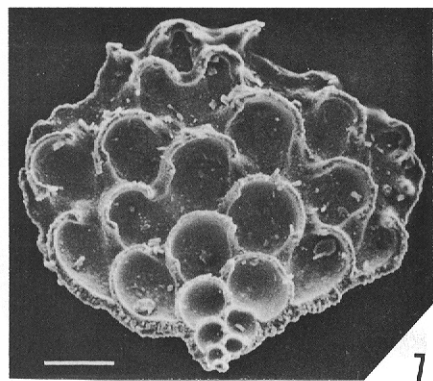
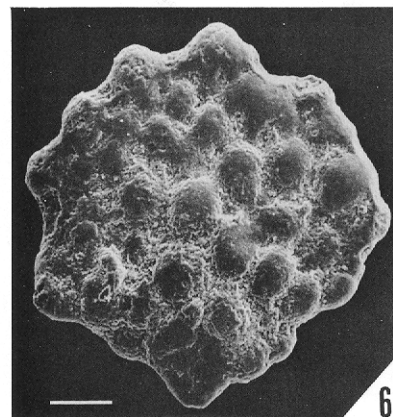
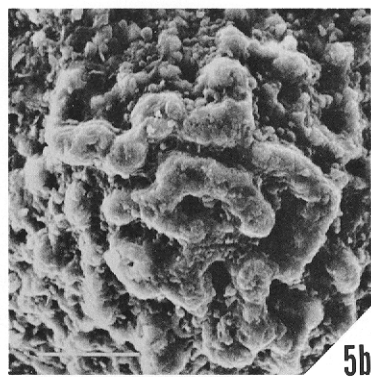
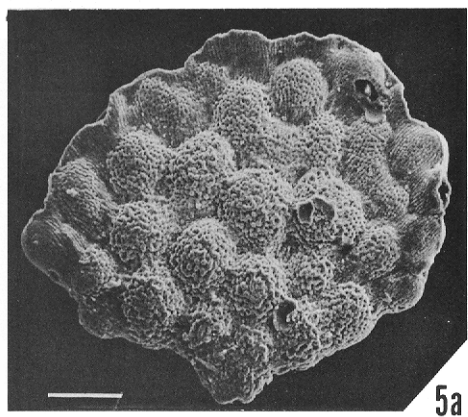
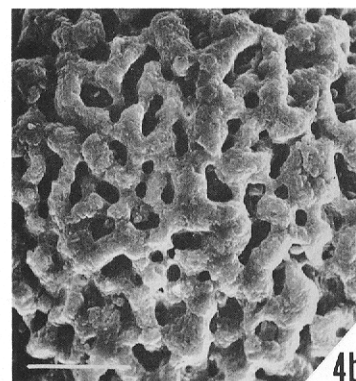
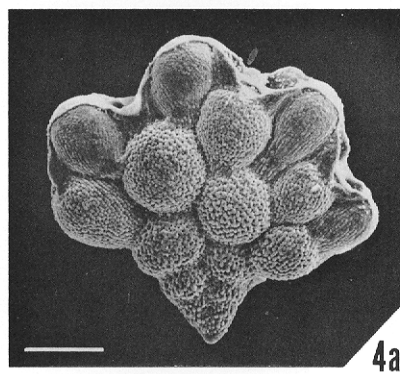
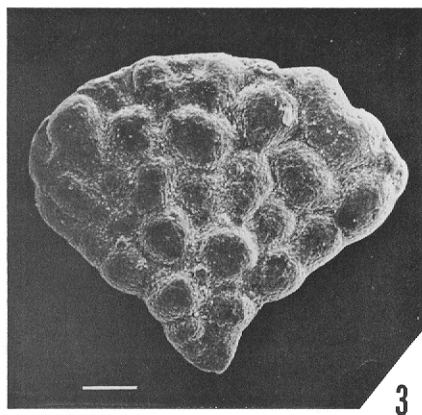
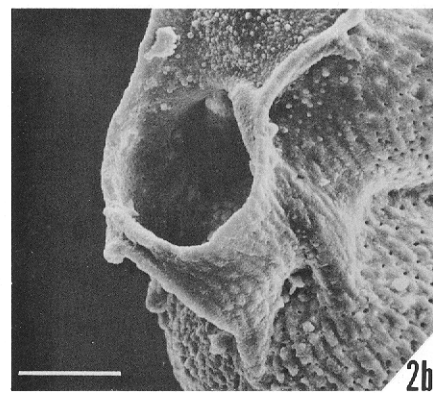
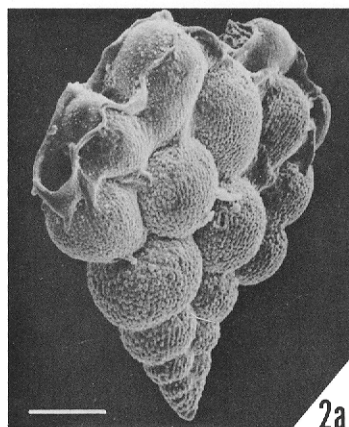
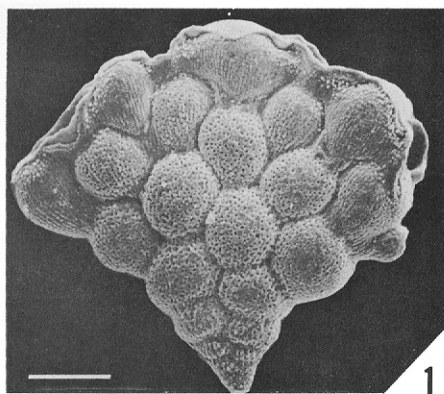
Type-species: *Planoglobulina acervulinoides* (Egger) (= *Guembelina acervulinoides* Egger 1899)

Description: Test calcareous, microgranular hyaline, perforate; laterally exhibits varying degrees of inflation; early portion biserial, with chambers rapidly increasing in size; later portion multiserial with chambers arranged

PLATE 1

- | | |
|---|--|
| 1. <i>Ventilabrella(?) austinana</i> Cushman 84 | 6. <i>Ventilabrella eggeri</i> Cushman 85 |
| Side view; line = 100 μ . Cushman 227. Gober Tongue of the Austin Chalk. | 6a: oblique view of neotype (USNM 170308); line = 100 μ . 6b: edge view; line = 100 μ . TX 252. Taylor Formation, "Lower Taylor Marl" Member. |
| 2. <i>Ventilabrella(?) austinana</i> Cushman 84 | 7. <i>Ventilabrella eggeri</i> Cushman 85 |
| Side view; line = 100 μ . AR 7A. Brownstown Marl. | Side view; line = 100 μ . TX 255A. Wolfe City Sand. |
| 3. <i>Ventilabrella browni</i> Martin, n. sp. 85 | 8. <i>Ventilabrella glabrata</i> Cushman 86 |
| Side view of holotype (USNM 170328); line = 100 μ . TX 244. Taylor Formation, "Lower Taylor Marl" Member. | Side view; note pyriform chambers in final row; line = 100 μ . TX 244. Taylor Formation, "Lower Taylor Marl" Member. |
| 4. <i>Ventilabrella browni</i> Martin, n. sp. 85 | 9. <i>Ventilabrella glabrata</i> Cushman 86 |
| Side view; line = 100 μ . TX 255A. Wolfe City Sand. | 9a: side view; line = 100 μ . 9b: edge view; line = 100 μ . 9c: portion of costal pattern; line = 20 μ . TX 375. Taylor Formation, "Lower Taylor Marl" Member. |
| 5. <i>Sigalia alpina</i> (de Klasz) 84 | |
| 5a: side view; line = 100 μ . 5b: portion of raised suture and cameral ridge; line = 20 μ . TX 255A. Wolfe City Sand. | |





in a single plane, resulting in a flabelliform test. Chambers globular to subglobular. Sutures depressed, usually distinct. Test exhibiting coarse longitudinal costae. Arched, basal apertures usually on front and back of all but outermost chambers in multiserial portion of test; outermost chambers with aperture on front only, facing inward; apertures visible only on final series of chambers. Merged cameral flanges and continuous, slightly raised parallel cameral ridges present on final series of chambers.

Range: Late Maestrichtian. *G. contusa-stuartiformis* Assemblage Zone, uppermost *G. gansseri* Subzone to top of *A. mayaroensis* Subzone.

Remarks: *Planoglobulina* Cushman differs from *Ventilabrella* Cushman by having a laterally inflated test, fewer chambers, stronger costae, and no vermicular ornamentation. *Planoglobulina* differs from *Racemiguembelina* Montanaro Gallitelli by having a flabelliform rather than conical test.

Planoglobulina, as Cushman originally noted (1927, p. 77), probably represents an end form of *Pseudotextularia* Rzehak (as does *Racemiguembelina*). *Planoglobulina* has rapidly expanding chambers in the biserial portion of the test, and exhibits the well developed costal and pore pattern characteristic of late Maestrichtian forms of *Pseudotextularia* such as *P. deformis* Kikoine and the *Pseudotextularia*-related genus *Racemiguembelina* Montanaro Gallitelli.

Planoglobulina acervulinoides (Egger)

Plate 3, figures 3-6

Pseudotextularia acervulinoides (Egger), CUSHMAN, 1926, p. 17, pl. 2, fig. 5; 1927, p. 158, pl. 27, fig. 3. WOORWIJK, 1937, p. 195, pl. 1, (?)fig. 19. CUSHMAN, 1938, p. 23, pl. 4, figs. 7a,b; 1946, p. 111, pl. 47, figs. 12, 13, not

figs. 14, 15. OLSSON, 1960, p. 28, pl. 4, fig. 12. DUPEUBLE, 1969, p. 158, pl. IV, (?)fig. 16. FUNNELL, 1969, p. 22, text fig. 4; pl. 1, fig. 7.

Description of neotype: Test flabelliform, inflated, especially in early portion. Six chambers in biserial portion, twenty-one chambers in multiserial portion. Chambers globular to subglobular, separated by depressed, slightly indistinct sutures. Heavy, closely spaced, longitudinal costae relatively continuous over early chambers; slightly finer and discontinuous over later chambers. Arched, basal apertures on front and back of all but outermost chambers in final row; outermost chambers with apertures on front only, facing inward.

Remarks: *P. acervulinoides* (Egger) differs from *P. brazoensis*, n. sp., by having (1) a less inflated, more bilaterally symmetrical test; (2) more chambers (from 13 to 20) in the multiserial portion of the test; and (3) slightly wider costae.

Dimensions: Neotype measures 550 μ in length, 575 μ in width, and 225 μ in maximum thickness. Other specimens vary from 375 to 550 in length; 375 μ to 575 μ in width; and 175 μ to 225 μ in maximum thickness.

