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PLANKTONIC FORAMINIFERA AND STRATIGRAPHY OF THE CORSICANA FORMATION (MAESTRICHTIAN) NORTH-CENTRAL TEXAS

BY

CHARLES C. SMITH and EMILE A. PESSAGNO, JR.

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PLANKTONIC FORAMINIFERA AND STRATIGRAPHY OF THE CORSICANA FORMATION (MAESTRICHTIAN) NORTH-CENTRAL TEXAS

CHARLES C. SMITH[1] AND EMILE A. PESSAGNO, JR.

ABSTRACT

This report deals with the biostratigraphy, lithostratigraphy, and micropaleontology of the Corsicana Formation of North Central Texas. A comparison of strata at the type locality of the Corsicana Formation with the type area of the Kemp Formation clearly demonstrates that these units are lithostratigraphic equivalents and can be encompassed by one formational name. Since the Corsicana Formation has a well-defined type locality and contains by far the best exposures of these units in their respective type areas, it is suggested that the term *Kemp* be abandoned and the term *Corsicana* be retained. The definition of the Corsicana Formation is emended, therefore, to include the calcareous clays, mudstones, and marls that overlie the Nacatoch Formation and underlie the Paleocene Kincaid Formation (Midway Group).

The present investigation indicates that the Corsicana Formation is middle Maestrichtian in age and is assignable to the *Globotruncana contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone. Through a detailed analysis of the planktonic foraminiferal assemblage, it has become possible to subdivide the *Globotruncana gansseri* Subzone into two new zonules: a lower *Globotruncana aegyptiaca* Zonule and an upper *Racemiguembelina fructicosa* Zonule.

The Corsicana Formation includes a rich, well preserved planktonic foraminiferal assemblage consisting of forty-nine species (four of which are new) assigned to thirteen genera. The scanning electron microscope has been utilized extensively in this study to describe and illustrate these taxa. The genus *Racemiguembelina* Gallitelli (1957) is emended and a new term *ponticulus* is proposed for the unique umbilical cover plates that characterize this genus.

ACKNOWLEDGMENTS

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Geosciences Division, University of Texas at Dallas, P. O. Box 30365, Dallas, Texas 75230. Contribution No. 197.

[1] Present address: Phillips Petroleum Company, Research Center, Bartlesville, Oklahoma 74004.

INTRODUCTION

The Corsicana Formation contains one of the richest and best preserved foraminiferal assemblages in the Upper Cretaceous succession of the Gulf Coastal Plain area. Although various investigators have described the Corsicana microfauna (Carsey, 1926; Plummer, 1926, 1931; Cushman and Todd, 1943; Cushman, 1946; Pessagno, 1967), no previous investigators have studied its planktonic foraminifera in detail utilizing the scanning electron microscope.

The present study attempts to reevaluate the lithostratigraphy and refine the biostratigraphy of the Corsicana Formation and to analyze its planktonic foraminiferal assemblage.

LITHOSTRATIGRAPHY

AREA OF INVESTIGATION

The Upper Cretaceous strata of Texas crop out in a northeast-southwest trending belt extending from northern

Bowie County in northeastern Texas, through the central portion of the state, into Maverick County in southwestern Texas. The areal extent of the Corsicana Formation in the area of investigation is shown in text fig. 1.

Throughout its exposure from Kaufman County to Milam County, the Corsicana Formation strikes approximately north-northeast and dips toward the southeast at the rate of 30 to 50 feet per mile. Although a continuous section of the Corsicana Formation is not exposed at any one locality within the area of investigation, the composite thickness of the formation probably does not exceed 250 to 300 feet.

From the North Central Texas area, the Corsicana Formation extends southwestward into Bexar County where it interfingers with and is replaced laterally by the Escondido Formation. The Escondido Formation consists of indurated calcareous mudstones and shales interbedded with calcareous sandstones.

Historical Development of Stratigraphic Nomenclature

The historical development of the nomenclature of the Navarro Group and its formational subdivisions has been presented by Adkins (1933, pp. 480–517) and Stephenson (1941, pp. 6–7). The names "Corsicana beds" and "Kemp beds" were proposed by R. T. Hill (1901, p. 342) as subdivisions of the Navarro Formation in North Central Texas. Hill (ibid.) stated: "The Corsicana beds are a brown sandy marl, with an occasional band of hard, calcareous sandstone in its upper portion. The sand is exceedingly fine, and is usually so mixed with clay as to be almost imperceptible." The stratigraphic limits of this unit were not defined, nor was a type locality designated for the "Corsicana beds."

The "Kemp beds" were defined by Hill (1901, p. 343) as ". . . a yellow clay bed containig nodules with supposedly Cretaceous fossils. . ." overlying the "Corsicana beds". Hill (ibid.) noted that the town of Kemp in Kaufman County was one mile west of the eastern edge of the outcrop of the "Kemp beds". As with the "Corsicana beds", the "Kemp beds" were poorly defined and no definite type locality was designated by Hill.

Stephenson (1927, pp. 13–15) briefly described the lithologic character and stratigraphic relations of the Navarro Formation in North Central Texas. He (ibid., p. 13) noted sandy beds near the middle of the Navarro Formation (presumably included in Hill's "Corsicana beds") and suggested they represented the approximate southwestern extension of the Nacatoch Sand of Arkansas. In 1928, Dane and Stephenson referred to the sandy marl below the Nacatoch Sand as the zone of *Exogyra cancellata*. Later, Stephenson (1929, p. 1331) noted that the Navarro Formation in North Central Texas consisted of four units in ascending order: (1) the lower Navarro or *Exogyra cancellata* zone, (2) the Nacatoch Sand Member, (3) an unnamed chalky marl member, and (4) an unnamed upper clay member (see text fig. 2).

In a personal communication to W. S. Adkins, Stephenson (in Adkins, 1933, p. 516) proposed the name *Neylandville Formation* for the clays below the Nacatoch Sand. Stephenson (ibid.) suggested that the Corsicana Formation ("Corsicana beds" of Hill, 1901) should be restricted to the unnamed chalky marl, and proposed the clay pit of the Corsicana Brick Company two miles south of the Courthouse in Corsicana as the type locality of the Corsicana Formation. Stephenson (ibid.) further noted that if the name Kemp was retained (that is, retained by Adkins for inclusion in "The Geology of Texas", Univ. Texas, Bull. 3232, 1933), it should be restricted to the upper clay member although Stephenson state, ". . . exposures of this are rare in the vicinty of Kemp, and the desirability of applying the name to this unit has not been fully considered". Adkins (1933, pp. 495–496) accepted Stephenson's suggestions, and restricted Hill's "Kemp beds" to the upper clay of Stephenson (see text fig. 2). Adkins (ibid.) noted, "The presumable type locality is the faulted inlier near Kemp."

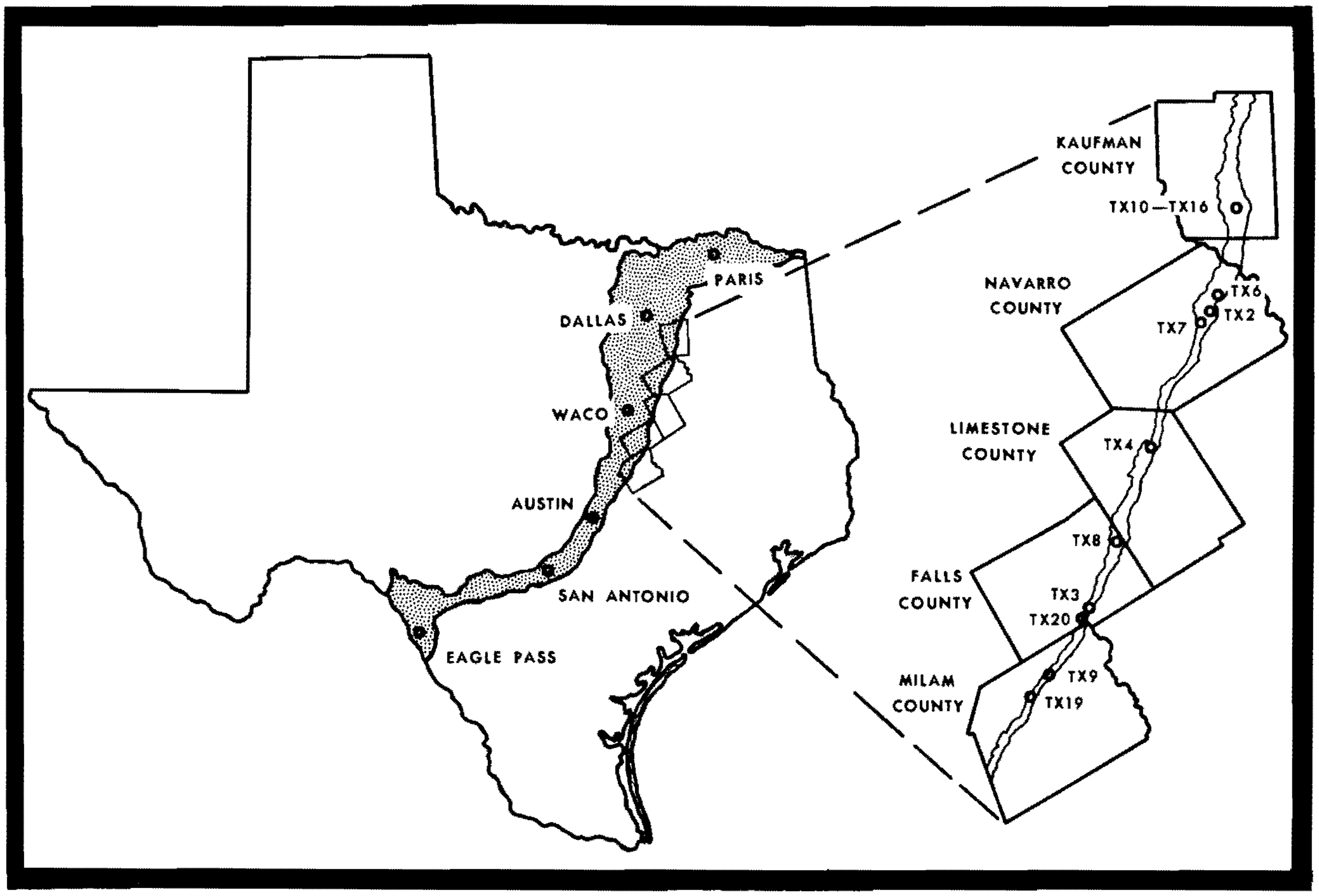
The lithostratigraphic names proposed by Stephenson (in Adkins, 1933, p. 516) were adopted by the United States Geological Survey for the cooperative geologic map of Texas published in 1937 (see Wilmarth, 1938, p. 527), and for the Cretaceous correlation chart published in 1942 (Stephenson, et. al., 1942). Until the present report, no significant revision of Navarro lithostratigraphy has occurred since 1933.

Lithology and Definition of Corsicana Formation

Throughout North Central Texas, the lithology of the Corsicana Formation may generally be described as a dark to light gray or grayish tan calcareous mudstone, locally glauconitic and occasionally quartzose silty and fine sandy with varying admixtures of muscovite mica, phosphatic fish tooth and bone fragments, and small pyrite and marcasite nodules. Detailed measured sections with accompanying lithologic descriptions of each sampled locality are presented in the Appendix.

The Corsicana Formation was formerly well exposed at its type locality in the clay pit of the Corsicana Brick Company just west of the Southern Pacific Railway and Farm Road 709, about two miles south of the Courthouse in Corsicana, Navarro County, Texas. This pit was abandoned in the middle 1930's. Since then it has filled with water and the slopes above water level concealed by talus and overgrown with vegetation. The active clay pit just east of this site was designated by Kellough (1962) as the reference, or alternate type locality of the Corsicana Formation (see Appendix, Locality TX2).

About 30 feet of dark gray calcareous mudstones are exposed in the active Corsicana clay pit (for measured section see Appendix, Locality TX2). Near the middle of the exposure is a twelve to fifteen inch bed of abundantly glauconitic and quartzose sandy mudstone which has not been



TEXT FIGURE 1

Map showing generalized distribution of Upper Cretaceous rocks in Texas and localities sampled in the area of investigation.

observed at other localities. Above the glauconitic bed, the clay is lithologically similar (although somewhat less calcareous and in part weathered yellowish-tan) to the underlying clay, but contains a markedly different microfauna consisting almost entirely of calcareous and arenaceous benthonic foraminiferal species (see Biostratigraphy). It is reasonable to assume that the upper portion of the exposure at this site would have been included in the "Kemp beds" of Hill (1901, p. 343) and the unnamed upper clay of Stephenson (1929, p. 1331). In referring to the now abandoned clay pit, Stephenson (1941, p. 23) stated, "These upper slopes are probably underlain by the Kemp clay, but the position of the contact between the clay and the underlying marl was not precisely determined at this locality."

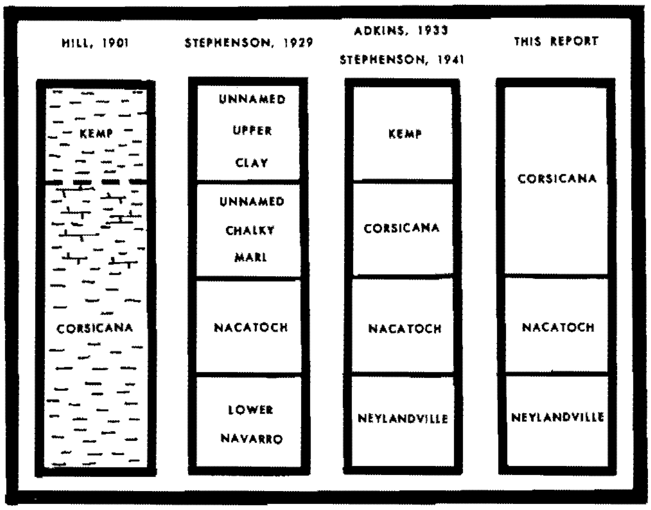
No definite type locality exists for the Kemp Formation in Texas. Adkins (1933, p. 495) stated that "The presumable type locality is the faulted inlier near Kemp", Kaufman County, Texas. Extensive field investigation in the Kemp area failed to substantiate any lithologic unit distinctively different from that of the Corsicana Formation exposed at its alternate type locality. Furthermore, calcareous mudstones exposed immediately below the Cretaceous-Tertiary contact in Falls County (see Appendix, Locality TX20) and Milam County (Locality TX9), although somewhat more glauconitic, are otherwise lithologically indistinguishable from the type Corsicana Formation.

Due to the marked lithologic similarity between the Corsicana and Kemp Formations, as well as the absence of a definite type locality for the Kemp, it seems best to abandon the name *Kemp.* The name *Corsicana Formation* is retained for the calcareous mudstones extending from the top of the Nacatoch Formation to the base of the overlying Paleocene Kincaid Formation in the North Central Texas area (refer to text fig. 2).

BIOSTRATIGRAPHY

The Type European Maestrichtian

The historical development of the Maestrichtian Stage, as well as a discussion of its type locality, geographic ex-



TEXT FIGURE 2

Historical development of Navarroan (Maestrichtian) stratigraphic nomenclature, North Central Texas.

tent, stratigraphic position, and paleontology, has been summarized by Berggren (1960, pp. 181–191; 1962, pp.7–19; 1964, pp. 104–116). The Maestrichtian Stage was formally erected by Dumont in 1849. The name *Maestrichtian* was taken from exposures of tuffaceous chalk in the vicinity of Maastricht, Holland. The lower boundary of the Maestrichtian Stage is generally considered to be marked by the first occurrence of the ammonite *Discoscaphites constrictus* (see Jeletzky, 1951, p. 16), and to overlie strata belonging to the late Campanian *Bostrychoceras polyplocum* Zone.

Birkelund (1957) proposed a zonal subdivision of the Upper Cretaceous of Denmark based on the belemnites and other groups of megafossils. He divided the Maestrichtian into four zones from bottom to top: (1) the *Belemnella lanceolata* Zone (the lower limit of *B. lanceolata* is generally regarded to coincide with the lower limit of *D. constrictus*); (2) the *B. lanceolata sumensis-B. occidentalis* Zone; (3) the *B. junior* Zone; and (4) the *B. casimirovensis* Zone. Jeletzky (1960, p. 28, Fig. 2) further subdivided the *B. lanceolata sumensis-B. occidentalis* Zone of Birkelund into a lower *B. lanceolata* mut. *junior* s.s. Zone and an upper *B. cimbrica* Zone.

Pessagno (1969, p. 27) presented an integration of the planktonic foraminiferal zonation for the western Gulf Coast with the northern European Maestrichtian cephalopod zones of Jeletzky. Although some doubt exists regarding the precise limits, Pessagno (ibid.) noted that the base of the *G. gansseri* Subzone occurs within the *B. lanceolata sumensis-B. occidentalis* Zone of Birkelund (1957, p. 62, Table 4), or probably within the upper part of the *B. lanceolata* mut. *junior* s.s. Zone of Jeletzky (1960, p. 28, Fig. 2). At present, the boundary between the *G. gansseri* Subzone and *A. mayaroensis* Subzone (between middle and late Maestrichtian) can be placed with reasonable accuracy near the boundary between the *B. junior* s.s. and *B. casimirovensis* Zones (see Berggren, 1964, p. 109; Pessagno, 1969, p. 27).

Previous Megafossil Studies

Traditionally, the Navarro Group has been recognized as being equivalent to the *Exogyra costata* Zone. The lower part of the *E. costata* Zone encompasses the *Exogyra cancellata* Subzone. This latter zonal unit is correlative with the Neylandville Formation in North Central Texas, and generally has the same areal extent as the *E. costata* Zone in the Gulf and Atlantic Coastal Plain Provinces (Stephenson, 1918, p. 157; Adkins, 1933, p. 489).

Stephenson (1941, p. 24) noted that the ammonite *Sphenodiscus* Meek, although rarely present in the Neylandville and apparently absent in the Nacatoch, becomes common in the Corsicana Formation. Two species of *Sphenodiscus*: *S. tirensis* Stephenson and *S. pleurisepta* (Conrad) were noted to be restricted to the Corsicana Formation. A total of ninety-eight species and subspecies of invertebrate fossils were reported to occur in the lower portion of the Corsicana Formation. Thirty-six of these species were found to be restricted to the lower portion of the Corsicana Formation. One hundred and five species of invertebrate megafossils were noted to occur in the upper part of the Corsicana Formation (= Kemp Formation of Stephenson, 1941). Fifty-three of these species were found to be restricted to the upper portion of the Corsicana Formation.

Stephenson (1941, p. 34) suggested that any attempt to correlate restricted zones in the Gulf Coastal Plain with zones of corresponding age (Maestrichtian) in the European type area is particularly difficult due to the paucity of common species. Nevertheless, his (ibid., p. 35) correlation of the Navarro Group with the type Maestrichtian was based on the common occurrence of *Sphenodiscus* (restricted to the *B. lanceolata* mut. *junior* and *B. cimbrica* Zones of Jeletzky (1960, p. 28, fig. 2). In addition, Stephenson (ibid.) reported a specimen of *Parapachydiscus* aff. *P. gollevillensis* (d'Orbigny) from the Escondido Formation of Texas (in part equivalent to the Corsicana Formation of North Central Texas; see Lithostratigraphy) and an internal mold similar to *P. gollevillensis* from the Prairie Bluff Chalk of Mississippi (age equivalent to the Corsicana Formation of Texas). Stephenson (ibid.) noted that *P. gollevillensis* is indicative of a Maestrichtian age

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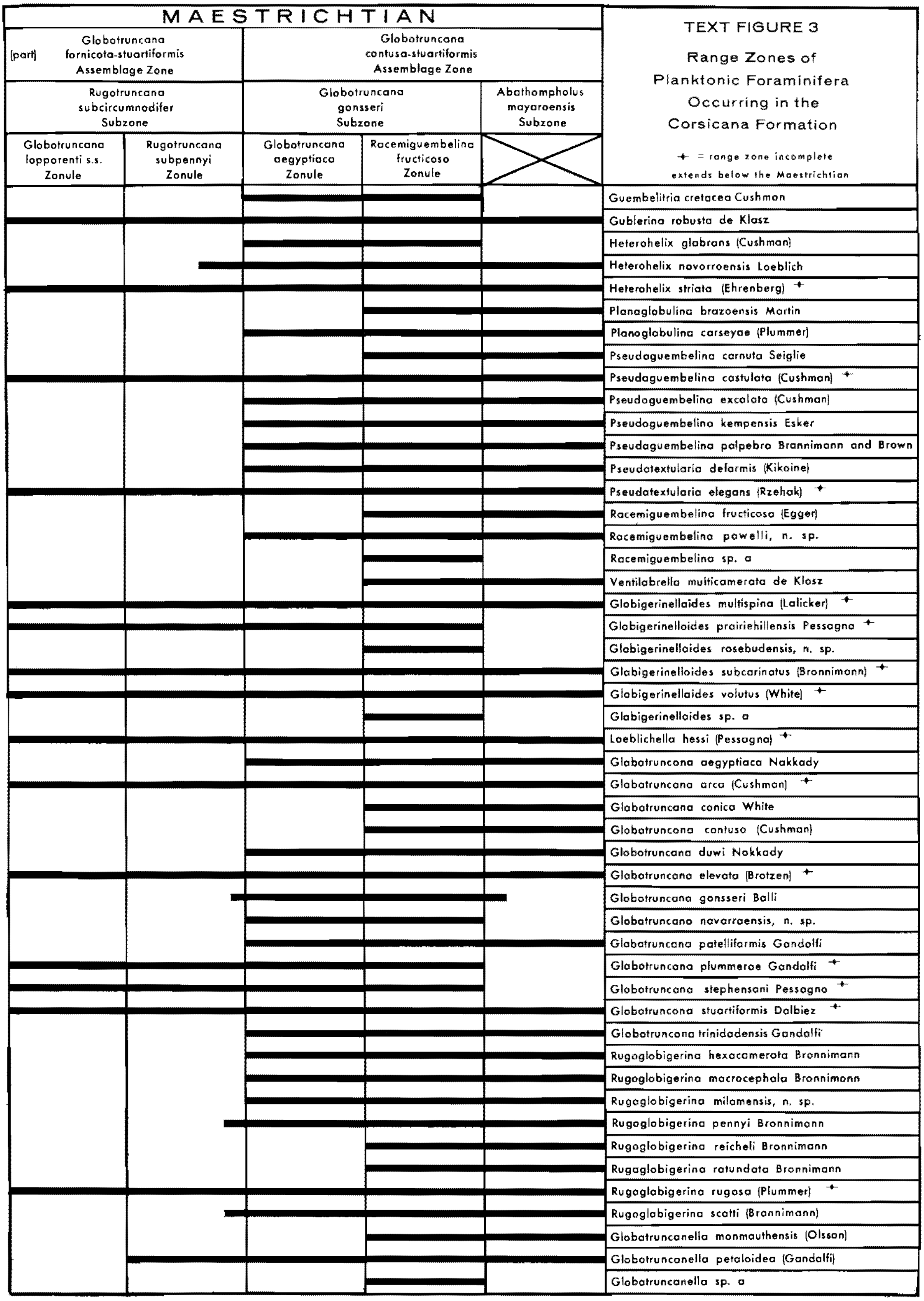
TEXT FIGURE 3

Range zones of planktonic foraminifera occurring in the Corsicana Formation.



TEXT FIGURE 3

Range Zones of Planktonic Foraminifera Occurring in the Corsicana Formation (see also Jeletzky, 1960, p. 31). Jeletzky (ibid.) reported *Scaphites* (*Discoscaphites*) *roanensis* Stephenson and other forms of *Discoscaphites* from the Escondido and Kemp Formations of Texas which he considered to be closely allied to *S.* (*D.*) *conradi* Morton in the Late Cretaceous of the Western Interior. Jeletzky (ibid.) assigned the Corsicana and Kemp Formations of Texas to his (1960, p. 28, fig. 2) *Scaphites* (*D.*) *nebrascensis* Zone of the Western Interior (= upper portion of the *B. cimbrica* Zone), or middle Maestrichtian as used herein.

Previous Foraminiferal Studies

A number of studies have been made of the foraminifera of the Navarro Group of Texas, Arkansas, and elsewhere in the Gulf Coastal Plain area (see Bibliography). One of the earliest investigations of the Cretaceous foraminifera of Texas was that of Carsey (1926). Carsey described thirty-two species of foraminifera (mostly arenaceous and calcareous benthonic forms) from the Corsicana Formation of Travis County, Texas. In 1926, Plummer described the Midway (Paleocene) foraminifera of Texas. In her discussion of the Navarro and Midway faunas (ibid., pp. 34–41), several new species of both benthonic and planktonic foraminifera (e.g., *Globigerina rugosa*) were described from Milam and Navarro Counties, Texas (see Appendix, Localities TX9 and TX2).

In 1931, Plummer incorporated sample material from the Corsicana Formation of Navarro, Limestone, Milam, and Travis Counties in her descriptions of the Cretaceous foraminifera of Texas (see Appendix, Localities TX2, TX9, and TX25). Among the planktonic species, *Ventilabrella carseyae* was described from the Corsicana Formation at Walkers Creek (see Appendix, Locality TX9), Milam County, Texas.

In 1943, Cushman and Todd recorded ninety-six species and subspecies of benthonic and planktonic foraminifera from the Corsicana Formation of Navarro, Limestone, and Travis Counties, Texas (see Appendix, Localities TX2, TX4, and TX25).

A major contribution toward a better understanding of Upper Cretaceous foraminiferal paleontology was the monographic work of Cushman (1946). Nearly 600 species and varieties of foraminifera (mostly benthonic) were recorded from numerous localities throughout Texas and the Gulf Coastal Region.

The only treatise to describe and illustrate the planktonic foraminiferal fauna of the Upper Cretaceous of Texas was that of Pessagno (1967). The morphology, taxonomy, and phylogeny of more than 100 species of planktonic foraminifera were analyzed, and a detailed system of zonation was proposed for the Upper Cretaceous of the Western Gulf Coastal Plain (Pessagno, 1969). Although Pessagno (1967; 1969) incorporated sample material from the Corsicana Formation and chronostratigraphically equivalent units throughout Texas, Arkansas, and Mexico, his treatment of the Corsicana fauna was, by necessity, less inclusive and detailed than that of the present study.

Definition of the *Globotruncana aegyptiaca* Zonule

The planktonic foraminifera of the Corsicana Formation of North Central Texas are represented by forty-nine species belonging to thirteen genera (text fig. 3). This assemblage is assignable to the middle Maestrichtian *Globotruncana contusa-stuartiformis* Assemblage Zone, *Globotruncana gansseri* Subzone. A detailed analysis of the planktonic foraminifera of the Corsicana Formation of Central and North Central Texas has resulted in the establishment of two new biostratigraphic units within the *G. gansseri* Subzone. The lower of these units is termed the *Globotruncana aegyptiaca* Zonule. It is distinguished from the early Maestrichtian *Rugotruncana subcircumnodifer* Subzone, *R. subpennyi* Zonule (text fig. 3) by the presence of *Guembelitria cretacea* Cushman, *Heterohelix glabrans* (Cushman), *Planoglobulina carseyae* (Plummer), *Pseudoguembelina excolata* (Cushman), *P. palpebra* Bronnimann and Brown, *Pseudotextularia deformis* (Kikoine), *Globotruncana aegyptiaca* Nakkady, *G. duwi* Nakkady, *G. gansseri* Bolli, *G. navarroensis* n. sp., *G. patelliformis* Gandolfi, *Rugoglobigerina hexacamerata* Bronnimann, *R. macrocephala* Bronnimann, and *R. milamensis* n. sp., as well as other middle Maestrichtian planktonic foraminifera (see text fig. 3).

The only horizon in Texas known to be assignable to the *G. aegyptiaca* Zonule is the Corsicana Formation as exposed along Onion Creek in Travis County, Texas (see Appendix, Locality TX25). The relative abundance of species recovered from samples at the Onion Creek locality is shown in text fig. 4.