Type locality: S-2 of Martin (see appendix): Gertschreuter Beds, Adelholzen, near Siegsdorf, Upper Bavaria.

Deposition of types: Neotype: USNM 170316; Topotypes: USNM 170317, 170318, 170319; and SM-7b of Pessagno Collection, University of Texas at Dallas.

Range: *G. contusa-stuartiformis* Assemblage Zone, uppermost *G. gansseri* Subzone to top of *A. mayaroensis* Subzone.

Occurrence: In Texas *P. acervulinoides* occurs abundantly in the late Maestrichtian portion of the

PLATE 2

- 1, 2, 4. *Ventilabrella riograndensis* Martin, n. sp. 88
1: side view of varatype (USNM 170314); line = 100 μ . 2a: oblique view; line = 100 μ . 2b: portion of cameral ridge and unique finger-like extensions; line = 50 μ . 4a: side view of paratype (USNM 170315); note pyriform chambers similar to *V. glabrata* (pl. 1, fig. 8); line = 100 μ . 4b: portion of vermicular ornamentation; line = 20 μ . 3/21/4/1. Rio Grande Rise.
3. *Ventilabrella riograndensis* Martin, n. sp. 88
Side view of holotype (USNM 170312); line = 100 μ . TYPE 4. Mendez Shale.
5. *Ventilabrella manuelensis* Martin, n. sp. 87

- 5a: side view; note crescent-shaped chambers in later portion of test; line = 100 μ . 5b: portion of heavy vermicular ornamentation; line = 20 μ . 12/111A/11/6. Orphan Knoll. (From Shorelab sample, Pessagno and Longoria; refer to bibliography).
6. *Ventilabrella manuelensis* Martin, n. sp. 87
Side view of holotype (USNM 170320); note subcircular outline of test; line = 100 μ . MX 13. Mendez Shale.
7. *Ventilabrella manuelensis* Martin, n. sp. 87
Side view of broken specimen showing chamber arrangement; line = 100 μ . 1/4A/2/1. Blake Bahama Basin.

Escondido Formation. In Mexico *P. acervulinoides* is common in the late Maestrichtian portion of the Mendez Shale (MX 78 of Pessagno, see appendix).

P. acervulinoides is present in late Maestrichtian sediments of the Rio Grande Rise, Joides Leg III (3/31/3/1, see appendix), and Orphan Knoll, Joides Leg XII (12/111A/11/1, see appendix).

Planoglobulina acervulinoides (Egger) has been figured as *Pseudotextularia acervulinoides* (Egger) from late Maestrichtian sediments of the Redbank Formation of New Jersey (Olsson, 1960); Galicia Bank, west of Spain (Funnell, et al., 1969); the eastern Aquitaine of France (Dupeuble, 1969); and Habana, Cuba (Voorwijk, 1937).

Planoglobulina brazoensis Martin, n. sp.

Plate 3, figure 7

Plate 4, figures 1, 2

Pseudotextularia elegans Rzehak var. *acervulinoides* (Egger), GLAESSNER, 1945, pl. 10, figs. 15c, d.

Pseudotextularia (Racemiguembelina) fruticosa (Egger), BERGGREN, 1962, p. 22, pl. VI, figs. 6a, b.

Pseudotextularia acervulinoides (Egger), WILLE-JANOSCHEK, 1966, p. 119, pl. 8, fig. 8.

Planoglobulina acervulinoides (Egger), PESSAGNO, 1967, p. 271, pl. 87, fig. 14.

Description: Test flabelliform, inflated, especially in early portion. Six rapidly expanding chambers in biserial portion; ten inflated, globular chambers in multiserial portion. Sutures fairly distinct, depressed. Coarse, discontinuous, longitudinal costae over entire test, separated by two or more rows of randomly arranged pores; costae somewhat finer on last row of

chambers. Arched, basal apertures on front and back of all but outermost chambers in last row; outermost chambers with apertures on front only, facing inward.

Remarks: *P. brazoensis*, n. sp., differs from *P. acervulinoides* (Egger), in its less symmetrical, more inflated test, narrower costae, and fewer number of chambers (15 to 18).

Dimensions: Holotype measures 525 μ in length, 475 μ in width, and 275 μ in maximum thickness. Other specimens vary from 500 μ to 550 μ in length; 450 μ to 525 μ in width; and 250 μ to 300 μ in maximum thickness.

Type locality: TX 9AH of Smith (see appendix): Kemp Clay exposed along south bank of Walter Creek, Milam County, Texas.

Deposition of types: Holotype: USNM 170324; Paratypes: USNM 170325, 170326, 170327; and SM-8b of Pessagno Collection, University of Texas at Dallas.

Range: *G. contusa-stuartiformis* Assemblage Zone, uppermost *G. gansseri* Subzone to *A. mayaroensis* Subzone.

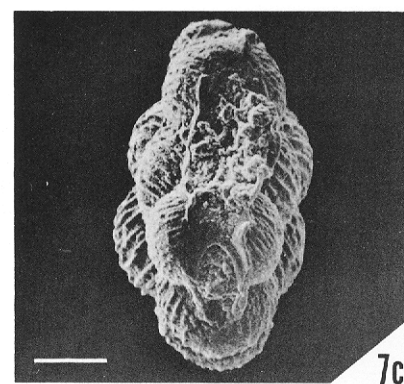
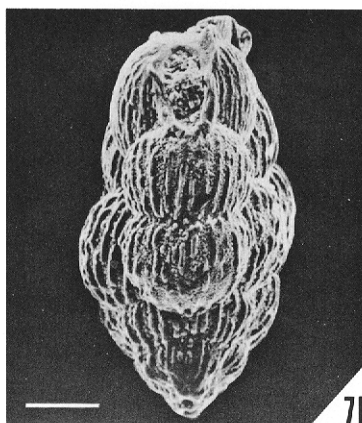
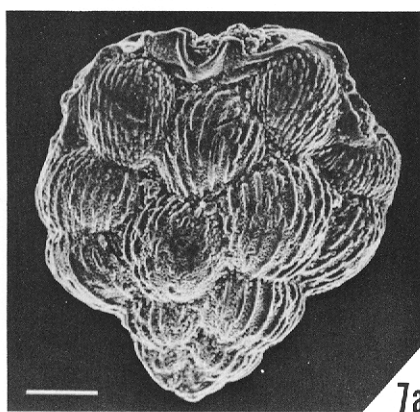
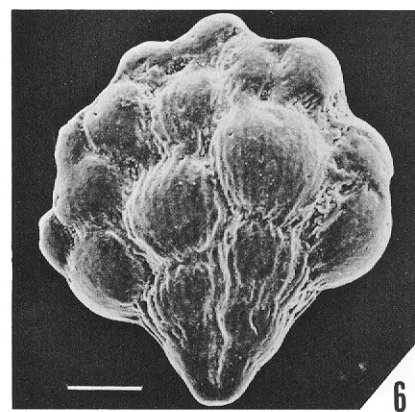
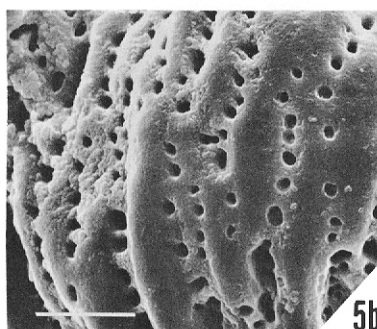
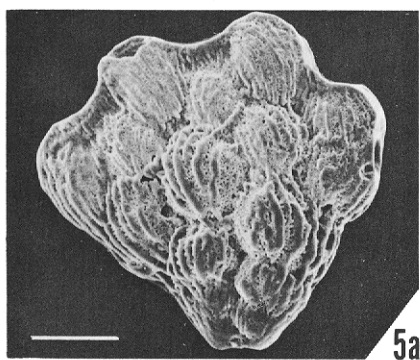
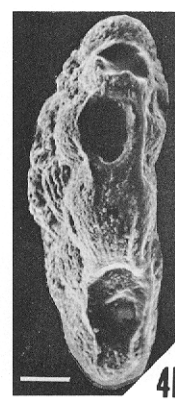
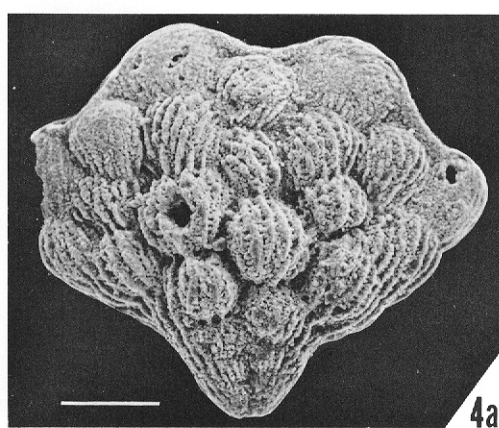
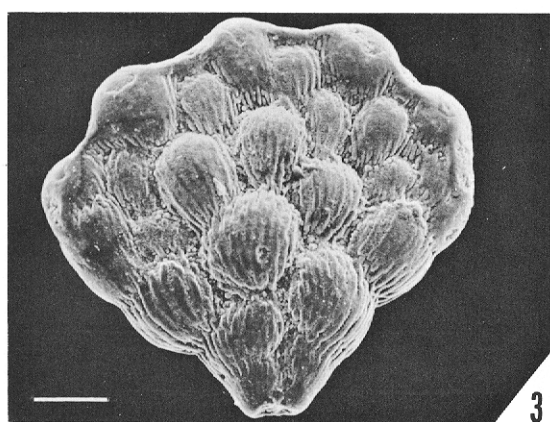
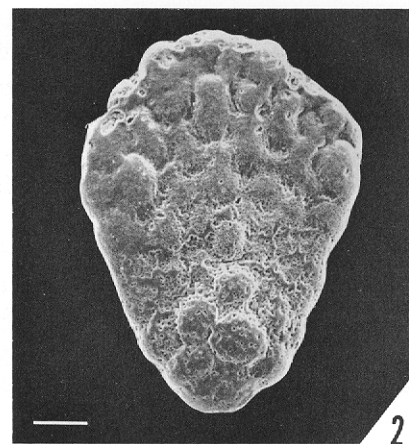
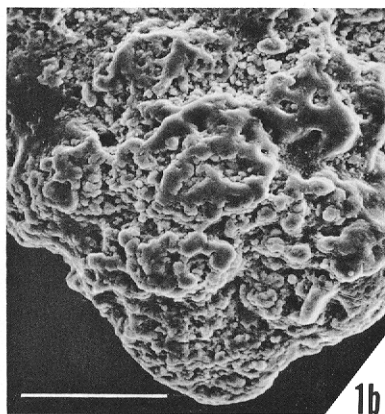
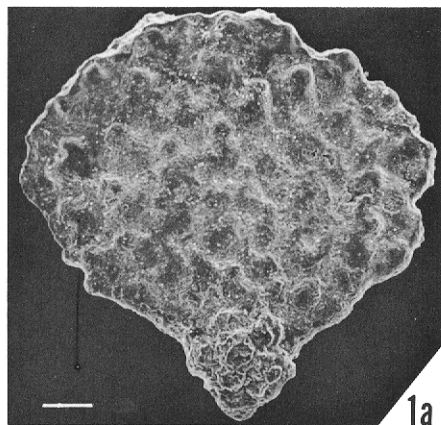
Occurrence: In Texas *P. brazoensis*, n. sp., occurs in the late Maestrichtian (uppermost *G. gansseri* Subzone) Kemp Clay of Falls and Milam counties (TX 267 of Pessagno; TX 9AH of Smith, see appendix).