Definition of the *Racemiguembelina fructicosa* Zonule

The *Racemiguembelina fructicosa* Zonule is the upper zonule of the *G. gansseri* Subzone. It is distinguished from the *G. aegyptiaca* Zonule by the presence of *Planoglobulina brazoensis* Martin, *Pseudoguembelina cornuta* Seiglie, *Racemiguembelina fructicosa* (Egger), *Venti-*

→

TEXT FIGURE 4

Distribution and relative abundance of planktonic foraminifera occurring in the Corsicana Formation (Locality TX25) along Onion Creek, Travis County, Texas. Rare = 1 to 3 individuals; Common = 4 to 10 individuals; Abundant = greater than 10 individuals.

RARE ✱ COMMON ◐ ABUNDANT ●

Species	TX169	TX170	TX171	TX172	TX173	TX174	TX175	TX176	TX177	TX178	TX179	TX180	TX181	TX182	TX183	TX184
Guembelitria cretacea Cushman	●	●	●	●	●	●	●	●	●	●	●	●	●	●	◐	✱
Gublerina robusta de Klasz			✱					✱		✱						
Heterohelix glabrans (Cushman)	◐	◐	◐	◐	◐	●	●	◐	◐	◐	◐	◐	◐			
Heterohelix navarroensis Loeblich	●	●	●	●	●	●	●	●	●	●	●	●	●	●	✱	✱
Heterohelix striata (Ehrenberg)	●	●	●	●	●	●	◐	●	◐	●	●	●	●	◐	✱	
Planoglobulina carseyae (Plummer)	◐	◐	◐	✱	◐	◐	✱	◐	◐	◐	◐	◐	✱			
Pseudoguembelina costulata (Cushman)	◐	◐	●	●	●	●	◐	●	◐	◐	◐	●	◐	✱		
Pseudoguembelina excolata (Cushman)	✱	◐	◐	◐	◐	◐	✱	✱	✱	✱	✱	✱	✱			
Pseudoguembelina kempensis Esker				✱	✱		✱		✱							
Pseudoguembelina palpebra Bronnimann and Brown	✱	◐	◐	◐	●	●	●	●	●	●	◐	◐				
Pseudotextularia deformis (Kikoine)	●	●	●	●	●	●	●	●	◐	●	◐	●	◐	◐		
Pseudotextularia elegans (Rzehak)	◐	●	◐	◐	◐	✱		◐		✱		✱	✱		✱	
Racemiguembelina powelli, n. sp.	✱	✱	◐		✱		✱	✱				✱				
Globigerinelloides multispina (Lalicker)	◐	●	●	●	●	●	●	●	◐	◐	◐	◐	◐	✱		
Globerinelloides prairiehillensis Pessagno	◐	●	●	●	●	●	●	●	●	●	◐	●	◐	✱		
Globigerinelloides subcarinatus (Bronnimann)	✱	◐	◐	◐	◐	●	●	◐	◐	◐	◐	◐	✱			
Globigerinelloides volutus (White)	◐	●	◐	◐	●	●	◐	●	●	●	●	●	◐			
Loeblichella hessi (Pessagno)	●	●	●	●	●	●	●	●	●	●	●	●	●	✱		
Globotruncna aegyptiaca Nakkady	●	●	●	●	●	●	●	●	◐	◐	◐	◐	◐	✱		
Globotruncana arca (Cushman)	◐	◐	◐	◐	◐	◐	●	●	◐	✱	✱	◐	◐			
Globotruncana duwi Nakkady	●	◐	●	●	●	◐	◐	◐	✱	✱	✱	◐	✱			
Globotruncana elevata (Brotzen)	●	●	●	●	●	●	●	●	✱	✱	◐	◐	◐			
Globotruncana gansseri Bolli	◐	●	●	●	●	●	●	●	◐	◐	●	●	◐	✱		
Globotruncana navarroensis, n. sp.	✱		✱					✱								
Globotruncana patelliformis Gandolfi	✱					✱										
Globotruncana plummerae Gandolfi						✱		✱								
Globotruncana stephensoni Pessagno	✱	✱	◐	◐	◐	◐	✱	✱		✱	✱	◐	✱			
Globotruncana stuartiformis Dalbiez	✱	◐	✱	✱	✱	✱	✱	✱				✱	✱			
Globotruncana trinidadensis Gandolfi	◐	●	●	●	●	●	◐	◐	◐	◐	◐	◐	◐			
Rugoglobigerina hexcamerata Bronnimann	◐	●	◐	●	●	●	●	●	◐	◐	◐	●	●	◐		
Rugoglobigerina macrocephala Bronnimann	✱		✱	✱	✱	✱	✱	✱				✱				
Rugoglobigerina milamensis, n. sp.	●	●	●	●	●	◐	◐	●	◐	●	●	●	✱	✱		
Rugoglobigerina pennyi Bronnimann	◐	✱	✱	✱	✱	◐	●	●	◐	◐	◐	●	✱			
Ruglobigerina rugosa (Plummer)	●	●	●	●	●	●	●	●	●	●	●	●	●	◐	✱	
Rugoglobigerina scotti (Bronnimann)	✱	◐	✱	✱	✱	◐	◐	◐	✱	✱	✱	●	◐	✱		
Globotruncanella petaloidea (Gandolfi)	✱	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐	✱			

TX2BA	TX2AA	TX2AB	TX2AC	TX2BB	TX2AD	TX2AE	TX2AF	RARE ✱ COMMON ◐ ABUNDANT ●
●	●	●	◐	◐	◐	✱	✱	Guembelitria cretacea Cushman
◐	✱							Gublerina robusta de Klasz
●	◐	◐	✱		✱		✱	Heterohelix glabrans (Cushman)
●	●	●	◐	✱	◐	◐	✱	Heterohelix navarroensis Loeblich
●	●	●	◐	✱	◐	✱		Heterohelix striata (Ehrenberg)
◐	◐							Planoglobulina brazoensis Martin
●	●	◐	✱	✱	◐			Planoglabulina carseyae (Plummer)
◐	◐	✱	✱					Pseudoguembelina cornuta Seiglie
●	◐	✱	✱		✱			Pseudaguembelina costulata (Cushman)
●	◐	✱						Pseudoguembelina excolata (Cushman)
◐	◐	✱		✱				Pseudoguembelina kempensis Esker
●	●	◐	✱	✱	◐	✱		Pseudoguembelina palpebra Brannimann and Brawn
●	●	●			●	✱		Pseudotextularia deformis (Kikoine)
◐	◐	✱	✱		✱			Pseudatextularia elegans (Rzehak)
◐	◐	✱						Racemiguembelina fructicosa (Egger)
✱	✱	✱			✱			Racemiguembelina powelli, n. sp.
◐	✱							Ventilabrella multicamerata de Klasz
●	◐							Globigerinelloides multispina (Lalicker)
●	●	◐	✱	✱	✱			Globigerinelloides prairiehillensis Pessagno
◐	◐							Globigerinelloides rosebudensis, n. sp.
◐	◐	✱						Globigerinelloides subcarinatus (Bronnimann)
◐	◐							Globigerinelloides volutus (White)
✱	✱	✱						Globigerinelloides sp. a
●	●	◐						Loeblichello hessi (Pessagna)
●	●	◐	◐	✱	◐	✱		Globotruncana aegyptiaca Nakkady
●	●	◐	◐	✱	◐			Globotruncana arca (Cushmon)
✱	✱	✱						Globotruncana conica White
◐	✱							Globotruncana contusa (Cushman)
◐	◐	✱	✱		✱			Globotruncano duwi Nakkady
●	●	◐	✱	✱	◐	✱		Globotruncana elevata (Brotzen)
●	●	◐	✱		✱			Globotruncano gansseri Bolli
●	◐							Globotruncana navarroensis, n. sp.
●	◐							Globotruncano patelliformis Gandolfi
✱	✱							Globotruncana plummerae Gandolfi
●	◐	◐						Globotruncana stephensoni Pessagno
◐	✱	✱						Globotruncana stuartiformis Dalbiez
●	●	●	✱		◐	✱		Globotruncano trinidadensis Gandolfi
●	●	◐			◐			Rugoglobigerina hexacamerata Bronnimann
◐	✱							Rugoglobigerino macrocephala Bronnimann
●	✱	✱						Rugaglobigerina milamensis, n. sp.
●	◐	✱						Rugoglobigerina pennyi Bronnimann
◐	◐	✱	✱		✱			Rugoglabigerina reicheli Bronnimann
◐	◐	✱						Rugoglabigerina ratundata Bronnimann
●	●	●	✱	✱	◐	✱	✱	Rugoglobigerina rugasa (Plummer)
●	◐	✱						Rugoglobigerina scotti (Brannimann)
◐	◐	✱	✱		✱			Glabotruncanella monmouthensis (Olssan)
●	●	●			✱			Glabatrunconella petalaideo (Gandolfi)
✱	✱	✱			✱			Globotruncanella sp. a

TEXT FIGURE 5

Distribution and relative abundance of planktonic foraminifera occurring in the alternate type locality of the Corsicana Formation (Locality TX2), Navarro County, Texas. Rare = 1 to 3 individuals; Common = 4 to 10 individuals; Abundant = greater than 10 individuals.

TX4AA	TX4AB	TX4AC	TX4AD	TX4AE	TX3BA	TX19XA	TX19XB	RARE ✱ COMMON ◐ ABUNDANT ●
◐	◐	◐	◐	◐	●	◐	◐	Guembelitria cretacea Cushman
✱	◐	✱	◐	◐	◐	✱	◐	Gublerina robusta de Klasz
◐	●	●	●	●	●	●	●	Heterahelix glabrans (Cushman)
●	●	◐	●	●	●	●	●	Heterahelix navarroensis Loeblich
●	●	●	●	●	●	●	●	Heterohelix striata (Ehrenberg)
✱	◐	✱	◐	●	◐	●	◐	Planoglobulina brazoensis Martin
◐	●	●	●	●	●	●	●	Planoglobulina corseyae (Plummer)
◐	●	◐	◐	●	◐	◐	◐	Pseudoguembelina cornuta Seiglie
✱	◐	✱	◐	◐	●	●	●	Pseudoguembelina costulato (Cushmon)
✱	◐	◐	◐	●	◐	◐	●	Pseudoguembelina excalata (Cushmon)
✱	◐	✱	◐	◐	◐	●	●	Pseudoguembelina kempensis Esker
●	●	◐	●	●	●	◐	◐	Pseudaguembelina palpebra Bronnimann and Brown
◐	●	●	●	●	●	●	●	Pseudotextularia deformis (Kikoine)
✱	●	◐	◐	●	●	◐	◐	Pseudotextulario elegans (Rzehok)
✱	◐	✱	◐	◐	◐	●	●	Racemiguembelina fructicoso (Egger)
◐	◐	●	◐	●	●	◐	◐	Racemiguembelina powelli, n. sp.
	✱		✱		✱			Racemiguembelina sp. a
◐	✱	◐	◐	✱	✱	◐	◐	Ventilabrella multicameroto de Klosz
◐	●	◐	●	●	●	●	●	Globigerinellaides multispina (Lalicker)
◐	●	●	●	●	●	●	●	Globerinelloides proiriehillensis Pessagno
✱	◐	◐	◐	◐	●	◐	◐	Globigerinellaides (?) rosebudensis, n. sp.
✱	◐	✱	◐	◐	◐	◐	◐	Globigerinelloides subcarinatus (Bronnimann)
✱	◐	◐	●	●	◐	◐	●	Globigerinelloides volutus (White)
	✱			✱	✱		✱	Globigerinelloides sp. a
●	●	●	●	●	●	●	●	Loeblichella hessi (Pessogno)
◐	●	●	●	●	●	●	●	Globotruncna oegyptioco Nakkady
◐	●	◐	●	●	●	●	●	Globotruncana arca (Cushman)
	◐	✱	✱	◐	◐	◐	◐	Globotruncano conico White
✱	◐	✱	◐	●	◐	◐	◐	Globatruncana contuso (Cushman)
◐	●	◐	●	●	●	◐	●	Globotruncana duwi Nakkady
●	●	◐	●	●	●	●	●	Globotruncono elevota (Brotzen)
◐	●	●	●	●	●	●	●	Globotruncana gansseri Bolli
◐	●	◐	◐	●	●	●	●	Globotruncona novorroensis, n. sp.
✱	◐	✱	◐	◐	◐	◐	◐	Globotruncona patelliformis Gandolfi
✱	◐	✱	◐	◐	◐	◐	◐	Globatruncona plummerae Gandolfi
◐	●	◐	◐	●	●	●	●	Globotruncono stephensoni Pessogno
✱	◐	◐	◐	●	●	●	●	Globotruncano stuortiformis Dalbiez
◐	●	●	●	●	●	●	●	Globotruncano trinidadensis Gondolfi
✱	◐	◐	●	●	●	●	●	Rugoglobigerino hexcomerato Bronnimann
✱	◐	✱	◐	◐	◐	◐	◐	Rugoglobigerina macrocephalo Brannimann
✱	◐	✱	✱	◐	◐	◐	◐	Rugoglobigerina milomensis, n. sp.
✱	◐	✱	◐	●	◐	◐	●	Rugoglobigerino pennyi Bronnimann
◐	◐	✱	◐	●	●	●	●	Rugoglobigerina reicheli Bronnimann
✱	◐	◐	◐	◐	●	◐	◐	Rugoglobigerina rotundota Bronnimann
	●	●	●	●	●	●	●	Ruglobigerino rugosa (Plummer)
◐	●	●	●	●	◐	◐	◐	Rugoglobigerina scotti (Bronnimann)
✱	◐	✱	◐	◐	●	●	●	Globotruncanella monmouthensis (Olsson)
●	●	●	●	●	●	●	●	Globotruncanella petaloidea (Gondolfi)
	✱			✱	✱	✱	✱	Globotrunconella sp. o

TEXT FIGURE 6

Distribution and relative abundance of planktonic foraminifera occurring in the Corsicana Formation at Localities TX4, TX3, and TX19. Rare = 1 to 3 individuals; Common = 4 to 10 individuals; Abundant = greater than 10 individuals.

TX20XA	TX20XB	TX20XC	TX20XD	TX20XE	TX20XF	TX20XG	TX20XH	RARE (✱) COMMON (◐) ABUNDANT (●)
Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant		Guembelitria cretacea Cushman
Rare			Rare					Gublerina rabusta de Klasz
Rare	Rare	Rare	Common	Rare	Rare	Rare		Heterohelix glabrans (Cushman)
Common	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant		Heterohelix navarroensis Loeblich
Common	Abundant	Abundant	Abundant	Abundant	Abundant	Common	Common	Heterohelix striata (Ehrenberg)
Common	Common	Rare	Common	Common	Common	Rare	Rare	Planoglobulina brazoensis Martin
Abundant	Common	Abundant	Abundant	Abundant	Abundant	Abundant	Rare	Planoglobulina carseyae (Plummer)
Common	Common	Abundant	Abundant	Abundant	Common	Common	Rare	Pseudoguembelina cornuta Seiglie
Common	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant		Pseudoguembelina costulata (Cushman)
Rare	Rare	Rare	Common	Rare	Rare	Rare	Rare	Pseudoguembelina excolata (Cushman)
Common	Abundant	Abundant	Common	Abundant	Abundant	Abundant	Rare	Pseudoguembelina kempensis Esker
Common	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Rare	Pseudoguembelina palpebra Bronnimann and Brown
Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Common	Pseudotextularia deformis (Kikoine)
Rare	Rare	Rare	Common	Rare	Rare	Rare		Pseudotextularia elegans (Rzehak)
Common	Rare		Common		Rare			Racemiguembelina fructicosa (Egger)
Rare	Rare	Rare	Common	Rare	Rare	Rare	Rare	Racemiguembelina powelli, n. sp.
Rare			Rare			Rare		Ventilabrella multicamerata de Klasz
Common	Abundant	Common	Common	Rare	Rare	Rare		Globigerinellaides multispina (Lalicker)
Common	Common	Abundant	Abundant	Abundant		Abundant		Globigerinelloides prairiehillensis Pessagno
Common	Abundant	Common	Rare	Common	Common	Rare		Globigerinelloides rosebudensis, n. sp.
Rare	Rare	Rare	Common		Rare	Rare		Globigerinelloides subcarinatus (Bronnimann)
Common	Rare	Common	Common	Rare	Common			Globigerinellaides volutus (White)
Rare								Globigerinelloides sp. a
Rare	Rare	Common	Common	Rare	Rare	Rare		Loeblichella hessi (Pessagno)
Abundant	Common	Common	Abundant	Common	Common	Common	Common	Globotruncana aegyptiaca Nakkady
Common	Common	Common	Abundant	Rare	Common	Common		Globotruncana arca (Cushman)
Rare	Rare	Common	Common		Rare	Rare	Rare	Globotruncana conica White
Common	Rare	Rare	Common	Rare	Rare	Rare		Globotruncana duwi Nakkady
Common	Common	Common	Abundant	Rare	Rare	Common	Rare	Globotruncana elevata (Brotzen)
Common	Common	Common	Abundant	Rare	Common	Rare	Rare	Globotruncana gansseri Bolli
Common	Common	Common	Abundant	Common	Common	Common	Common	Globotruncana stephensoni Pessagno
Rare	Common	Rare	Common		Rare	Common		Globotruncana stuartiformis Dalbiez
Common	Common	Common	Abundant	Common	Common	Common	Rare	Globotruncana trinidadensis Gandolfi
Common	Common	Common	Common	Common	Common	Rare	Rare	Rugoglobigerina hexacamerata Bronnimann
Rare		Rare	Common	Rare	Rare	Rare		Rugoglobigerina macrocephala Bronnimann
Rare	Rare	Rare	Common		Rare	Rare		Rugoglobigerina milamensis, n. sp.
Common	Common	Common	Abundant	Rare	Common	Rare	Rare	Rugoglobigerina pennyi Bronnimann
Rare	Rare	Common	Common	Rare	Common	Common		Rugoglobigerina reicheli Bronnimann
Rare	Rare	Rare	Common	Rare	Rare	Rare	Rare	Rugoglobigerina rotundata Bronnimann
Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Rare	Rugoglobigerina rugosa (Plummer)
Abundant	Abundant	Abundant	Abundant	Rare	Common	Common	Rare	Rugoglobigerina scotti (Bronnimann)
Common	Abundant	Abundant	Abundant	Abundant	Abundant	Abundant	Rare	Globotruncanella monmouthensis (Olsson)
Common	Abundant	Abundant	Abundant	Rare	Common	Common		Globotruncanella petaloidea (Gandolfi)

TEXT FIGURE 7

Distribution and relative abundance of planktonic foraminifera occurring in the Corsicana Formation (Locality TX20) along the Brazos River, Falls County, Texas. Rare = 1 to 3 individuals; Common = 4 to 10 individuals; Abundant = greater than 10 individuals.

labrella multicamerata de Klasz, *Globigerinelloides rosebudensis* n. sp., *Globotruncana conica* White, *G. contusa* (Cushman), *Rugoglobigerina reicheli* Bronnimann, *R. rotundata* Bronnimann, and *Globotruncanella monmouthensis* (Olsson). It is distinguished from the overlying *Abathomphalus mayaroensis* Subzone by the presence of *Guembelitria cretacea* Cushman, and *G. navarroensis* n. sp., as well as several other species (refer to text fig. 3), and by lacking *Abathomphalus mayaroensis* (Bolli), *A. intermedia* (Bolli), and *Pseudotextularia intermedia* de Klasz.

The *Racemiguembelina fructicosa* Zonule is represented throughout North Central Texas by the Corsicana Formation. The Arkadelphia Marl of Arkansas, the upper portion of the Escondido Formation of Texas, and the upper portion of Papagallos Shale of northeastern Mexico, are also assignable to this zonule.

Analysis of Fauna

The present investigation does not have a statistical analysis of the foraminiferal fauna as an objective. However, a few notations can be made regarding the relative abundances of the forms encountered during this study.

The planktonic foraminiferal fauna recovered from the alternate type locality of the Corsicana Formation contains a diversified assemblage dominated by the Heterohelicidae, Globotruncanidae, and Rugoglobigerinidae (see Appendix, Locality TX2). An examination of the chart showing the relative abundance of species at this site (text fig. 5) shows a decrease in diversity as well as abundance of planktonic forms higher in the section. Sample TX2AG (see Appendix) is void of planktonic foraminifera, the fauna being represented entirely by benthonic forms. The rare occurrence, or absence, of planktonic forms and dominance of benthonic foraminifera in the upper portion of the Corsicana Formation at its alternate type locality is probably due to a more shallow neritic marine environment or to a salinity change. One of the few planktonic forms found to persist to near the top of this section is *Guembelitria cretacea* Cushman. In the Escondido Formation of southwestern Texas, this same species is one of the few planktonic foraminifera occurring in a shallow neritic facies with numerous oyster biostromes. Furthermore, *G. cretacea* has not been observed from the Late Cretaceous JOIDES samples examined by either author. Hence, it is likely that *Guembelitria cretacea* is a specialized neritopelagic species which was able to withstand conditions of low salinity.

The planktonic foraminiferal fauna at localities TX3, TX4, and TX19 (see text fig. 6) is similar to the fauna at locality TX2. Localities TX20 and TX9 (see Appendix), however, are both stratigraphically high in the Corsicana Formation and are the only two localities in North Central Texas observed to be in contact with the overlying Paleocene Kincaid Formation. Both sites differ in their faunal composition from all other localities in North Central Texas by lacking *Globotruncana contusa* (Cushman), *G. navarroensis* n. sp., *G. patelliformis* Gandolfi, and *G. plummerae* Gandolfi (text figs. 7, 8). Although

RARE ✱ COMMON ◐ ABUNDANT ●

TX9XC	TX9AC	TX9XD	TX9AD	TX9XE	Species
Rare	Rare		Common	Abundant	Guembelitria cretacea Cushman
			Rare	Common	Gublerina robusta de Klasz
			Rare	Abundant	Heterohelix globrans (Cushman)
Rare	Rare	Rare	Common	Abundant	Heterohelix navarroensis Loeblich
	Rare		Rare	Abundant	Heterohelix striata (Ehrenberg)
			Common	Abundant	Planoglobulina brazoensis Martin
		Rare	Common	Abundant	Planoglobulina carseyae (Plummer)
				Abundant	Pseudoguembelina cornuta Seiglie
			Rare	Common	Pseudoguembelina costulata (Cushman)
				Common	Pseudoguembelina excolata (Cushman)
	Rare	Rare	Common	Abundant	Pseudoguembelina kempensis Esker
			Rare	Abundant	Pseudoguembelina palpebra Brannimann and Brown
		Rare	Common	Abundant	Pseudotextularia deformis (Kikoine)
			Rare	Common	Pseudotextularia elegans (Rzehak)
				Common	Racemiguembelina fructicosa (Egger)
			Common	Common	Racemiguembelina powelli, n. sp.
				Rare	Ventilabrella multicamerata de Klasz
			Rare	Common	Globigerinelloides multispina (Lalicker)
		Rare	Rare	Abundant	Globerinelloides prairiehillensis Pessagno
			Rare	Common	Globigerinelloides (?) rosebudensis, n. sp.
				Common	Globigerinelloides subcarinatus (Bronnimann)
				Common	Globigerinelloides. volutus (White)
				Rare	Globigerinelloides sp. a
		Rare	Rare	Common	Loeblichella hessi. (Pessagno)
Rare	Rare	Rare	Rare	Abundant	Globotruncna aegyptiaca Nakkady
			Rare	Common	Globotruncana arca (Cushman)
				Common	Globotruncana conica White
				Common	Globotruncana duwi Nakkady
			Rare	Abundant	Globotruncana elevata (Brotzen)
			Rare	Abundant	Globotruncana gansseri Bolli
			Rare	Abundant	Globotruncana stephensoni Pessagno
				Common	Globotruncana stuartiformis Dalbiez
Rare	Rare	Rare	Rare	Abundant	Globotruncana trinidadensis Gandolfi
				Common	Rugoglobigerina hexcamerata Bronnimann
			Rare	Common	Rugoglobigerina macrocephala Bronnimann
			Rare	Abundant	Rugoglobigerina milamensis, n. sp.
				Common	Rugoglobigerina pennyi Bronnimann
				Common	Rugoglobigerina reicheli Bronnimann
			Rare	Abundant	Rugoglobigerina rotundata Bronnimann
Rare	Rare	Rare	Common	Abundant	Ruglobigerina rugosa (Plummer)
			Rare	Abundant	Rugoglobigerina scotti (Bronnimann)
	Rare		Common	Common	Globotruncanella monmouthensis (Olsson)
		Rare	Rare	Abundant	Globotruncanella petaloidea (Gandolfi)
				Rare	Globotruncanella sp. a

TEXT FIGURE 8

Distribution and relative abundance of planktonic foraminifera occurring in the Corsicana Formation (Locality TX9) along Walkers Creek, Milam County, Texas. Rare = 1 to 3 individuals; Common = 4 to 10 individuals; Abundant = greater than 10 individuals.

the absence of these species is probably due to environmental fluctuation during the deposition of the upper portions of Corsicana Formation, an analysis of the benthonic fauna which could confirm such an environmental conclusion is beyond the scope of the present report, and must await further investigation.

SYSTEMATIC PALEONTOLOGY

Morphologic Terminology

The morphologic terminology proposed for the planktonic foraminifera by Bolli, et al. (1957, pp. 9–15) has been adopted for use in the present publication. The following terms are defined in order to minimize the confusion resulting from the lack of a widespread and acceptable morphological nomenclature.

Apertural view, the edge view of biserial, planispiral, or trochospiral tests in which the apertural opening is orientated "upward" or facing the observer (Pl. 9, fig. 1).

Abapertural view, the edge view of biserial, planispiral, or trochospiral tests in which the apertural opening is orientated "downward" or away from the observer (Pl. 9, fig. 3).

Lateral view, the side view of biserial and multiserial tests of the family *Heterohelicidae* (Pl. 2, fig. 8).

Ultimate chamber, the final or last-formed chamber (see Explanation, Pl. 2, fig. 8).

Penultimate chamber, the chamber immediately preceding the ultimate chamber (see Explanation, Pl. 2, fig. 8).

Antipenultimate chamber, the chamber immediately preceding the penultimate chamber, or the second from the last-formed chamber (see Explanation, Pl. 2, fig. 8).

Ponticulus (–i), a new term proposed for the cover plate(s) over the central cavity of *Racemiguembelina* (see Remarks under *R. fructicosa*).

Foraminiferal Classification

The identification of the foraminiferal species in the Corsicana Formation of North Central Texas has been conducted through comparative studies with previously published Upper Cretaceous literature, as well as through the examination of both primary and secondary type material. Comparative slides and washed residues from stratigraphic units other than the Corsicana Formation were used extensively in establishing stratigraphic ranges for species encountered in the Corsicana Formation.

The generic and suprageneric classification follows the "Treatise on Invertebrate Paleontology", Part C, Protista 2, Volume 2 (Loeblich and Tappan, 1964) with emendation by Pessagno (1967).

Deposition of Types

The holotype and two paratypes of new species will be deposited in the U. S. National Museum, Washington, D. C. Remaining paratypes will be filed in the Pessagno Collection at The University of Texas at Dallas. Hypotypes, faunal slides, and washed residues will remain in the possession of the authors.

Sample Preparation and Illustration

The method of sample preparation outlined by Pessagno (1967, p. 375) was followed throughout this investigation.

Following specific identification with the light microscope, selected specimens were chosen for scanning electron microscope examination. Individual specimens were mounted on 13 mm. diameter coverslips which were previously glued to T-shaped brass plugs. All specimens were shadow-cast (see Urban and Padovani, 1970, pp. 137–139) with a 60 percent gold/40 percent palladium alloy in a Denton DV-502 vacuum evaporator. Specimen plugs were then transferred to a JEOLCO JSM-1 Scanning Electron Microscope for examination and photographic illustration.

SYSTEMATIC DESCRIPTIONS

Superfamily GLOBIGERINACEA

Family HETEROHELICIDAE Cushman

Subfamily GUEMBELITRIINAE Montanaro Gallitelli

Genus **Guembelitria** Cushman, 1933

Type species.–Guembelitria cretacea Cushman, 1933.

Remarks.–The diagnosis of Loeblich and Tappan (1964, p. C652) is followed herein.