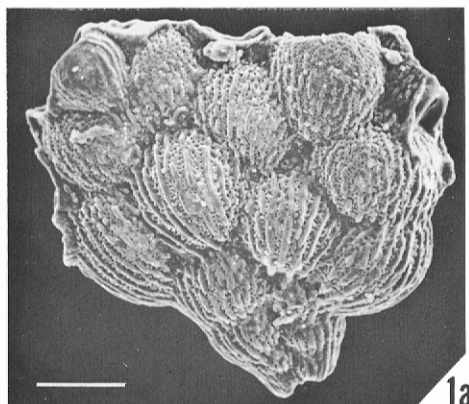
In Mexico *P. brazoensis*, n. sp., is abundant in the late Maestrichtian portion of the Papagallos Shale (MX 174 of Pessagno, see appendix).

The specimen figured by Berggren (1962, pl. VI, fig. 6) from the late Maestrichtian of southern Scandinavia is *Planoglobulina brazoensis* Martin, n. sp., not *Pseudotextularia (Racemiguembelina) fruticosa* (Egger). *R. fruticosa* is conical in shape and has coverplates, with accessory apertures, which extend over the last few

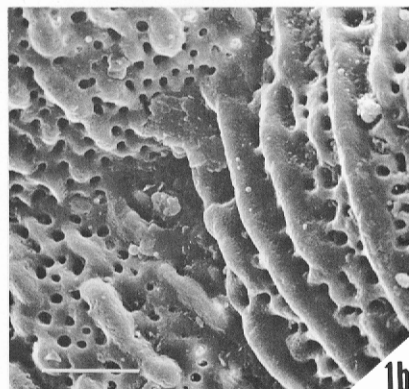
PLATE 3

- | | |
|--|---|
| 1. <i>Ventilabrella multicamerata</i> de Kasz 88 | 6. <i>Planoglobulina acervulinoides</i> (Egger) 81 |
| 1a: side view of large, atypical specimen; line = 100 μ . 1b: portion of vermicular ornamentation; line = 100 μ . MX 78. Mendez Shale. | Side view of topotype (USNM 170318); line = 100 μ . S-2. Gerhardtstreuter Beds. |
| 2. <i>Ventilabrella multicamerata</i> de Kasz 88 | 7. <i>Planoglobulina brazoensis</i> Martin, n. sp. 82 |
| Side view of typical specimen; note elongate, subtriangular test and almost flat, crescent-shaped chambers: line = 100 μ . S-2. Gerhardtstreuter Beds. | 7a: side view of holotype (USNM 170324); line = 100 μ . 7b: edge view; note inflated test; line = 100 μ . 7c: top view; compare thickness of test with that of <i>P. acervulinoides</i> above (fig. 4b); line = 100 μ . TX9AH. Kemp Clay. |
| 3. <i>Planoglobulina acervulinoides</i> (Egger) 81 | 8. <i>Ventilabrella manuelensis</i> Martin, n. sp. 87 |
| Side view of neotype (USNM 170316); line = 100 μ . S-2. Gerhardtstreuter Beds. | Side view; line = 100 μ . MX 13. Mendez Shale. |
| 4, 5. <i>Planoglobulina acervulinoides</i> (Egger) 81 | 9. <i>Sigalia ornatissima</i> (Cushman and Church) 84 |
| 4a: side view; line = 100 μ . 4b: top view; line = 100 μ . 5a: side view; line = 100 μ . 5b: portion of wide, heavy costae; line = 20 μ . DR27-3. Escondido Formation. | Side view; note thickened sutures, subrectangular chambers and heavily beaded early portion of test; line = 100 μ . NSF 447. Panoche Group. |

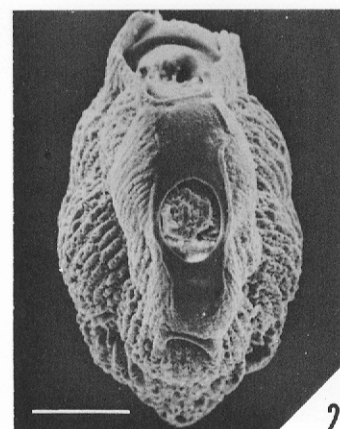




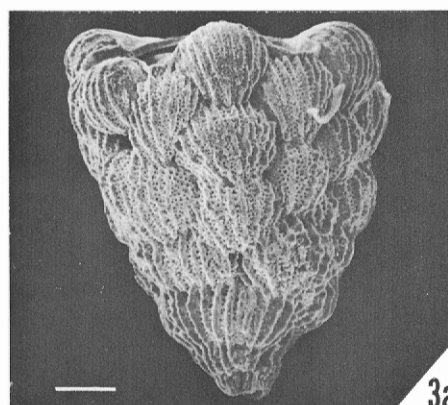
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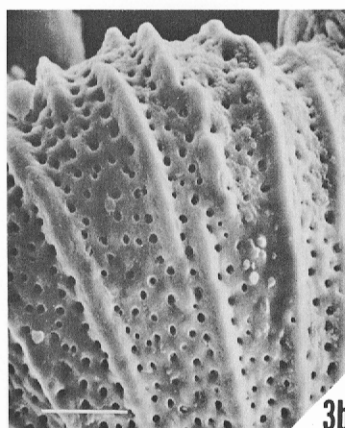
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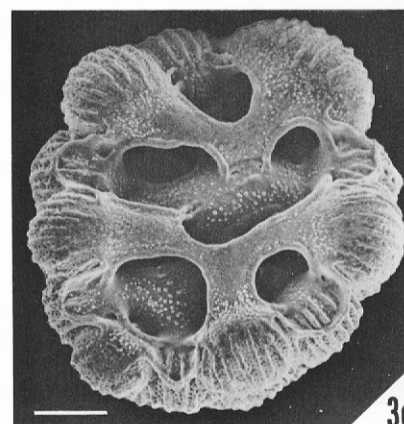
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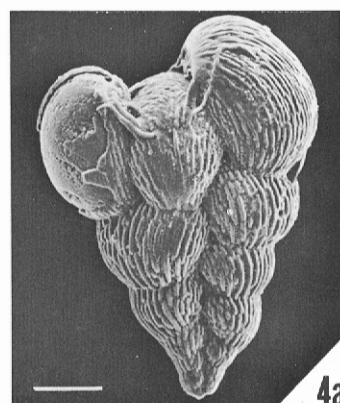
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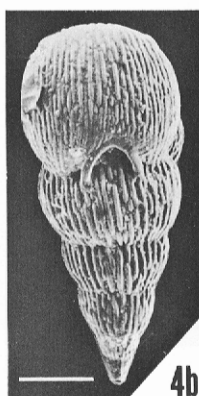
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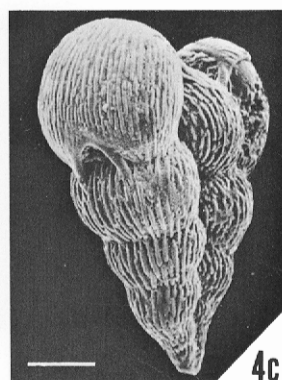
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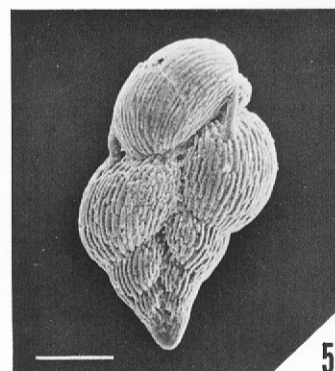
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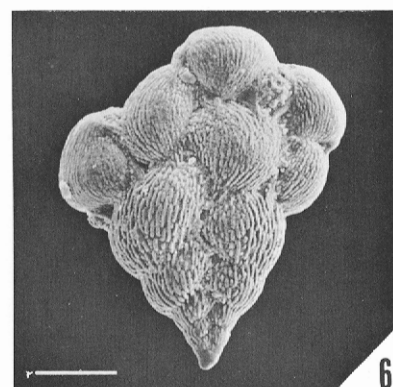
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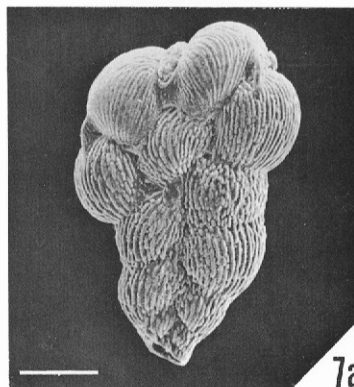
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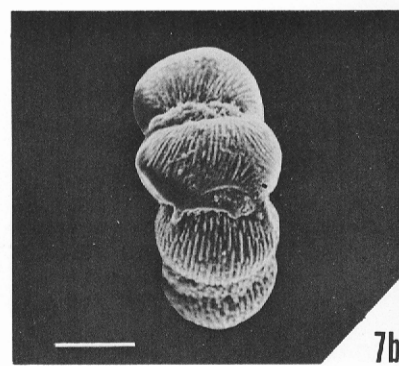
5



6



7a



7b

series of circumferentially arranged chambers (see plate 4, fig. 3c).

P. brazoensis, n. sp., is also found in late Maestrichtian sediments from the Rio Grande Rise, Joides Leg III (3/21/3/6 to 3/21/3/1, see appendix), and from Orphan Knoll, Joides Leg XII (12/111A/11/4 to 12/111A/11/1, see appendix).

Planoglobulina(?) carseyae Plummer

Plate 4, figures 4-7

Ventilabrella carseyae PLUMMER, 1931, p. 178, pl. 9, figs. 7-9, not fig. 10. CUSHMAN, 1946, p. 112, pl. 48, figs. 1-5. *Planoglobulina carseyae* (Plummer), GALLITELLI, 1957, pl. 32, fig. 13. OLSSON, 1960, p. 29, pl. 4, fig. 13. PESSAGNO, 1967, p. 271, pl. 87, figs. 10, (?)15, 16.