Guembelitria cretacea Cushman

Plate 1, figures 1, 2–3, 4–5, 6, 7–8.

1933. *Gumbelitria cretacea* Cushman, pp. 37–38, pl. 4, figs. 12a–b.
1936. *Gumbelitria cretacea* Cushman. Cushman, p. 418, pl. 1, figs. 12a–b.
1936. *Gumbelitria cretacea* Cushman. Jennings, p. 28, pl. 3, figs. 12a–b.
1938. *Gumbelitria cretacea* Cushman. Cushman, p. 19, pl. 3, figs. 14a–b.
1941. *Gumbelitria cretacea* Cushman. Cushman and Hedberg, pp. 91–92, pl. 22, fig. 17.
1943. *Gumbelitria cretacea* Cushman. Cushman and Todd, p. 65, pl. 11, fig. 16.
1946. *Gumbelitria cretacea* Cushman. Cushman, p. 103, pl. 44, figs. 14a–c.
1948. *Gumbelitria cretacea* Cushman. Cushman, p. 259, pl. 24, fig. 12(?).
1957. *Guembelitria cretacea* Cushman. Gallitelli, p. 136, pl. 31, figs. 1a–b.
1960. *Guembelitria cretacea* Cushman. Olsson, pp. 27–28, pl. 4, fig. 8.
1962. *Guembelitria cretacea* Cushman. Skinner, p. 38, pl. 5, fig. 13.
1964. *Guembelitria cretacea* Cushman. Loeblich and Tappan, p. C652, fig. 523: 1a–b.
1964. *Guembelitria cretacea* Cushman. Said and Sabry, p. 390, pl. 3, fig. 32.
1965. *Guembelitria cretracea* Cushman. Perlmutter and Todd, p. I 13, pl. 2, fig. 8.
1967. *Guembelitria cretacea* Cushman. Bandy, p. 23, text-fig. 12 (6).
1967. *Guembelitria cretacea* Cushman. Pessagno, p. 258, pl. 87, figs. 1, 2, 3.
1970. *Guembelitria cretacea* Cushman. Olsson, p. 601, pl. 91, figs. 1a–b, 2, 4a–c, 5, 6, 7, 9; pl. 92, figs. 1, 3a–b, 4a–b.

Description.–Test small, triserial throughout; chambers globular, spherical, increasing rapidly in size as added; sutures strongly depressed; wall finely perforate, each pore surrounded by a blunt cone of microgranular calcite; wall of ultimate chamber usually smooth or showing weakly developed pore cones; aperture interiomarginal, highly arched, semicircular, occasionally asymmetrically directed, bordered by a thickened rim.

Remarks.–Guembelitria cretacea Cushman displays a distinctive and unusual pore pattern. Each chamber is covered with circular to elliptically-shaped pore cones. A single pore, rarely two pores, penetrates each pore cone (Pl. 1, figs. 3, 8). In areas where the pores are closely spaced, the raised margins of the pore cones will often merge into linear, flattened, ridge-like structures (Pl. 1, fig. 5). The distinctive pore cone morphology has been observed on all individuals of *G. cretacea* examined to date.

The only other species of *Guembelitria* known to the writers, *Guembelitria harrisi* Tappan (1940, p. 115), was examined with the scanning electron microscope; its chamber walls were likewise found to have well-developed pore cones (Pl. 2, figs. 1–2, 3). Although *G. harrisi* Tappan and *G. cretacea* Cushman are similar in test shape, chamber arrangement, and wall ornamentation, *G. harrisi* differs in having a low and only slightly arched aperture. In addition, *G. harrisi* is known only from the late Albian through Cenomanian whereas *G. cretacea* is a middle Maestrichtian species. That no species of *Guembelitria* are known from the Turonian through the early Maestrichtian is puzzling, but may be due in part to the occurrence of *Guembelitria* in shallow to middle neritic marine environments.

Olsson (1970, p. 601) described the unusual pore pattern of *Guembelitria cretacea* in his study of specimens from the Cretaceous Redbank Formation of New Jersey and from "triserial forms" from the Paleocene Pine Barren Member of the Clayton Formation in Alabama. Although Olsson stated that his "triserial forms" have a pore pattern basically identical with that of *Guembelitria cretacea,* he believed them to be related to *Chiloguembelina* and to

Globoconusa because of differences in apertural shape. Olsson continues. . . "Thus the transition from *Guembelitria* to *Chiloguembelina* involves the development of an asymmetrically directed aperture, of which an apertural flange is a consequence, and of a terminal biserial stage."

The occurrence of numerous, typical *G. cretacea* with asymmetrically directed apertures in the Corsicana Formation of Texas (Pl. 1, figs. 2, 7) suggests that the asymmetric apertures have no particular phylogenetic significance. Olsson (1970, p. 600) notes that the basal Paleocene (lower few centimeters) at Millers Ferry contains reworked Cretaceous Foraminifera. It seems probable, therefore, that the "transitional triserial form" with an asymmetric aperture merely represents reworked Cretaceous *Guembelitria cretacea.*

In addition to variation in apertural shape, *G. cretacea* shows marked variation in length of the test as well as degree in inflation of the ultimate few chambers.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone.

Occurrence.–The type locality of *Guembelitria cretacea* Cushman is in a clay pit of the Seguin Brick and Tile Company, 0.8 miles south of McQueeny, Guadalupe County, Texas, exposing the Corsicana Formation.

Numerous reports of this species have shown it to be restricted to middle and late Navarroan strata in the Gulf Coastal Plain area. *G. cretacea* has been reported from the Corsicana Formation in Texas by Cushman (1933, p. 38; 1938, p. 19; 1946, p. 103), Cushman and Todd (1943, p. 65), and Pessagno (1967, p. 258), as well as from the Arkadelphia Marl in Arkansas (Skinner, 1962, p. 38; Pessagno, 1967, p. 258) and the Prairie Bluff Formation and basal Paleocene in Alabama (Olsson, 1970, p. 598).

Guembelitria cretacea has been reported from the late Cretaceous of the Atlantic Coastal Plain by Cushman (1936, p. 418; 1948, p. 244), Jennings (1936, p. 28, Olsson (1960, p. 28), and Perlmutter and Todd (1965, p. I 13). It has also been recorded from the Maestrichtian of Egypt (Said and Sabry, 1964, p. 390) and Colombia (Cushman and Hedberg, 1941, p. 92).

The occurrence of *G. cretacea* in the Corsicana Formation of Texas is shown in text figs. 4–8.

Subfamily HETEROHELICINAE Cushman

Genus **Gublerina** Kikoine, 1948

Type species.–*Gublerina cuvilieri* (= *Ventilabrella ornatissima* Cushman and Church, 1929).

Remarks.–The diagnosis of Loeblich and Tappan (1964, pp. C654–C655) is followed herein.

Gublerina robusta de Klasz

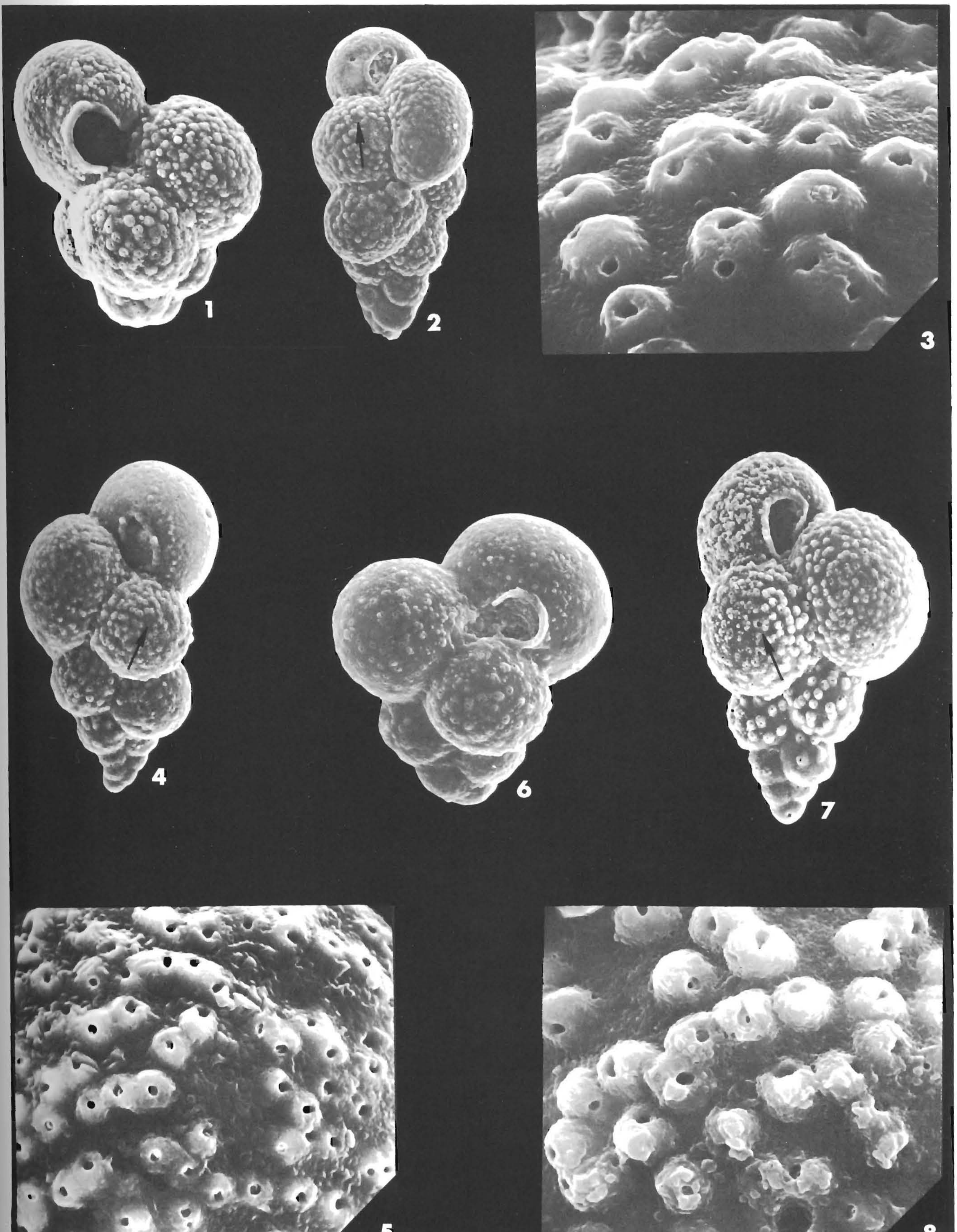
Plate 2, figures 4–5, 6–7

1941. (?) *Ventilabrella reniformis* MARIE, p. 264, pl. 28, figs. 277a–c.
1953. *Gublerina acuta* DE KLASZ, p. 246, pl. 8, figs. 3a–b.
1953. *Gublerina acuta* subsp. *robusta* DE KLASZ, p. 247, pl. 8, figs. 4a–b, 5a–b.
1953. *Gublerina hedbergi* BRONNIMANN and BROWN, p. 155, text-figs. 11a–b, 12a–b.
1957. *Gublerina acuta robusta* de Klasz. GALLITELLI, p. 141, pl. 32, fig. 9.
1965. *Gublerina acuta* de Klasz. PERLMUTTER and TODD, pp. I 14, I 15, pl. 2, fig. 18.
1967. *Gublerina robusta* de Klasz. PESSAGNO, p. 265, pl. 75, fig. 11.
1969. *Gublerina reniformis* (Marie), BROWN, p. 59, pl. 2, fig. 6; pl. 4, figs. 3a–b, 4a–c.

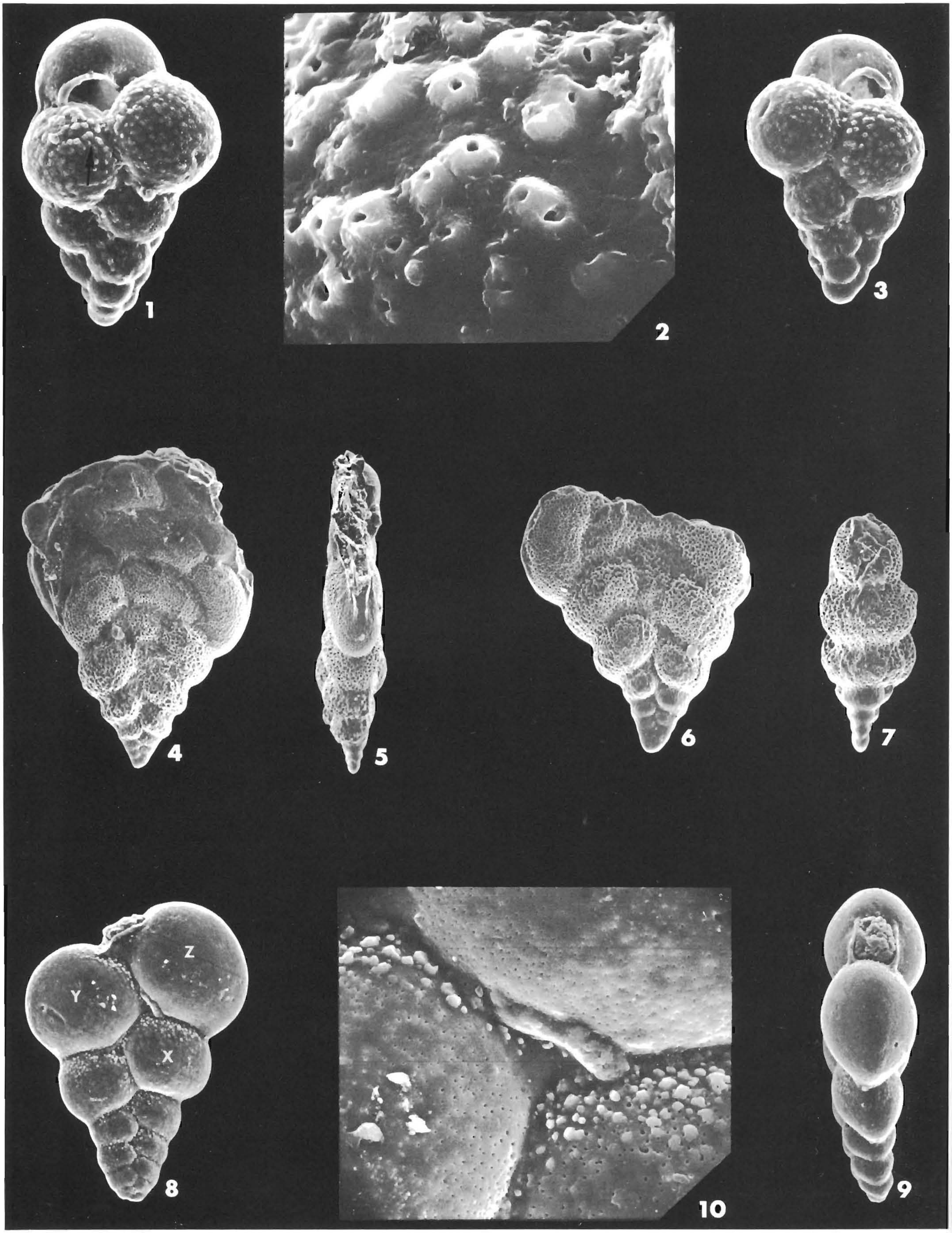
Description.–Test much compressed, triangular in outline; initial chambers showing planispirally coiled early stage, followed by a biserial intermediate stage; in final stage chambers diverging, arranged in two series with a broad, nonseptate or incompletely divided, depressed central area; occasionally showing proliferation of chambers terminally; initial portion of test in lateral view weakly lobate, becoming distinctly lobate terminally; initial chambers flattened, increasing gradually in size as added; later chambers becoming strongly inflated, tending to become somewhat reniform; sutures distinct, initially almost straight, oblique, and flush, later becoming distinctly depressed, curved, and limbate; wall of early chambers exhibit fine longitudinal costae; all later chambers with roughened vermicular ornamentation which tends to be more strongly developed apically than abapically; apertures not observed due to damage of ultimate portion of tests.

PLATE 1

		Page
1.	*Guembelitria cretacea* Cushman .... TX20XA-11A26. Note strongly inflated terminal chambers, well-developed pore cones, and symmetrical aperture; 415×.	15
2–3.	*Guembelitria cretacea* Cushman .... TX3BA-0B48. 2, Note elongate test and asymmetrical aperture; 210×. 3, Enlargement showing pore cone morphology; 2750×.	15
4–5.	*Guembelitria cretacea* Cushman .... TX3BA-1. 4, Individual with elongate test and symmetrical aperture; 310×. 5, Enlargement showing pore cones which have merged into linear, flattened, ridge-like structures; 2060×.	15
6.	*Guembelitria cretacea* Cushman .... TX3BA-0B50. Individual with symmetrical aperture; 480×.	15
7–8.	*Guembelitria cretacea* Cushman .... TX3BA-12BA24. 7, Note elongate test, asymmetrical aperture, and poorly developed pore cones on initial portion of test; 340×. 8, Enlargement showing pore cone morphology; 690×.	15



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS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Remarks.–De Klasz (1953, pp. 246–247) described *Gublerina acuta* and the subspecies *G. acuta robusta.* Studies of populations of this species indicate that *G. acuta* is an immature individual, and that the subspecies *G. acuta robusta* is typical of mature forms. The two are considered to be the same species, and the name given by de Klasz to the mature form, *G. robusta,* is retained herein.

According to Bronnimann and Brown (1954, p. 62), *Gublerina acuta robusta* de Klasz (1953) is a senior synonym of *G. hedbergi* Bronnimann and Brown (1953).

Brown (1969, p. 59) regarded *G. robusta* as a junior synonym of *Ventilabrella reniformis* Marie. Examination of the figures of the holotype of *V. reniformis* (Marie, 1941, pl. 28, fig. 277; Brown 1969, pl. 4, figs. 4a–c) leaves some doubt as to whether these forms are identical. It seems best, therefore, to retain the name *G. robusta* de Klasz until an examination is made of the types of *V. reniformis* Marie.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, *G. calcarata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The holotype of *Gublerina robusta* de Klasz (1953, pl. 8, figs. 4a–b) is from the Maestrichtian "Bucheck beds", south of Siegsdorf, Bavaria. The figured paratype (ibid., pl. 8, figs. 5a–b) is from Maestrichtian strata south of Gan, southwestern France. De Klasz (ibid., p. 247) also noted the presence of *G. robusta* in the late Maestrichtian Mendez Shale at its type locality near Mendez Station, Veracruz, Mexico.

De Klasz (1953, p. 246) noted *Gublerina acuta* (herein considered a junior synonym of *G. robusta*) from the Maestrichtian of Bavaria, France, southwestern Sinai, Egypt, and from the Mendez Shale near Veracruz, Mexico.

Bronnimann and Brown (1953, p. 150, 155) described *Gublerina hedbergi* from the late Maestrichtian of Cuba, and noted its occurrence in the Kemp Clay in Texas. Perlmutter and Todd (1965, p. I 14) noted *G. robusta* in the Late Cretaceous Monmouth Group in Suffolk County, New York. Pessagno (1967, p. 265) found this species in the Mendez Shale in Mexico and Corsicana Marl in Texas.

Genus **Heterohelix** Ehrenberg, 1843

Type species.–*Spiroplecta americana* Ehrenberg, 1844.

Remarks.–The diagnosis of Loeblich and Tappan (1964, pp. C652–C653) is followed herein.

Heterohelix glabrans (Cushman)

Plate 2, figures 8–10; Plate 3, figures 1–3

1936. *Guembelina tessera* CUSHMAN, p. 418, pl. 1, figs. 9a–b.
1938. *Guembelina glabrans* CUSHMAN, p. 15, pl. 3, figs. 1a–b, 2.
1941. *Guembelina glabrans* Cushman. CUSHMAN and HEDBERG, p. 92, pl. 22, figs. 16a–b.
1943. *Guembelina glabrans* Cushman. CUSHMAN and TODD, p. 64, pl. 11, fig. 14.
1946. *Guembelina glabrans* Cushman. CUSHMAN, p. 109, pl. 46, figs. 17a–b, 18.
1960. *Heterohelix glabrans* (Cushman). OLSSON, pp. 26–27, pl. 4, fig. 4.
1967. *Heterohelix glabrans* (Cushman). PESSAGNO, p. 259, pl. 88, figs 1–2, 10–11.

Description.–Test biserial, much compressed, about twice as long as broad, tapering throughout; chambers flattened initially, becoming slightly inflated terminally, about as high as broad, increasing rapidly in size as added; sutures distinct, straight to very slightly curved; oblique, flush to slightly depressed initially, becoming strongly depressed terminally; wall very weakly pustulose initially, latter chambers noncostate, smooth, finely perforate throughout; primary aperture interiomarginal, a high, narrow, rectilinear opening with a lip and flanges along its sides; sutural supplementary apertures present in adult individuals.

Remarks.–Scanning electron micrographs of this species show small, narrow, sutural supplementary apertures on each side of the test at the base of preceding chambers near the median line of the test (Pl. 2, fig. 10; Pl. 3, fig. 3).

PLATE 2

		Page
1–2.	*Guembelitria harrisi* Tappan .... PTX329-D7. Britton Formation, Dallas Co., Texas. 1, Note low and broadly-arched aperture diagnostic of this species; 275×. 2, Enlargement showing pore cone morphology identical to *G. cretacea* Cushman; 2060×.	15
3.	*Guembelitria harrisi* Tappan .... PTX329-D5. Britton Formation, Dallas Co., Texas; 275×.	15
4–5.	*Gublerina robusta* de Klasz .... TX4AB-5AA21. Note widely-flaring compressed test and vermicular ornamentation; 80×.	16
6–7.	*Gublerina robusta* de Klasz .... TX4AC-12. Individual with fine longitudinal costae on initial chambers, and strongly inflated medial and terminal chambers with vermicular ornamentation; 105×.	16
8–10.	*Heterohelix glabrans* (Cushman) .... TX2AA-7. 8, Note smooth, polished test, rapid increase in size of chambers, and sutural supplementary apertures; 165×. X = Antipenultimate chamber; Y = Penultimate chamber; Z = Ultimate chamber. 9, Apertural view showing narrow, highly-arched, rectilinear primary aperture; 165×. 10, Enlargement showing sutural supplementary aperture with well-developed lip. Note fine pores penetrating chamber walls; 690×.	17

These apertures are indistinct in the initial stage, become more distinct, larger, and often show a well-developed lip. In the later stage these lips often overlap the two preceding chambers (Pl. 2, fig. 10).

H. glabrans Cushman differs from *H. globulosa* (Ehrenberg) in being more compressed laterally, in having non-costate, smooth and polished final chambers, and in having a rather high and narrow primary aperture.

Heterohelix glabrans is distinguished from *H. pulchra* (Brotzen) by having a polished test, and terminal chambers which are almost as broad as high, rather than broadened or reniform shaped chambers.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone.

Occurrence.–Cushman (1936, p. 418) initially recorded this species as *Guembelina tessera* (Ehrenberg) from Late Cretaceous strata exposed along the walls of the Georges Bank Canyons.

The type locality of *Heterohelix glabrans* (Cushman) is the exposure of Kemp Clay (= Corsicana Formation) along the branch of Mustang Creek, one mile west-southwest of Noack, Williamson County, Texas.

Cushman and Todd (1943, p. 64) reported *H. glabrans* from several localities in the Corsicana Formation of Texas. Pessagno (1967, p. 259) recorded its occurrence at the type locality of the Mendez Shale in Mexico, in the Corsicana Formation of Texas, and in the Arkadelphia Marl of Arkansas. Cushman (1946, p. 109) recorded *H. glabrans* in the upper portion of the Selma Chalk of Tennessee and the Prairie Bluff Chalk of Alabama. Olsson (1960, pp. 26–27) found it in the Redbank and New Egypt Formations of New Jersey, and noted its occurrence in the Navesink Formation. *H. glabrans* also occurs in the upper portion of the Colon Formation in Columbia, South America (see Cushman and Hedberg. 1941, p. 92). Its occurrence in the Corsicana Formation of Texas is shown in text figs. 4–8.

Heterohelix navarroensis Loeblich

Plate 3, figures 4–5, 6–7

1844. *Spiroplecta americana* EHRENBERG, p. 75.
1854. *Spiroplecta americana* EHRENBERG, p. 24, pl. 32, I, figs. 13–14; pl. 32, II, fig. 25.
1951. *Heterohelix navarroensis* LOEBLICH, pp. 107–108, pl. 12, figs. 1, 2, 3a–b; text-fig. 2.
1951. *Heterohelix americana* (Ehrenberg). LOEBLICH, p. 108, text-fig. 1.
1957. *Heterohelix navarroensis* Loeblich. GALLITELLI, p. 137, pl. 31, figs. 5a–b, 6, 7, 8, 9, 10, 11.
1960. *Heterohelix navarroensis* Loeblich. OLSSON, p. 27, pl. 4, fig. 5.
1962. Not *Heterohelix navarroensis* Loeblich. PESSAGNO, p. 358, pl. 1, fig. 4.
1964. *Heterohelix americana* (Ehrenberg). LOEBLICH and TAPPAN, pp. C652–C654, fig. 523: 5a–b.
1967. *Heterohelix navarroensis* Loeblich. PESSAGNO, p. 261, pl. 89, figs. 8–9.
1969. *Heterohelix navarroensis* Loeblich. BROWN, pp. 33–34, pl. 1, figs. 1, 2, 3, 4, 5, 6a–b.

Description.–Test biserial, slightly compressed laterally, tapering throughout; initial chambers arranged in a flattened planispiral coil, early biserial chambers slightly inflated, increasing rather slowly in size as added; terminal four or five biserial chambers becoming inflated and subglobular; sutures distinct, straight, slightly oblique, flush initially, becoming depressed terminally; wall faintly costate, finely perforate; aperture interiomarginal, symmetrical, a low arch with slight lip and flanges.

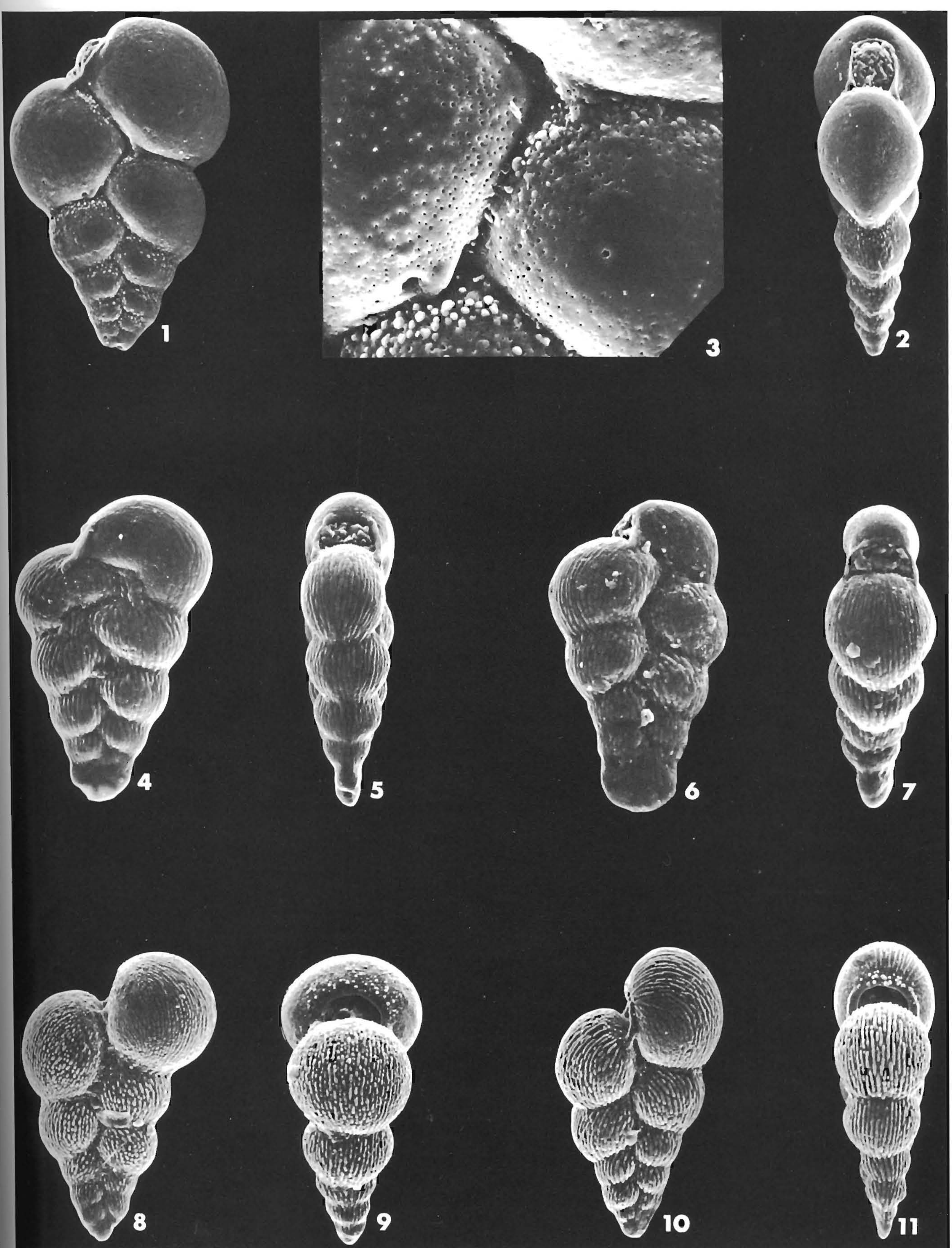
Remarks.–Loeblich (1951, p. 108) noted a difference in surface ornamentation and chamber shape between Ehrenberg's illustration of *Spiroplecta americana* and the new species *H. navarroensis.* Although type material was not available for comparison, Loeblich considered the two synonymous until further study might prove otherwise. Later, Loeblich and Tappan (1964, p. C654) stated that specimens from the Selma Chalk of Mississippi (which may be regarded as topotypes) showed *Heterohelix americana* (Ehrenberg) and *H. navarroensis* to be synonymous, and considered *H. navarroensis* a junior synonym of *H. americana.*