Remarks: The original description of Plummer (1931, p. 178) is accepted herein.

P.(?) carseyae is tentatively placed in *Planoglobulina* because: (1) the holotype is multiserial in one plane (Plummer, 1931, pl. IX, figs. 8a, b); and (2) certain of the multiserial forms exhibit a somewhat laterally inflated, flabelliform test.

The writer feels, however, that *Planoglobulina(?) carseyae* could as easily be placed in *Pseudotextularia*, because: Plummer (1931, p. 178) included biserial as well as multiserial forms within this species, and the biserial forms exhibit chambers which increase rapidly in size, and the low, broad, basal apertures on the final series of chambers characteristic of *Pseudotextularia*.

It would perhaps be advisable, at a later date, to emend Plummer's (1931, p. 178) description to include only multiserial forms of *P.(?) carseyae*, and assign them to *Planoglobulina*. Plummer's biserial forms could then be given a new species name and placed under *Pseudotextularia* (as emended by Montanaro Gallitelli in 1957).

Range: *G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone to *A. mayaroensis* Subzone.

Occurrence: Plummer (1931, p. 178) originally described *P.(?) carseyae* (as *Ventilabrella carseyae*) from the late Maestrichtian (*G. gansseri* Subzone) Corsicana Marl, Milam County, Texas. This species is also found in the Kemp Clay (TX 267 of Pessagno, TX 9AH of Smith, see appendix) of Falls and Milam Counties, Texas.

The writer has observed specimens similar to the specimen of *P.(?) carseyae* figured (as *Planoglobulina carseyae* (Plummer)) by Montanaro Gallitelli (1957, pl. 32, fig. 13) in late Maestrichtian samples from the Rio Grande Rise (Joides Leg III, see appendix).

P.(?) carseyae has been reported from the Maestrichtian Papagallo Shale of Mexico (Pessagno, 1967, p. 272), Arkadelphia Marl of Arkansas (ibid.), and the Redbank Formation of New Jersey (Olsson, 1960, p. 29).

P.(?) carseyae has been reported as *Planoglobulina acervulinoides* (Egger) by Said and Kenawy (1956, p. 140) from the Maestrichtian of Egypt.

Genus *Ventilabrella* Cushman, 1928, emended

Type-species: *Ventilabrella eggeri* Cushman, 1928

Description: Test calcareous, microgranular hyaline, perforate; laterally compressed; early portion biserial, later portion with proliferation of chambers in plane of biseriality, resulting in a flabelliform test. Chambers globular to pyriform. Sutures always depressed, usually distinct. Test exhibiting longitudinal costae or combination of costae and vermicular ornamentation. Arched, basal apertures usually on front and back of all but outermost chambers in multiserial portion of test; outermost chambers with aperture on front only, facing inward; apertures visible only on final series of chambers. Merged cameral flanges and continuous,

PLATE 4

1. *Planoglobulina brazoensis* Martin, n. sp. 82
1a: side view; line = 100μ. 1b: portion of costal pattern; line = 20μ. TX 267. Kemp Clay.
2. *Planoglobulina brazoensis* Martin, n. sp. 82
Top view, showing later chambers aligned in a single plane; line = 100μ. 3/21/3/1. Rio Grande Rise.
3. *Racemiguembelina fruticosa* (Egger) 82
3a: side view; note conical test; line = 100μ.
3b: portion of costal pattern; line = 25μ. 3c: top view; note circular chamber arrangement, completely unlike *P. brazoensis*, n. sp. (fig. 2),

- and tegilla-like chamber extensions; line = 100μ.
3/21/3/1. Rio Grande Rise.
- 4-7. *Planoglobulina(?) carseyae* Plummer 83
4a: side view; line = 100μ. 4b: edge view; note small sutural aperture and rapid, uniform chamber growth; line = 100μ. 4c: oblique view; line = 100μ; 5: side view; note slightly reniform chambers; line = 100μ. 6: side view; line = 100μ. 7a: side view; line = 100μ. 7b: top view; note absence of cameral ridge; line = 100μ. TX 170. Corsicana Marl.

slightly raised parallel cameral ridges present on final series of chambers.

Range: *G. bulloides* Assemblage Zone, *G. fornicata* Subzone to *G. contusa-stuartiformis* Assemblage Zone, *A. mayaroensis* Subzone.

Remarks: *Ventilabrella* Cushman differs from *Sigalia* Reiss by having: (1) depressed sutures and (2) globular rather than subrectangular chambers; from *Gublerina* Kikoin by having chambers which are not separated by broad, non-septate areas; and from *Planoglobulina* Cushman by having a laterally compressed test, more chambers in the multiserial portion of the test, and finer costae or vermicular ornamentation.

Ventilabrella alpina de Klasz (pl. 1, fig. 5) is reassigned to *Sigalia* because of its raised, thickened sutures and subglobular to subrectangular chambers in the multiserial portion of the test. This species is abundant in the Campanian "Lower Taylor Marl" Member of the Taylor Formation and in the Wolfe City Sand of Texas, which would indicate a higher range for *Sigalia* than has been previously reported.

V. ornatissima Cushman and Church (pl. 2, fig. 8) is reassigned to *Sigalia* Reiss because of its (1) raised, thickened sutures; (2) subrectangular chambers; and (3) heavily beaded, rather than costate, ornamentation on its earlier chambers.

Strangely, *V. ornatissima* is most often assigned to *Gublerina*, rather than *Sigalia*. Workers tend to confuse *V. ornatissima* with *Gublerina cuvillieri* Kikoin, the type-species of *Gublerina*. Montanaro Gallitelli, in her 1957 revision of the Heterohelcidae, considered *G. cuvillieri* to be a junior synonym of *V. ornatissima*.

Measurements were taken on at least 15 individuals of each species described herein.

Ventilabrella(?) austinana Cushman

Plate 1, figures 1, 2

Ventilabrella eggeri Cushman, CARMAN, 1929, p. 314, pl. 34, fig. 7. LOETTERLE, 1937, p. 35, pl. 5, fig. 5.

Ventilabrella austinana CUSHMAN, 1938, p. 26, pl. 4, fig. 19a, b; 1944, p. 92, pl. 14, fig. 7.

Description: Test subtriangular, not always laterally compressed. Eight to ten chambers in biserial portion, gradually increasing in size; multiserial portion with one or two rows of three chambers of variable size, not always perfectly aligned in plane of biseriality. Chambers globular, separated by distinct, depressed sutures. Test covered by very fine, closely spaced costae. Arched, basal apertures on front of both outer

chambers in multiserial portion. Cameral flanges and cameral ridges absent.

Remarks: *V. (?) austinana* differs from all other species of *Ventilabrella* by exhibiting: (1) little or no lateral compression; (2) chambers of variable size in the final row, not always arranged in the plane of biseriality; (3) finer, more closely spaced costae; and (4) no cameral flanges or cameral ridges.

Cushman (1946, p. 111) described *V. (?) austinana* as having smooth test walls. All specimens observed by the writer, including topotypes, were finely costate throughout, and appeared smooth only when worn.

It is doubtful that *V. (?) austinana* is a primitive species of *Ventilabrella*, because of the characteristics mentioned above. This species is more likely an aberrant form of *Heterohelix*. It has fine, closely spaced costae similar to *H. reussi* (Cushman), and has apertures only on the chamber fronts, facing inward, as in all species of *Heterohelix*. No transitional forms have been observed which would indicate that *V. (?) austinana* gave rise to any other *Ventilabrella*. *V. (?) austinana* probably evolved from *H. reussi* (Cushman), which was the dominant species of *Heterohelix* in Turonian, Coniacian and Santonian strata.

Further study of *V. browni*, n. sp., rather than *V. (?) austinana*, will probably provide better insight into the ancestry of the genus. Both species occur in the Santonian, yet *V. browni* already exhibits the laterally compressed, flabelliform test and cameral flanges and ridges characteristic of the more advanced forms of *Ventilabrella*.

Dimensions: Topotypes vary from 325 μ to 375 μ in length; 225 μ to 275 μ in width; and 100 μ to 125 μ in maximum thickness.

Range: *G. bulloides* Assemblage Zone, *M. concavata* Subzone to *G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, (*P. elegans* Zonule).

Occurrence: In Texas *V. (?) austinana* Cushman occurs in the early Santonian (*M. concavata* Subzone) portion of the middle member of the Austin Chalk in Dallas County (D4-3 of Martin, see appendix), where it is common. It also occurs in the early Campanian Gober Tongue of the Austin Chalk in Fanin County (its type locality; see Cushman 277 in appendix), and in the Campanian "Lower Taylor Marl" Member of the Taylor Formation in McLennan County.

In Arkansas *V. (?) austinana* is found in the lower part of the Brownstown Marl (AR 7A of Pessagno, see appendix).

Cushman (1946, p. 111) reported *V. (?) austinana*

from the Niobrara Chalk of Nebraska and Kansas, the lower part of the Selma Chalk of Itawamba County, Mississippi, and from the Turonian Eagle Ford Shale near Pottsboro, Grayson County, Texas. The writer has never observed *V. (?) austinana* in the Eagle Ford Shale or in any other Turonian age sediments.

Ventilabrella browni Martin, n. sp.

Plate 1, figures 3, 4

Description: Test flabelliform, laterally compressed, with six to eight subglobular chambers in biserial portion; up to ten subglobular to pyriform chambers in multiserial portion. Longitudinal costae very heavy on biserial portion; costae finer and discontinuous on multiserial portion. Sutures indistinct, depressed. Arched, basal apertures on front and back of all but outermost chambers in final row; outermost chambers with apertures on front only, facing inward.

Remarks: *V. browni* Martin, n. sp., differs from *V. glabrata* Cushman by having: (1) stronger costae on the biserial portion; (2) fewer chambers in the multiserial portion of the test; and (3) less distinct sutures.

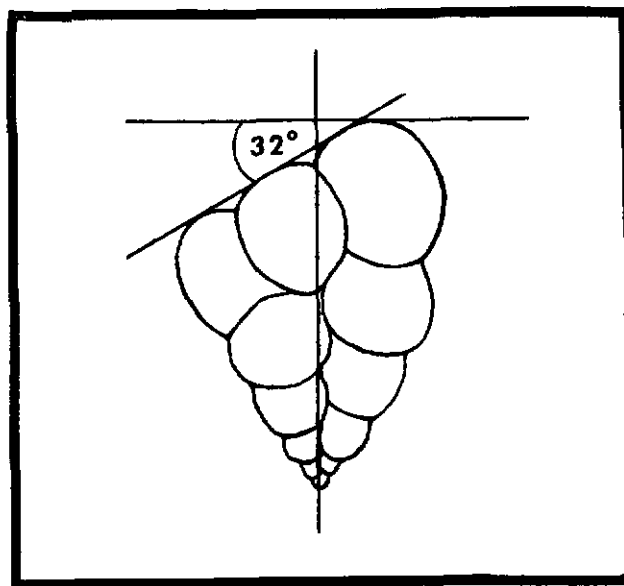
V. browni, n. sp. should not be confused with *Sigalia alpina* (de Klasz) (= *Ventilabrella alpina* de Klasz), which occurs abundantly with *V. browni* in the "Lower Taylor Marl" Member of the Taylor Formation, and in the Wolfe City Sand. *S. alpina* has raised, beaded sutures (pl. 1, fig. 5); otherwise, both forms are similar in their test shape and strongly costate early chambers. There is some possibility that *V. browni* may represent a transitional form between *Sigalia* and *Ventilabrella*.