In a detailed study of the Heterochelicidae, Brown (1969, p. 34) agreed with Loeblich and Tappan (1964, p. C654), but concluded that since *Spiroplecta americana* Ehrenberg, 1844, was a junior secondary homonym of *Textilaria americana* Ehrenberg, 1843, the existing name *H. navarroensis* Loeblich should be retained as the name for this species. The conclusion reached by Brown is tentatively followed herein.

Heterohelix navarroensis Loeblich is similar to *H. stri-*

PLATE 3

		Page
1–3.	*Heterohelix glabrans* (Cushman) .... TX2AA-6. 1–2, Individual with fine longitudinal costae on initial chambers; 185×. 3, Enlargement showing sutural supplementary apertures with poorly-developed lips; 620×.	17
4–5, 6–7.	*Heterohelix navarroensis* Loeblich .... 4–5, TX4AC-15B34, 275×; 6–7, TX2AB-8, 310×. Note compressed test, flattened initial planispiral coil, and fine longitudinal costae.	18
8–9, 10–11.	*Heterohelix striata* (Ehrenberg) .... 8–9, TX20XA-14A54, 165×; 10–11, TX3BA-14C14, 155×. Note globular to spherical chambers terminally, rather coarse, discontinuous costae, and the broad, highly-arched aperture.	19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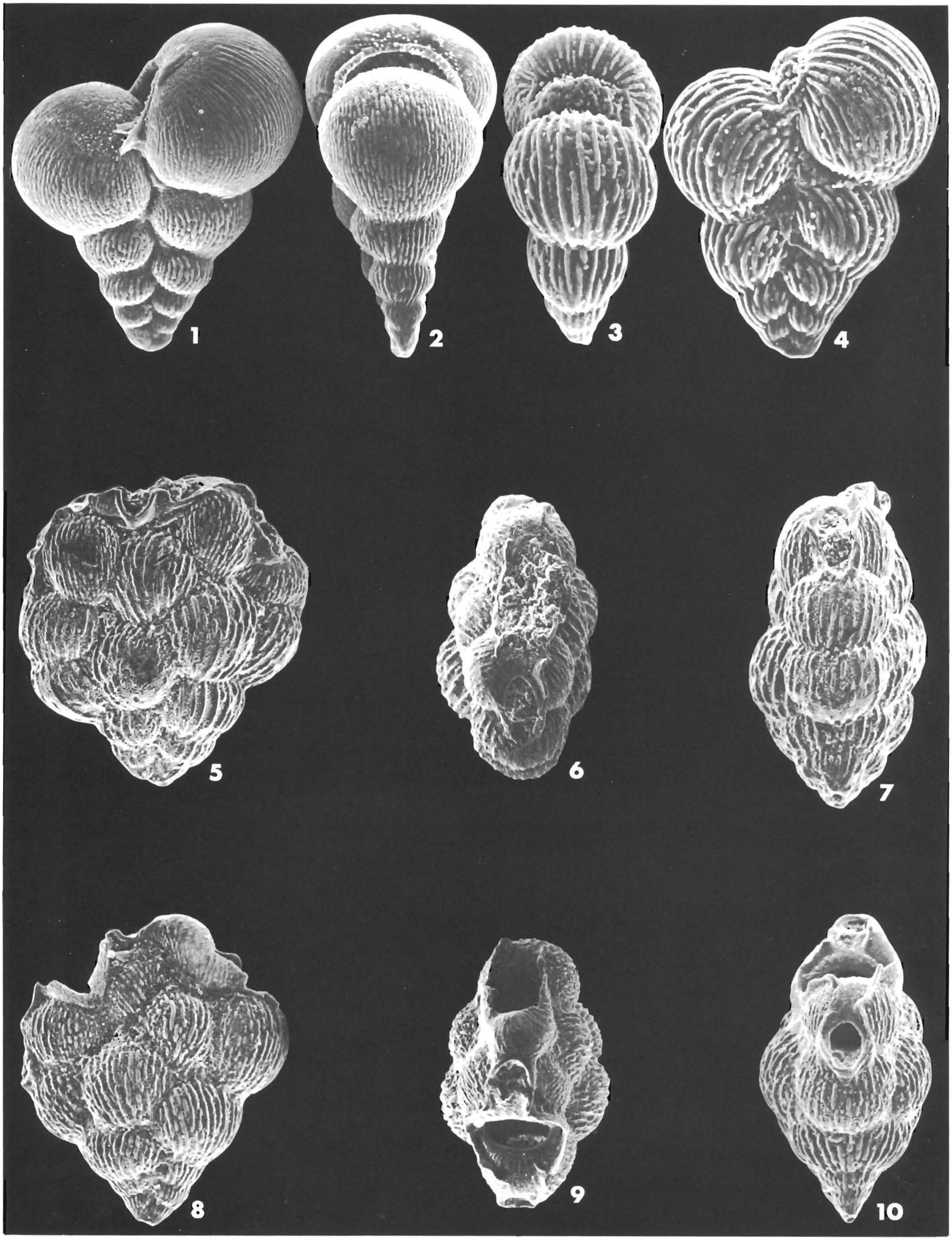
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ata (Ehrenberg) but differs in being generally smaller in size, in usually possessing an initial coiled stage, in the test being laterally compressed, and in being much more finely costate.

Range.–G. fornicata-stuartiformis Assemblage Zone, *R. subcircumnodifer* Subzone, upper part of *R. subpennyi* Zonule to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–Loeblich (1951, p. 108) originally described *H. navarroensis* from the Kemp clay in a pit of the Seguin Tile and Brick Company near McQueeney, Guadalupe County, Texas. Loeblich (ibid.) also noted its presence in the Corsicana Formation near Austin, Travis County, Texas.

Olsson (1960, p. 27) noted this species from the Navesink, Redbank, and New Egypt Formations of New Jersey. Pessagno (1967, p. 261) reported *H. navarroensis* from the Corsicana Marl, San Miguel, and Escondido Formations of Texas, and the Arkadelphia Marl of Arkansas.

Heterohelix striata (Ehrenberg)

Plate 3, figures 8–9, 10–11;
Plate 4, figures 1–2, 3–4

1840. *Textilaria striata* EHRENBERG, p. 135, pl. 4, figs. 1 alpha, 1 alpha prime, 2 alpha, 3 alpha; not 9 alpha.
1946. *Guembelina striata* (Ehrenberg). CUSHMAN, pp. 104–105, pl. 45, figs. 4, 5.
1953. *Pseudoguembelina striata* (Ehrenberg). BRONNIMANN and BROWN, p. 154, text-fig. 6 (p. 151).
1962. *Heterohelix striata* (Ehrenberg). BERGGREN, pp. 21–22, pl. 6, figs. 1a–b, 2a–b, 3a–b, 4a–b, 5a–b.
1962. *Heterohelix navarroensis* Loeblich. PESSAGNO, p. 358, pl. 1, fig. 4.
1964. (?)*Pseudoguembelina striata* (Ehrenberg). SAID and SABRY, p. 394, pl. 3, fig. 21.
1967. *Heterohelix striata* (Ehrenberg). PESSAGNO, p. 264, pl. 78, figs. 4–5; pl. 88, figs. 3–4, 5, 6–7; pl. 98, fig. 16.

Description.–Test biserial, about twice as long as broad, tapering throughout; microspheric individuals sometimes showing initial planispiral coil; in lateral view weakly lobate initially, becoming strongly lobate terminally; initial chambers flattened, increasing gradually in size and degree of inflation as added; terminal chambers much inflated, globular to spherical; sutures distinct, curved, oblique, flush initially becoming strongly depressed terminally; wall with moderately well developed costae; costae closely spaced, generally following the contour of the chambers; ultimate chamber may be finely costate or smooth; primary aperture interiomarginal, a high, rather wide arch with lateral flanges; accessory apertures occasionally present at the base of the ultimate chamber near the median line of the test.

Remarks.–As noted by Pessagno (1967, p. 264), the taxonomic status of *H. striata* (Ehrenberg) has been somewhat uncertain. Ehrenberg's figured specimens of *Textilaria striata* were collected from a number of geographic localities (Denmark, Germany, Poland) and stratigraphic horizons. Pessagno (ibid.) formally designated figure 2 alpha of Ehrenberg (1840, pl. 4) as the lectotype figure and lectotype specimen of *T. striata.* The type locality and type lithic unit were designated by Pessagno (ibid.) as the Kjolby Gaard Marl at Kjolby Gaard, Jutland, Denmark (see Berggren, 1962, pl. 5, fig. 1).

Heterohelix striata is similar to *H. globulosa* (Ehrenberg), but differs in having the test surface ornamented with well-developed medium costae.

Studies of numerous individuals of *H. striata* from the Corsicana Formation of Texas show there to be considerable variation in chamber shape and in the degree of chamber inflation. A peculiar form, rare in the material examined, and herein referred to *Heterohelix* sp. aff. *H. striata* (Pl. 4, figs. 3–4), differs from the typical in the presence of rather widely spaced and massive costae. Further investigation, beyond the scope of the present study, may prove this form to be a distinct new species.

Range.–G. fornicata-stuartiformis Assemblage Zone, *A. blowi* Subzone, *D. multicostata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence. –Heterohelix striata is a common species in the Campanian and Maestrichtian of the Gulf Coastal Plain (Pessagno, 1967, p. 264; 1969, Sheet 1, pl. 3; Cushman, 1946, p. 105). It has been recorded from the Maestrichtian of Cuba (Bronnimann and Brown, 1953, p. 154), Campanian and Maestrichtian of Puerto Rico (Pessagno, 1962, p. 358), as well as the Maestrichtian of Scandinavia (Berggren, 1962, pp. 21–22), Europe (Ehrenberg, 1840, p. 135) and northern Africa (Said and Sabry, 1964, p. 394). Its occurrence in the Corsicana Formation of Texas is shown in text figs. 4–8.

PLATE 4

		Page
1–2.	*Heterohelix striata* (Ehrenberg) .... TX3BA-14B51. Individual with planispirally coiled initial stage. Note spherical to subspherical chambers and strongly lobate test; 210×.	19
3–4.	*Heterohelix* sp. aff. *H. striata* (Ehrenberg) .. TX2AA-4. Note massive, widely-spaced and discontinuous costae; 210×.	19
5–7, 8–10.	*Planoglobulina brazoensis* Martin .... 5–7, Holotype, TX9AH-17A30, 105×; 8–10, TX20XA-17A55, 105×. Note flabelliform, inflated test; inflated chambers in the initial portion of the multiserial stage which are somewhat offset laterally from the plane of biseriality; and the chambers terminally which are realigned in a single plane.	20

Genus **Planoglobulina** Cushman, 1927

Type species.–Planoglobulina acervulinoides Egger, (1899).

Remarks.–Cushman (1927b, p. 77) proposed the genus *Planoglobulina* and selected *Guembelina acervulinoides* Egger (1899) as its type species. The following year, Cushman (1928, p. 3), in his description of *Ventilabrella*, selected Egger's figure 20 (1899, pl. 14) as the lectotype of *Planoglobulina acervulinoides* (Egger). Examination of the lectotype figure of *Guembelina acervulinoides* (ibid., pl. 14, fig. 20; Brown, 1969, pl. 3, fig. 2) reveals that the specimen does not conform to the description of *Planoglobulina* presented by Cushman (1927b, p. 77); that is, the chambers comprising the test do not all lie in a single plane. Rather, the specimen probably belongs to *Racemiguembelina* Gallitelli. A reexamination of the lectotype and confirmation of its morphology is impossible since the specimen was in the Egger Collection in Munich and destroyed during World War II.

In a recent study of *Ventilabrella* and *Planoglobulina*, Martin (1972, p. 81) selected a neotype for *Planoglobulina acervulinoides* (Egger) from the Gerhartsreiter Schichten Adelholzen (one of several localities cited by Egger, 1899, p. 36) from near Siegsdorf, approximately 100 kilometers southeast of Munich, Germany. As reinstated, *Planoglobulina*, like *Ventilabrella*, includes forms with a proliferation of chambers which terminally lie in a single plane. Distinguishing characteristics of *Planoglobulina* (as applied by Martin, ibid.) are the strongly inflated test in the biserial stage and initial portion of the multiserial stage (as observed in edge view), and the medium to coarse longitudinal costae.