V. browni Martin, n. sp., is named for the late Noel K. Brown, Jr., in honor of his work on the Heterohelidae.

Dimensions: The holotype measure 385μ in length, 425μ in width, and 125μ in maximum thickness. Other specimens vary from 325μ to 450μ in length; 250μ to 475μ in width; and 125μ to 130μ in maximum thickness.

Type locality: TX 244 of Pessagno (see appendix): Taylor Formation, "Lower Taylor Marl" Member; exposure on south bank of Tradinghouse Creek, McLennan County, Texas.

Deposition of types: Holotype: USNM 170328; Paratypes: USNM 170329, 170330, 170331, and SM-4 of Pessagno Collection, University of Texas at Dallas.



TEXT FIGURE 6

Outline diagram of a typical *V. eggeri* Cushman, showing angle of slope on final series of chambers.

Range: *G. bulloides* Assemblage Zone, *G. fornicata* Subzone to *G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, (*G. calcarata* Zonule).

Occurrence: In Texas *V. browni* has been observed in the late Santonian portion of the "Hutchins Chalk" Member of the Austin Chalk (D11-1 of Martin, see appendix). It also occurs abundantly with *V. glabrata* Cushman and *V. eggeri* Cushman in the Campanian "Lower Taylor Marl" Member of the Taylor Formation, and in the Wolfe City Sand (TX 255A of Pessagno, see appendix).

In Arkansas *V. browni* is found in the lower part of the Brownstown Marl (AR 7A of Pessagno, see appendix).

V. browni occurs in the late Santonian and early Campanian portions of the Cariblanco Formation of Puerto Rico (OP 2196 and OP 200 of Pessagno, see appendix).

Ventilabrella eggeri Cushman, emended

Plate 1, figures 6, 7

Ventilabrella eggeri CUSHMAN, 1928, p. 2, pl. 1, figs. 10-12. Not *Ventilabrella eggeri* Cushman, WILLE-JANOSCHEK, 1966, p. 125, pl. 8, fig. 7.

Description of neotype: Test subtriangular, laterally compressed. Biserial portion comprising majority of

test with six to eight globular to subglobular chambers; multiserial portion consisting of only one row of three subglobular to pyriform chambers; final row of chambers with slope of thirty-two degrees (see text fig. 6). Sutures somewhat indistinct, depressed. Costae relatively even, arranged longitudinally; heavy on biserial portion; finer and discontinuous on multiserial portion; chamber nearest apex of test in multiserial portion (see pl. 1, fig. 6a); outermost chamber with aperture on front only, facing inward.

Remarks: *V. eggeri* Cushman differs from other species of *Ventilabrella* by having (1) a final row of chambers which has an average slope of thirty-two degrees, and (2) basal apertures on both front and back of outermost chamber farthest from apex of test.

According to Montanaro Gallitelli (1957, p. 142), no holotype or paratype specimens of *V. eggeri* occur in the Cushman Collection or U. S. National Museum collections. However, it has been pointed out by Brown (1969, p. 40) that Cushman may have had no reason to select a holotype for *V. eggeri* because the holotype already existed in the Egger Collection in Munich. The specimen figured by Egger in 1899 (pl. 14, figs. 17, 18) and later figured by Cushman in 1928 (pl. 1, figs. 10a, b) might well have been the intended holotype for *V. eggeri*. The Egger Collection was destroyed during World War II (Brown, 1969, p. 41; Prof. Herbert Hagn, 1971, pers. comm.).

In light of this information, it seems quite possible that the holotype of *V. eggeri* originally came from Bavaria. This, however, cannot be proven, and therefore the following points must be considered: (1) No holotype or paratype specimens exist for *V. eggeri*, making necessary the selection of a neotype or lectotype; (2) Cushman (1928, p. 2, 3) officially listed the Taylor Marl as the type level and Texas as the type locality for *V. eggeri*; and (3) if a neotype is selected, it should be chosen from the type locality given by Cushman: the Taylor Marl of Texas.

The writer selected a neotype, rather than a lectotype, for *V. eggeri* because Cushman's three figured specimens (1928, pl. 1, figs. 10a, b, 11, 12) are poorly executed and not representative of specimens found in any abundance in the Taylor Marl.

Dimensions: The neotype measures 300μ in length, 275μ in width, and 100μ in thickness, with a slope of 32 degrees on the final row of chambers. Other specimens of *V. eggeri* measure from 300μ to 325μ in length, 275μ to 300μ in width, and 100μ in thick-

ness; final row of chambers varies in slope from 28 to 38 degrees.

Type locality: The neotype was selected from the original type level for *V. eggeri*, the Campanian "Lower Taylor Marl" Member of the Taylor Formation (TX 252 of Pessagno, see appendix); buff calcareous mudstone breaking with conchoidal fracture; collected from exposure on south bank of Tradinghouse Creek, 53.5 feet above creek; McLennan County, Texas.

Deposition of types: Neotype: USNM 170308; Topotypes: USNM 170309, 170310 and 170311, and SM-1 of Pessagno Collection, University of Texas at Dallas.

Range: *G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone (*D. multicostata* Zonule) to *G. elevata* Subzone (*P. elegans* Zonule).

Occurrence: *V. eggeri* Cushman has been noted thus far in Texas in the early Campanian Gober Tongue of the Austin Chalk in Fannin County, in the Campanian "Lower Taylor Marl" Member of the Taylor Formation in Dallas, McLennan and Ellis Counties, and in the Campanian Wolfe City Sand in McLennan County.

V. eggeri Cushman also occurs in the early Campanian portion of the Cariblanco Formation of Puerto Rico (OP 200 of Pessagno, see appendix).

The specimen figured by Wille-Janoschek (1966, pl. 8, fig. 7) as *V. eggeri* Cushman, from the late Campanian portion (Nierntaler Facies) of the Gosau beds of Upper Austria (Salzburg), is assignable to *V. manuelensis* Martin, n. sp.

Ventilabrella glabrata Cushman, emended

Plate 1, figures 8, 9

Ventilabrella eggeri CUSHMAN, 1928, p. 2, pl. 1, fig. 11(?), not figs. 10a, b, 12; 1944, p. 92, pl. 14, fig. 8; 1946, p. 111, pl. 47, figs. 17-19.

Ventilabrella eggeri Cushman var. *glabrata* CUSHMAN, 1938, p. 26, pl. 4, figs. 15-17; 1946, p. 111, pl. 47, figs. 20-22.

Not *Ventilabrella eggeri glabrata* Cushman, SAID and KENAWY, 1956, pl. 140, pl. 3, fig. 46.

Planoglobulina glabrata (Cushman), MONTANARO GALLITELLI, 1957, p. 141, pl. 32, figs. 10-12. PESSAGNO, 1967, p. 272, pl. 88, figs. 12, 13, 17.

Description: Test compressed, flabelliform; biserial portion tapered, distinct, with six to eight chambers; adult test with twenty-six or more chambers. Chambers globular, sometimes pyriform in later stages. Sutures very distinct, depressed, occasionally giving hexagonal outline to chambers in side view. Fine, evenly spaced,

longitudinal costae over entire test, separated by rows of pores often appearing in linear series; costae continuous on early chambers, broken on later chambers. Arched, basal aperture on front and back of all but outermost chambers in multiserial portion of test; outermost chambers with aperture on front only, facing inward.

Remarks: *Ventilabrella glabrata* Cushman is the only species of *Ventilabrella* with fine, relatively even costae covering the entire surface of the test, separated by rows of well-aligned pores. All other species of *Ventilabrella* have: (1) costae which vary from fine to medium over different portions of the test; (2) pores randomly distributed between discontinuous costae; (3) vermicular ornamentation with fine costae visible only on the final series of chambers; and (4) any combination of the above.

Dimensions: Topotypes varied from 325 μ to 450 μ in length; 250 μ to 475 μ in width; and 75 μ to 100 μ in maximum thickness.

Range: *G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone (*D. multicostata* Zonule) to *G. elevata* Subzone (*G. calcarata* Zonule).

Occurrence: In Texas *V. glabrata* occurs abundantly in the Campanian "Lower Taylor Marl" Member of the Taylor Formation, along with *Sigalia alpina* (de Klasz) and *V. eggeri* Cushman. *V. glabrata* also occurs in the Wolfe City Sand (TX 255A of Pessagno, see appendix), and one specimen was found in the Pecan Gap Chalk (D8-4 of Martin, see appendix).

Cushman (1946, p. 112) noted *V. glabrata* from the Gober Tongue of the Austin Chalk, and suggested that it might extend into the Neylandville Marl.

In Arkansas *V. glabrata* is found in the lower part of the Brownstown Marl (AR 7A of Pessagno, see appendix).

V. glabrata occurs in the early Campanian portion of the Cariblanco Formation of Puerto Rico (OP 200 of Pessagno, see appendix).

Ventilabrella manuelensis Martin, n. sp.

Plate 2, figures 5–8

Ventilabrella eggeri Cushman, WILLE-JANOSCHEK, 1966, p. 125, pl. 8, fig. 7.

Planoglobulina multicamerata (de Klasz), PESSAGNO, 1967, p. 272, pl. 89, fig. 15.

Description: Test flabelliform to subcircular, compressed. Six chambers in diminished biserial portion, after which test abruptly flares out, having thirty-five

chambers in multiserial portion. Early chambers in multiserial portion globular, with heavy vermicular ornamentation; later chambers globular to subglobular; fine, closely spaced, longitudinal costae on final series of chambers; two chambers in later portion of test sometimes merging to form single, crescent-shaped chamber. Sutures depressed, slightly obscured by vermicular ornamentation. Arched, basal apertures on front and back of all but outermost chambers in final row.

Remarks: *V. manuelensis* n. sp., differs from *V. multicamerata* de Klasz in its abruptly flaring, subcircular test and smaller number of chambers in the multiserial portion. *V. manuelensis* differs from other species of *Ventilabrella* in its abruptly flaring, subcircular test, diminished biserial portion, larger number of chambers, and heavy vermicular ornamentation.

V. manuelensis is named for the town of Manuel in northeastern Mexico, which is situated near the type locality for the species in the Gonzales–Aldama area.

Dimensions: Holotype measures 675 μ in length, 650 μ in width, and 150 μ in maximum thickness. Other specimens vary from 525 μ to 675 μ in length; 550 μ to 675 μ in width; and 150 μ to 175 μ in maximum thickness.

Type locality: MX 13 of Pessagno (see appendix): Mendez Shale.

Deposition of types: Holotype: USNM 170320; Paratypes: USNM 170321, 170322, 170323; and SM-9b of Pessagno Collection, University of Texas at Dallas.

Range: *G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone (*G. calcarata* Zonule) to *R. subcircumnodifer* Subzone (*R. subpennyi* Zonule) possibly higher.

Occurrence: In Mexico, *V. manuelensis* is abundant in the late Campanian and early Maestrichtian portions of the Mendez Shale (MX 13, MX 15 of Pessagno, see appendix).

V. manuelensis occurs in late Campanian sediments of the Blake Bahama Basin, Joides Leg I (1/4A/1/2, see appendix); in late Campanian sediments of the Rio Grande Rise, Joides Leg III (3/21/5/5, see appendix); and in late Campanian and early Maestrichtian sediments of Orphan Knoll, Joides Leg XII (12/111A/11/6 to 12/111A/11/5, see appendix).

V. manuelensis was found in one late Maestrichtian sample from the Mendez Shale (MX 80 of Pessagno, see appendix), and in late Maestrichtian samples from Joides Leg XII (12/111A/11/1, see appendix), both

of which contain reworked late Campanian and early Maestrichtian species.

***Ventilabrella multicamerata* de Klsz**

Plate 3, figures 1, 2

Guembelina acervulinoides EGGER, 1899, p. 36, pl. 14, figs. 21, 22, not figs. 14–18, 20.

Planoglobulina acervulinoides (Egger), CUSHMAN, 1927, p. 77. WHITE, 1929, p. 33, pl. 4, fig. 6.

Ventilabrella multicamerata DE KLSZ, 1953, p. 230, pl. 5, figs. 1a, b.

Not *Planoglobulina multicamerata* (de Klsz), PESSAGNO, 1967, p. 272, pl. 89, fig. 15.

Planoglobulina sp., DUPEUBLE, 1969, p. 159, pl. IV, fig. 15.

Description: Test subtriangular, one-third longer than wide; six to eight chambers in biserial portion; thirty-six or more chambers in multiserial portion. Test reaching maximum thickness at one-fourth its length, measuring from apex; remainder of test extremely compressed laterally. Ornamentation coarsely vermicular on early chambers, diminishing to fine, broken, longitudinal costae on final series of chambers. Sutures ill-defined, slightly depressed. Apertures arched, basal, on front and back of all but outermost chambers in multiserial portion of test; outermost chambers with aperture on front only, facing inward.

Remarks: *Ventilabrella multicamerata* de Klsz differs from other species of *Ventilabrella* by its elongate, subtriangular shape, its relatively small biserial portion obscured by coarse, vermicular ornamentation, and its numerous, extremely compressed chambers with poorly defined sutures in the multiserial portion of the test.

Dimensions: Maximum length = 800 μ ; maximum width = 600 μ ; maximum chamber thickness at one-fourth the length of test, measured from apex = 225 μ ; maximum chamber thickness of remaining compressed portion of test = 100 μ .

Range: *G. contusa-stuartiformis* Assemblage Zone, uppermost *G. gansseri* Subzone to top of *A. mayaroensis* Subzone.

Occurrence: *V. multicamerata* de Klsz has been found to be a common species in the late Maestrichtian (lower *A. mayaroensis* Subzone) of the Mendez Shale of Mexico. It occurs more rarely in the early Maestrichtian (upper *G. gansseri* Subzone) Papagallos Shale of Mexico (MX 174 of Pessagno, see appendix), and in the Escondido Formation of Medina County, Texas (DR27-3 of Martin, see appendix). *V. multicamerata* is also present in the Kemp Clay of Milam County, Texas (TX 9AH of Smith see appendix).

Pessagno (1967, pl. 89, fig. 15) figured a specimen which he called *Planoglobulina multicamerata* (de Klsz) from a late Maestrichtian sample of Mendez Shale (MX 80 of Pessagno, see appendix) which contained reworked late Campanian and early Maestrichtian elements. The specimen was reexamined and assigned to *V. manuelensis* Martin, n. sp., a Campanian form.

Pessagno (1967, p. 273) also identified but did not figure a specimen of *V. multicamerata* from one locality in the late Campanian Wolfe City Sand (TX 255A of Pessagno, see appendix) at McLennan County, Texas. The present study has shown that *V. multicamerata* does not extend into the Campanian. The specimen was reexamined and found to be referable to *V. glabrata* Cushman.

V. multicamerata has been found in abundance in samples from the latest Maestrichtian (upper *A. mayaroensis* Subzone) sediments at Orphan Knoll, Site 111A of Joides Leg XII, northeast of Newfoundland, in latest Maestrichtian material from the Gulf of Mexico (S-1 of Martin, see appendix), and from Upper Bavaria (S-2 of Martin, see appendix).

V. multicamerata de Klsz was originally described from the late Maestrichtian Gerhardtshreuter beds in Upper Bavaria, southeast Germany (de Klsz, 1954, p. 230). De Klsz also noted its occurrence in the upper part of the lower Maestrichtian in the Gerhardtshreuter beds and upper part of the Bucheck Beds, in association with *Pseudotextularia intermedia* de Klsz. He also noted *V. multicamerata* in the type Mendez Shale at Mendez Station, Mexico, and in the Maestrichtian of Gan, Basses-Pyrenees dept., southwestern France.

***Ventilabrella riograndensis* Martin, n. sp.**

Plate 2, figures 1–4

Description: Test flabelliform, slightly compressed; Eight chambers in biserial portion; twenty-two chambers in multiserial portion. Chambers globular to pyriform. Sutures distinct, depressed. Fine, discontinuous segments of longitudinal costae cover majority of test, rearranging into a vermicular pattern on early chambers. Arched, basal apertures on front and back of all but outermost chambers in multiserial portion; outermost chambers usually with apertures on front only, facing inward.

Remarks: *V. riograndensis*, n. sp., superficially resembles *V. glabrata* Cushman in test shape, but differs in having vermicular ornamentation, fine, broken costae,

and a less compressed test. The number of chambers in *V. riograndensis* varies from 23 to 34. Rarely, chambers in the last two rows (in well-preserved specimens) send finger-like extensions down into previously-formed chambers (pl. 2, fig. 2b). Vermicular ornamentation is well-developed on the early portion of most well-preserved specimens (pl. 2, fig. 4b).

Dimensions: Holotype measures 575μ in length, 675μ in width, and 150μ in maximum thickness. Other specimens vary from 475μ to 575μ in length; 400μ to 625μ in width; and 150μ to 200μ in maximum thickness.

Type localities: Holotype and paratype from *TYPE 4* of Pessagno (see appendix): Remaining paratypes from 3/21/4/1: Joides Leg III, Site 21, Rio Grande Rise in the South Atlantic (see appendix).

Deposition of types: Holotype: USNM 170312; Paratypes: USNM 170313, 170314, 170315, and SM-5 of Pessagno Collection, University of Texas at Dallas.

Range: *G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone (*G. calcarata* Zonule) to *G. contusa-stuartiformis* Assemblage Zone, *A. mayaroensis* Subzone.

Occurrence: In Mexico *V. riograndensis* occurs in the early Maestrichtian portion of the Mendez Shale (MX 13 and *TYPE 4* of Pessagno, see appendix). In Puerto Rico *V. riograndensis* is found in the early Maestrichtian portion of the Rio Yauco Formation (OP 2690 of Pessagno, see appendix).

V. riograndensis is abundant in sediments from the Maestrichtian (*G. gansseri* Subzone) portion of Site 21 of Joides Leg III from the Rio Grande Rise in the South Atlantic.

REFERENCES

- BERGGREN, W. A., 1962, Some planktonic foraminifera from the Maestrichtian and type Danian stages of southern Scandinavia: Stockholm Contr. Geology, 9, no. 1.
- BRÖNNIMANN, P., and RENZ, H. H., 1967, Proceedings of the first international conference on planktonic microfossils, v. 2. Leiden, E. J. Brill, 745 p., 84 pls., 19 tables, 4 charts.
- BROWN, NOEL K., JR., 1969, Heterohelidae Cushman, 1927, amended, a Cretaceous planktonic foraminiferal family: in Brönnimann, P., and Renz, H. H., editors, Proc. First Internat. Conf. on Planktonic Microfossils, Geneva, v. 2. Leiden, E. J. Brill, p. 21-67.
- CARMAN, K. W., 1929, Some foraminifera from the Niobrara and Benton formations of Wyoming: Jour. Paleontology, v. 3, no. 3, p. 309-315, pl. 34.
- CUSHMAN, J. A., 1925, The genera *Pseudotextularia* and *Guembelina*: Cushman Lab. Foram. Research Contr., v. 15, no. 6, p. 133-134.
- , 1926, Some foraminifera from the Mendez Shale of eastern Mexico: Cushman Lab. Foram. Research Contr., v. 2, pt. 1, p. 16-26, pls. 2, 3.
- , 1927a, Some new genera of the foraminifera: Cushman Lab. Foram. Research Contr., v. 2, pt. 4, p. 77-81, pl. 11 (part).
- , 1927b, An outline of a re-classification of the foraminifera: Cushman Lab. Foram. Research Contr., v. 3, pt. 1, p. 1-105, pls. 1-21.
- , 1927c, New and interesting foraminifera from Mexico and Texas: Cushman Lab. Foram. Research Contr., v. 3, pt. 2, p. 111-119, pls. 22, 23.
- , 1927d, Some characteristic Mexican fossil foraminifera: Jour. Paleontology, v. 1, no. 2, p. 147-172, 6 pls.
- , 1928, Additional genera of the foraminifera: Cushman Lab. Foram. Research Contr., v. 4, pt. 1, p. 1-8, pl. 1.
- , 1935, Some foraminifera from the Mendez Shale of eastern Mexico: Cushman Lab. Foram. Research Contr., v. 2, pt. 1, p. 16-24, pls. 1-3.
- , 1938, Cretaceous species of *Guembelina* and related genera: Cushman Lab. Foram. Research Contr., v. 14, pt. 1, p. 2-28, pls. 1-4.
- , 1944, Foraminifera of the lower part of the Mooreville Chalk of the Selma Group of Mississippi: Cushman Lab. Foram. Research Contr., v. 20, pt. 4, p. 83-96, pls. 13, 14.
- , 1946, Upper Cretaceous foraminifera of the Gulf Coastal region of the United States and adjacent areas: U.S. Geol. Survey Prof. Paper, no. 206, p. 1-241, pls. 1-66.
- DAVIES, T. A., BERGGREN, W. A., LAUGHTON, A. S., WHITMARSH, R., ULRICH, F., MUSICH, L., RUFFMAN, A., HINTE, J. E. VAN, PERCH-NEILSEN, K., and BENSON, R., 1970, Deep Sea Drilling Project, Leg XII: Hole Summaries: unpublished report.
- DOUGLAS, R. G., 1969, Upper Cretaceous planktonic foraminifera in northern California: Micropaleontology, v. 15, no. 2, p. 151-209, pls. 1-11.
- DUPEUBLE, P. A., 1969, Foraminifères planctoniques (Globotruncanidae et Heterohelidae) du Maestrichtien Supérieur en Aquitaine Occidentale: in Brönnimann, P., and Renz, H. H., editors, Proc. First Internat. Conf. on Planktonic Microfossils, Geneva, v. 2. Leiden, E. J. Brill, p. 153-161.
- EGGER, J. G., 1899, Foraminiferen und Ostrakoden aus den Kreidemergeln der oberbayerischen Alpen: K. Bayer. Akad. Wiss. München, abh., Cl. II, v. 21, pt. 1, p. 3-230, pls. 1-27.
- ELLIS, BROOKS F., and MESSINA, ANGELINA R., 1959, Catalogue of foraminifera: Am. Mus. Nat. History, New York.
- EWING, MAURICE, WORZEL, J. L., BEALL, AL, BUKRY, D., BERGGREN, W. A., BURK, C. A., FISCHER, A. G., and PESSAGNO, E. A., JR., 1968, Initial reports of the Deep Sea Drilling Project, Volume I: Washington (U.S. Government Printing Office), p. 179-213.
- FRIZZELL, D. L., 1954, Handbook of Cretaceous foraminifera of Texas: Univ. Texas, Bur. Econ. Geology Rept. Inv., no. 22, p. 1-232, pls. 1-21.
- FUNNELL, B. M., FRIEND, J. K., and RAMSAY, A. T. S., 1969, Upper Maestrichtian planktonic foraminifera from Galicia

- Bank, west of Spain: *Palaeontology*, v. 12, pt. 1, p. 19-41, pls. 1-5, 22 text-figs.
- GALLITELLI, E. M., 1957, A revision of the foraminiferal family *Heterohelicidae*, in Loeblich, A. R., Jr., et al., *Studies in foraminifera*, U.S. Natl. Mus. Bull. no. 215, p. 133-154.
- GALLOWAY, J. J., 1933, A manual of foraminifera; James Furman Kemp Memorial Ser., publ. 1, 483 p., 42 pl., Principia Press (Bloomington, Indiana).
- , WHITE, M. P., and DOANE, G. H., 1924, Plates of foraminifera, V. V—Upper Cretaceous: Internatl. Petrol. Co.
- GLAESSNER, M. F., 1936, Die foraminiferengattungen *Pseudotextularia* and *Amphimorphina*: *Probl. Paleontol.*, Moscow Univ. Lab. Paleontol., v. 1, p. 116-134, pl. 1-2, text figs. 1-3.
- , 1945, Principles of micropaleontology: Melbourne Univ. Press, 296 p., 14 pl., 64 text figs., 7 tables.
- HOFER, J., 1951a, The toothplate-foraminifera: *Arch. Neerlandaises Zool.*, v. 8, livr. 4, p. 353-373, figs. 1-30.
- , 1951b, The foraminifera of the Siboga Expedition, Part III, Ordo Dentata, Subordines Protoforaminata, Biforaminata, Deuteroforaminata: *Siboga-Exped.*, Mond. IVa, p. 1-513, text fig. 1-348.
- KLASZ, I. DE, 1953, Einige neue oder wenig bekannte foraminiferen aus der helvetischen Oberkreide der bayerischen Alpen sublich Traunstein (Oberbayern): *Geol. Bavarica*, no. 17, p. 223-244, pl. 4-7.
- KUPPER, I., 1964, Mikropalaontologische Gliederung der Oberkreide des Beckenuntergrundes in den oberosterreichischen Molassebohrungen: *Geol. Gesell. Wien Mitt.*, Bd. 56 (1963), p. 591-651, pl. 1-4, 3 tables.
- LOEBLICH, A. R., JR., 1951, Coiling in the *Heterohelicidae*: *Cushman Found. Foramin. Research Contr.*, v. 2, pt. 3, p. 106-111, pl. 12.
- , and TAPPAN, H., 1964, Sarcodina chiefly "Thecamoebians" and Foraminiferida: *Treatise on Invert. Paleont.*, pt. C, Protista 2, v. 1-2, p. C1-C900, figs. 1-653.
- , ———, and BECKMANN, J. P., BOLLI, H. M., GALLITELLI, E. M., and TROELSEN, J. C., 1957, *Studies in Foraminifera*: U. S. Natl. Mus. Bull. 215, p. 1-323, pl. 1-74, 30 text figs.
- LOETTERLE, G. J., 1937, The micropaleontology of the Niobrara Formation in Kansas, Nebraska, and South Dakota: *Nebraska Geol. Survey*, ser. 2, Bull. 12, p. 1-73, pl. 1-11.
- MARTIN, L., 1964, Upper Cretaceous and Lower Tertiary foraminifera from Fresno County, California: *Geol. Bundesanst., Österreich, Jahrb., Sonderbd.* 9, 128 p., 16 pl., text-figs. A-D, 5 figs.
- MAXWELL, A. E., HERZEN, R. VON, HSU, K. J., ANDREWS, J. E., SAITO, T., MILOW, E. D., BOYCE, R. E., and PERCIVAL, S. F., 1970, Initial reports of the Deep Sea Drilling Project, Volume III: Washington (U.S. Government Printing Office), p. 367-402.
- OLSSON, R. K., 1960, Foraminifera of latest Cretaceous and earliest Tertiary age in the New Jersey Coastal Plain: *Jour. Paleontology*, v. 34, no. 1, p. 1-58, pl. 1-12.
- , 1964, Late Cretaceous planktonic foraminifera from New Jersey and Delaware: *Micropaleontology*, v. 10, no. 2, p. 157-188, pl. 1-7.
- PESSAGNO, E. A., JR., 1962, The Upper Cretaceous stratigraphy and micropaleontology of south-central Puerto Rico: *Micropaleontology*, v. 8, no. 3, p. 349-368, pl. 1-6.
- , 1967, Upper Cretaceous planktonic foraminifera from the western Gulf Coastal Plain: *Paleontographica Americana*, v. 5, no. 37, p. 245-445, pl. 48-101, fig. 1-63.
- , 1969a, Upper Cretaceous stratigraphy of the western Gulf Coast area of Mexico, Texas, and Arkansas: *Geol. Soc. America Inc. Mem.* 111, 139p., 60 pl.
- , 1969b, The Neosciadocapsidae, a new family of Upper Cretaceous radiolaria: *Bull. Am. Paleontology*, v. 56, no. 253, p. 373-439, pl. 23-38, 4 text figs.
- , and LONGORIA, J. F., 1972, Shore laboratory report; Mesozoic foraminifera: in Davies, T. A., et al., *Deep Sea Drilling Project, Leg XII*, in press.
- PLUMMER, H. J., 1931, Some Cretaceous foraminifera in Texas: *Univ. Texas Bull.* 3101, p. 109-203, pl. 8-15.
- POKORNY, V. J., 1954, *Zaklady zoologicke mikropaleontologie: Nakladatelstvi Ceskoslovenske Akad. Ved*, p. 1-651.
- POWELL, J. DAN., PESSAGNO, E. A., JR., McNULTY, C. L., JR., ROTHWELL, W. T., JR., SCHELL, W. W., and WILLIAMS, T. E., 1970, Field trip guidebook for the First Interamerican Micropaleontological Colloquium, July 19-30, 1970: *Geology Dept., Univ. of Texas at Arlington*, unpublished.
- REISS, Z., 1963, Reclassification of perforate foraminifera: Ministry of Development, State of Israel, *Geol. Survey Bull.* no. 35, 111p., 8 pls., 1 text fig.
- SAID, R., and KENAWY, A., 1956, Upper Cretaceous and lower Tertiary foraminifera from northern Sinai, Egypt: *Micropaleontology*, v. 2, no. 2, p. 105-173, pls. 107, text-figs. 1-6.
- SIGAL, J., 1952, *Ordre des Foraminifera*: in Piveteau, J., *Traite de Paleontologie*, v. 1, p. 133-301.
- SMITH, C. C., 1971, Foraminifera and biostratigraphy of the Corsicana Formation of north-central Texas, (manuscript in preparation, University of Texas at Dallas, Dallas, Texas).
- STOLL, N. R. (Chairman), 1964, XV International Congress of Zoology, 1964, International Code of Zoological Nomenclature: International Trust for Zoological Nomenclature, London, 175p.
- STONE, B., 1946, *Siphogenerinoides* Cushman (order Foraminifera, family Buliminidae): *Jour. Paleontology*, v. 20, no. 5, p. 463-478, figs. 1, 2, pl. 71, 72.
- VOORWIJK, G. H., 1937, Foraminifera from the Upper Cretaceous of Habana, Cuba: *Koninkl. Wetensch. Akad. Amsterdam Proc.*, v. 40, no. 2, p. 190-198, pls. 1-3.
- WHITE, M. P., 1929, Some index foraminifera of the Tampico Embayment area of Mexico: *Jour. Paleontology*, v. 3, no. 1, p. 30-58, pl. 4, 5.
- WILLE-JANOSCHEK, U., 1966, Stratigraphie und Tektonik der Schichten der Oberkreide und des Alttertiars im Raume von Gosau und Abtenau (Salzburg): *Geol. Bundesanst., Österreich, Jahrb.*, Bd. 109, p. 91-172, pl. 1-11, 3 text figs.
- WILLIAMS, T. E., 1957, Correlation by insoluble residues in the Austin Chalk of southern Dallas County, Texas: *Southern Methodist Univ., Field and Lab.*, v. 25, p. 37-45, 1 pl.

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APPENDIX

Microfossil localities referred to in the text are listed below. Sample localities of Pessagno are prefixed by *TX* (Texas); *MX* (Mexico), *AR* (Arkansas), *OP* (Puerto Rico), *NSF* (California); and *TYPE* (type localities for important species).

For more detailed information on *TX*, *MX*, *AR*, and *TYPE* localities, refer to Pessagno, 1969a; for *OP* localities: Pessagno, 1962; and for *NSF* localities: Pessagno, 1969b. All other Texas localities mentioned herein are discussed in Powell, et al., 1970, unless otherwise specified.

For further information on *JOIDES* localities, refer to Ewing, et al., 1968 (*JOIDES* Leg I); Maxwell, et al., 1970 (*JOIDES* Leg III); and Davies, et al., 1970, (*JOIDES* Leg XII).

MEXICO

MX 13. Type locality for *Ventilabrella manuelensis* Martin, n. sp. Mendez Shale. Cream to buff-colored, calcareous mudstone exposed by bridge on south side of Gonzalez on Tampico-Ciudad Mante Highway. Kilometer post reading K59.06.

MX 15. Mendez Shale. Red to cream-colored calcareous siltstone exposed on north side of Tampico-Ciudad Mante Highway. Rancho Elfaisar near kilometer post K51.00 and relatively near contact with Valasco.

MX 78. Mendez Shale. Red calcareous mudstone breaking with conchoidal fracture. Manuel-Aldama Road; 4.5 miles (7.2 kilometers) from intersection with Tampico-Ciudad Mante Highway; near site where Manuel-Aldama road crosses south fork of Arroyo Pedregoso.

MX 80. Mendez Shale. Dark grey to brown indurated calcareous mudstones breaking with conchoidal fracture. Manuel-Aldama Road; 10.045 miles (16.70 kilometers) from Tampico-Ciudad Mante Highway; 2.089 miles (3.34 kilometers) from Barranco.

MX 174. Papagallos Shale. Buff calcareous mudstones from auger hole near mapped Upper Cretaceous-Lower Tertiary contact. Lowlying hill east of Mexico, D. F.—Nuevo Laredo Highway (Rt. 85); near road entrance to Ranchos Santa Celia and La Esperanza. Kilometer post reading; K1174.57.

TYPE 4. Type locality for *Ventilabrella riograndensis* Martin, n. sp., and for *Globotruncana ventricosa* White. Mendez Shale. Cream-colored calcareous mudstone breaking with conchoidal fracture. Base of north bank of Arroyo Pedregoso about 75 yards north of road. Bridge crossing of Manuel-Aldama road; about 1.29 kilometers from Barranco and 23.5 kilometers from the intersection with the Tampico-Ciudad Mante Road.

TEXAS

Rio Grande Area:

DR 27-3 of Martin. Escondido Formation. Collected 18 feet above base of exposure along west bank of Seco Creek of the Towe Ranch, 3 miles north of D'Hanis and west of Farm Road 1796.

Austin Area:

TX 170. Corsicana Marl. Dark grey to buff calcareous mudstones. From exposure just upstream (north) of Route 71

bridge crossing over Onion Creek, Travis County. Collected 11 feet above level of creek. U. S. G. S. Montopolis Quadrangle (15').

Waco Area:

TX 244. Type locality of *Ventilabrella browni* Martin, n. sp. Taylor Formation, "Lower Taylor Marl" Member. Dark grey, calcareous mudstone breaking with conchoidal fracture. Exposure on south bank of Tradinghouse Creek, McLennan County; 3.5 feet above creek; 1.5 miles west of juncture between Tradinghouse Creek and Tehuacana Creek; 1 airline mile S68E of Harrison Switch (large meander in Tradinghouse Creek); 0.2 miles due south of county road bridge over Tradinghouse Creek. Waco East Quadrangle (7.5').

TX 252. Type locality for *Ventilabrella eggeri* Cushman. Taylor Formation, "Lower Taylor Marl" Member. Buff calcareous mudstone breaking with conchoidal fracture. Exposure on south bank of Tradinghouse Creek, McLennan County; 53.5 feet above creek; 1.5 miles west of juncture between Tradinghouse Creek and Tehuacana Creek; 1 airline mile S68E of Harrison Switch (large meander in Tradinghouse Creek); 0.2 miles due south of county road bridge over Tradinghouse Creek. Waco East Quadrangle (7.5').

TX 255A. Wolfe City Sand. Silty, buff-colored marl exposed on tributary of Tradinghouse Creek immediately north of county road; 1.8 airline miles N31E of Hallsburg and 1.1 airline miles S24W of west end of New Lake Mart; McLennan County.

TX 267. Kemp Clay. Greenish-grey, calcareous, glauconitic mudstone. Farm Road 413 Bridge over Brazos River; collected along east bank of river immediately north of bridge; 2.4 airline miles southeast of Highland, Falls County; 2 airline miles north of point where Brazos River enters Milam County from Falls County.

TX 9AH of Smith. Type locality of *Planoglobulina brazoensis* Martin, n. sp. Kemp Clay. South bank of Walter Creek, 18 feet above base of creek, 6 miles N15E of Cameron, Milam County (refer to Smith, 1971, in manuscript).

Dallas Area:

TX 375. Type locality for *Ventilabrella glabrata* Cushman. Taylor Formation, "Lower Taylor Marl" Member. Clay pit of Baron Brick Company at Palmer, Ellis County; grey to buff calcareous mudstone with conchoidal fracture; collected at base of clay pit (as of 1962). Same as locality 231 of Cushman (1946, p. 6).

D11-1 of Martin. Austin Chalk, "Upper Chalk" Member. Exposed just downstream from the spillway of Lake Waxahachie about 4 miles southeast of Waxahachie, on Farm Road 877.

Cushman 277. Gober Tongue of the Austin Chalk. Exposure along creek bank, approximately 7 yards west of Randolph road, 4 miles north of Leonard, Fannin County, Texas. (See Cushman, 1946, p. 7).

D8-4 of Martin. Pecan Gap Formation. Collected 12 feet above contact with Wolfe City Sand. Exposure in road ditch

along east side of Andrews Road, approximately 800 feet south of its intersection with Slate Rock Road, 1.7 miles east of Bristol.

D4-3 of Martin. Austin Chalk, Middle Member. Collected 37 feet above base of exposure in east bank of Ten Mile Creek, 100–200 yards upstream from bridge on Pleasant Run Road, 1 mile N. and 1 mile E. of DeSoto.

SOUTHWESTERN ARKANSAS

AR 7A. Lower part of Brownstown Marl. Dark grey mudstone breaking with conchoidal fracture; containing common *Exogyra ponderosa* Roemer. 1.7 miles west of Brownstown on Brownstown-Ben Lomond Road, Sevier County.

CALIFORNIA

NSF 477. Upper part of Panoche Group (undifferentiated); limestone nodules associated with light grey calcareous mudstone. Exploration Adit number 1:110–270 feet. California Dept. of Water Resources, Div. of Design and Construction; Del Valle Dam and Reservoir Damsite Foundation Exploration. U. S. Army Corps of Engineers, Texla Quad. (15'). Coordinates E1,639,000; N408,250.

NSF 573. "Marsh Creek Formation". Sample from limestone nodules interbedded with dark grey siliceous to calcareous mudstones. Antioch South Quad. (7.5'). TIN–R2E; Sect. 32. South bank of Marsh Creek, 0.15? miles downstream from bridge; Valley Road Crossing of Marsh Creek, Contra Costa County.

PUERTO RICO

OP 200. Cariblanco Formation. Marls interbedded with calcareous siltstones and calcilutites. Coamo Quadrangle: 162,637E; 29,850N. South-central Puerto Rico.

OP 2196. Cariblanco Formation. Marls interbedded with calcareous siltstones and calcilutites. Rio Descalabrado Quad: 152,890E; 20,800N. South-central Puerto Rico.

OP 2690. Rio Yauco Formation. Marls interbedded with calcareous mudstones. Penuelas Quadrangle: 124,900E; 25,575N. South-central Puerto Rico.

GULF OF MEXICO

S-1 of Martin. Core sample from late Maestrichtian sediments, from B. W. McNeely, Shell Oil Co., Metairie, Louisiana.

EUROPE

S-2 of Martin. Type locality for *Planoglobulina acervulinoides* (Egger). Gerhardsreuter Beds, Adelholzen, near Siegsdorf, 100 km southeast of Munich. Upper Bavaria. Sample from Prof. Herbert Hagn.

JOIDES LEG I

1/4A/2/1A. Site 4A, Core 2, Section 1A (Top). Late Campanian. Located between the Hatteras Abyssal Plain and the Bahama Platform; Just seaward of Cat Gap, a valley which breaks the continuity between the Blake outer ridges

and the ridge extending north-northeast of San Salvador Island.

JOIDES LEG III

3/21/8/6—3/21/3/1. Site 21. Site 21. Campanian-Maestrichtian. Located on the northeastern edge of the Rio Grande Rise in the South Atlantic.

Maestrichtian (A. mayaroensis Subzone):

3/21/3/1 (0–2 cm)
3/21/3/1 (99–101 cm)
3/21/3/3 (99–101 cm)
3/21/3/4 (79–81 cm)
3/21/3/5 (79–81 cm)
3/21/3/6 (79–81 cm)

Maestrichtian (G. gansseri Subzone):

3/21/4/1 (99–101 cm). Co-type locality for *Ventilabrella riograndensis* Martin, n. sp.
3/21/4/2 (79–81 cm)
3/21/4/3 (79–81 cm)

Maestrichtian (R. subcircumnodifer Subzone):

3/21/4/4 (79–81 cm)
3/21/4/5 (79–81 cm)
3/21/4/6 (79–81 cm)
3/21/5/1 (99–101 cm)
3/21/5/2 (79–81 cm)
3/21/5/3 (79–81 cm)
3/21/5/4 (79–81 cm)
3/21/5/5 (79–81 cm)
3/21/5/6 (79–81 cm)

Campanian (P. elegans Zonule):

3/21/6/3 (79–81 cm)
3/21/6/4 (79–81 cm)
3/21/6/5 (79–81 cm)
3/21/6/6 (79–81 cm)
3/21/7/1 (99–101 cm)
3/21/7/3 (79–81 cm)
3/21/7/4 (79–81 cm)
3/21/7/5 (79–81 cm)
3/21/7/6 (79–81 cm)
3/21/8/1 (99–101 cm)
3/21/8/2 (79–81 cm)
3/21/8/3 (79–81 cm)
3/21/8/4 (79–81 cm)
3/21/8/5 (79–81 cm)
3/21/8/6 (79–81 cm)

JOIDES LEG XII

12/111A/11/6—12/111A/11/1. Site 111A, Core 11. Latest Campanian–Maestrichtian. Located at Orphan Knoll, north-east of Newfoundland.

Latest Campanian:

12/111A/11/6 (142–143 cm)
12/111A/11/5 (78–81 cm)

Maestrichtian:

12/111A/11/4 (71–74 cm)
12/111A/11/3 (76–77 cm)
12/111A/11/2 (76–79 cm)
12/111A/11/1 (142–143 cm)