Planoglobulina brazoensis Martin

Plate 4, figures 5–7, 8–10;
Plate 5, figures 1–2

1945. *Pseudotextularia elegans* Rzehak var. *acervulinoides* (Egger). Glaessner, pl. 10, figs. 15c–d.
1962. *Pseudotextularia* (*Racemiguembelina*) *fructicosa* (Egger). Berggren, pp. 22–24, pl. 6, figs. 6a–b.
1964. *Planoglobulina acervulinoides* (Egger). Loeblich and Tappan, pp. C655–C656, fig. 525: 4.
1967. *Planoglobulina acervulinoides* (Egger). Pessagno, p. 271, pl. 87, fig. 14.
1972. *Planoglobulina brazoensis* Martin, pp. 82–83, pl. 3, figs. 7a–c; pl. 4, figs. 1a–b, 2.

Remarks.–Planoglobulina brazoensis Martin differs from other species of *Planoglobulina* by having globular to spherical chambers which in the later stage of the biserial portion and early stage of the multiserial portion of the test are greatly inflated and somewhat offset laterally from the biserial arrangement (Pl. 4, figs. 6–7, 9–10; Pl. 5, fig. 2).

Planoglobulina brazoensis is similar to *P. carseyae* (Plummer) but differs in (1) the test being more broadly triangular and expanding much more rapidly in width as observed in lateral view; (2) the test in apertural view expanding much more rapidly in width; (3) the multiserial portion of the test comprising more than half the total height of the test, and (4) the terminal portion of the multiserial stage consisting of from five to seven inflated chambers.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Planoglobulina brazoensis* Martin is in an exposure of the uppermost Corsicana Formation (middle Maestrichtian, *R. fructicosa* Zonule) along the southern bank of Walkers Creek, Milam County, Texas (see Appendix, Locality TX9).

The specimen figured by Berggren (1962, pl. 6, figs. 6a–b) as *Pseudotextularia* (*Racemiguembelina*) *fructicosa* (Egger) from the late Maestrichtian, Kjolby Gaard Marl in Denmark, is a typical *Planoglobulina brazoensis* Martin.

During the course of this investigation, *P. brazoensis* has been observed in samples from numerous localities in the Corsicana Formation of North Central Texas (see text figs. 5–8), as well as in the Papagallos Shale (*R. fructicosa* Zonule) of Mexico (Appendix, Pessagno sample MX174). *Planoglobulina brazoensis* was not observed in the lower portion of the Corsicana Formation, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, exposed along Onion

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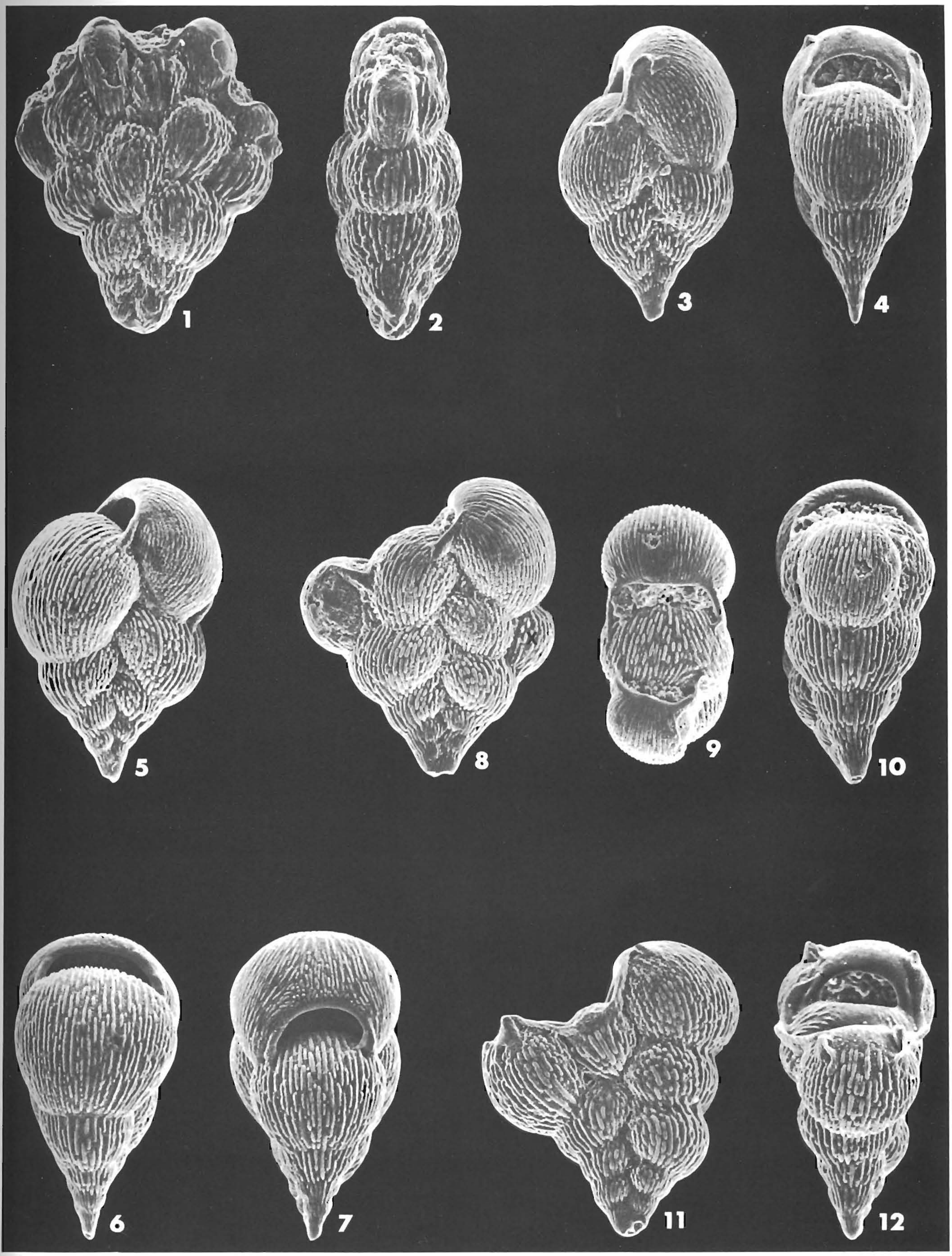
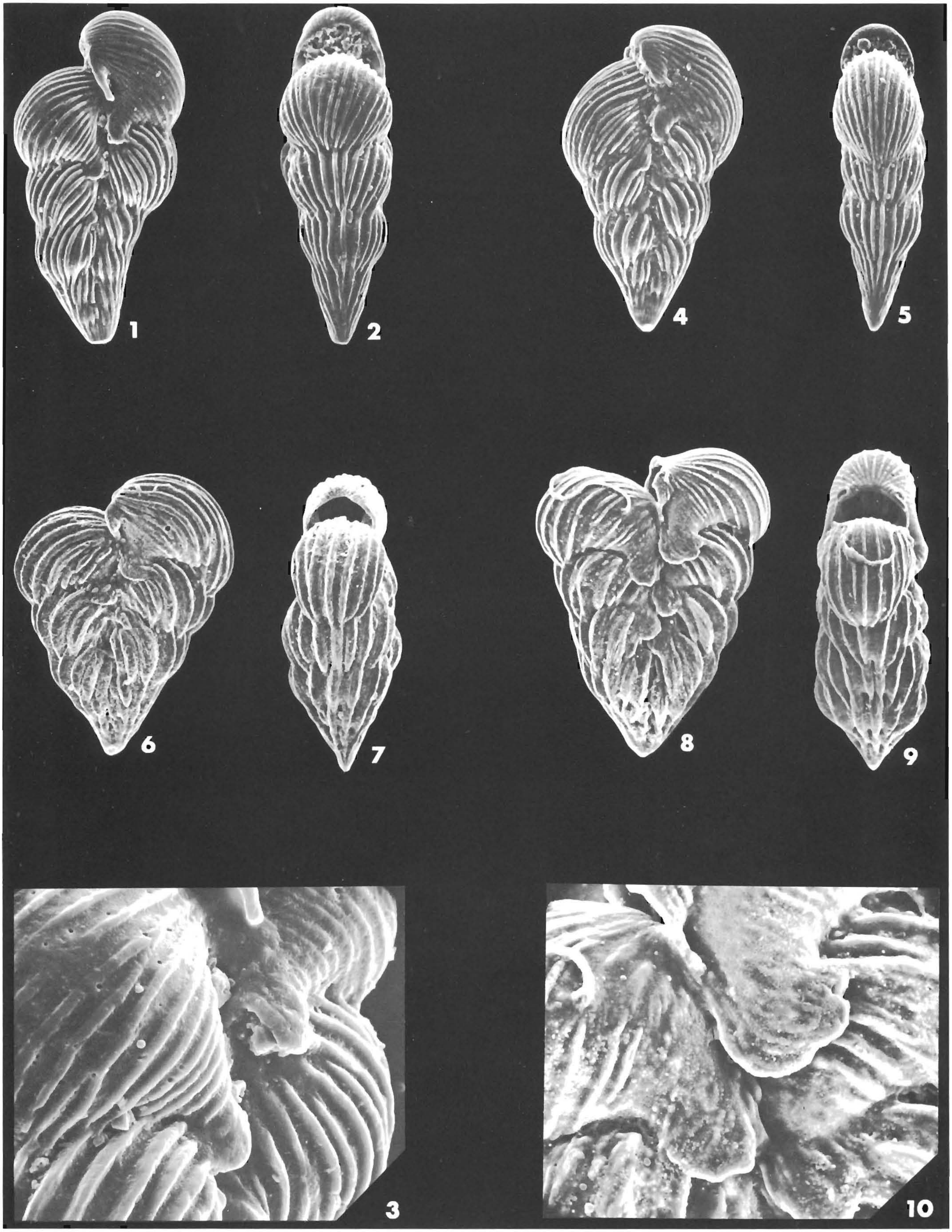
PLATE 5

		Page
1–2.	*Planoglobulina brazoensis* Martin .... TX9XF-17C16, Topotype; 120×.	20
3–4.	*Planoglobulina carseyae* (Plummer) .... TX3BA-18C15. Biserial individual showing axially elongate ultimate chambers. Note rather coarse, closely-spaced, and discontinuous costae; 120×.	21
5–7.	*Planoglobulina carseyae* (Plummer) .... TX3BA-8. Biserial individual with a supplementary aperture along the peripheral margin and at the base of the ultimate chamber; 140×.	21
8–10.	*Planoglobulina carseyae* (Plummer) .... TX4AC-17A36. Multiserial individual with three terminal chambers. Note primary apertures directed toward median line of test, and small supplementary chamber "X"; 125×.	21
11–12.	*Planoglobulina carseyae* (Plummer) .... TX20XA-18BA56. Multiserial individual. 11, Note that the median line of the terminal multiserial portion of the test is asymmetric with the median line of the initial biserial portion of the test; 125×.	21



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

Creek, Travis County, Texas (see Appendix, Locality TX25).

Planoglobulina carseyae (Plummer)

Plate 5, figures 3–4, 5–7, 8–10, 11–12

1931. *Ventilabrella carseyae* PLUMMER, pp. 178–179, pl. 9, figs. 7a–c, 8a–b, 9a–c; not fig. 10.
1938. *Ventilabrella carseyae* Plummer. CUSHMAN, pp. 26–27, pl. 4, figs. 20, 21a–b, 22, 23a–b, 24a–b.
1943. *Ventilabrella carseyae* Plummer. CUSHMAN and TODD, p. 65, pl. 11, fig. 18.
1946. *Ventilabrella carseyae* Plummer. CUSHMAN, p. 112, pl. 48, figs. 1a–b, 2, 3, 4a–b, 5a–b.
1957. *Planoglobulina carseyae* (Plummer). GALLITELLI, pl. 32, fig. 13.
1967. *Planoglobulina carseyae* (Plummer). PESSAGNO, pp. 271–272, pl. 87, figs. 10, 15, 16.
1969. *Pseudotextularia carseyae* (Plummer). BROWN, pp. 54–55, pl. 4, figs. 8a–b, 9a–b; text-figs. 11a–c, 12a–c.
1971a. *Heterohelix elegans* (Rzehak). EL-NAGGAR, pl. 7, figs. a, d–e.

Description.–Test biserial, earliest portion coiled, later portion biserial throughout; multiserial form initially biserial, lacking early planispiral coil, later portion of test becoming multiserial through development of supplementary chambers in the plane of biseriality, terminal portion of test usually consisting of but three chambers; early chambers flattened, increasing gradually in size as added, rapidly becoming globular to spherical; in later portion increasing only slightly in size as added; terminal few chambers in lateral view generally becoming elongate and extended axially; terminal supplementary chambers often smaller in size than preceding chambers; sutures initially flush, later becoming curved and strongly depressed; wall rather coarsely costate, costae closely spaced, discontinuous, generally following the contour of chamber surfaces; wall finely perforate; apertures interiomarginal, wide, rather highly arched to rectilinear openings, the outermost two terminal chambers each having a single basal aperture directed toward the median line of the test, or occasionally having supplementary apertures at the base of the outermost chambers.

Remarks.–Diagnostic characters of *Planoglobulina carseyae* (Plummer) are the unique chamber arrangement and apertural characters of multiserial individuals, and the tendency of both biserial and multiserial forms to have terminal chambers which are somewhat extended axially.

Examination of numerous individuals, including abundant topotypes of *Planoglobulina carseyae* (Plummer), shows a wide range of variation in chamber arrangement, chamber shape, and apertural characteristics. The terminal multiserial portion of the test tends to be asymmetric with the median line of the biserial early portion (Pl. 5, figs. 8, 11). A characteristic of these multiserial forms is the tendency of the multiserial portion to consist of but three chambers, although individuals will rarely have an additional supplementary chamber, or more, at the base of the outermost terminal chambers (Pl. 5, fig. 8).

In apertural character, the tendency of most multiserial individuals is to have a single, basal apertural opening on each of the two outermost terminal chambers directed toward the median line of the test (Pl. 5, figs. 9, 12). Less commonly, one or both of the outermost terminal chambers will possess a supplementary apertural opening along the peripheral margin at the base of the chamber, and directed toward the initial portion of the test.

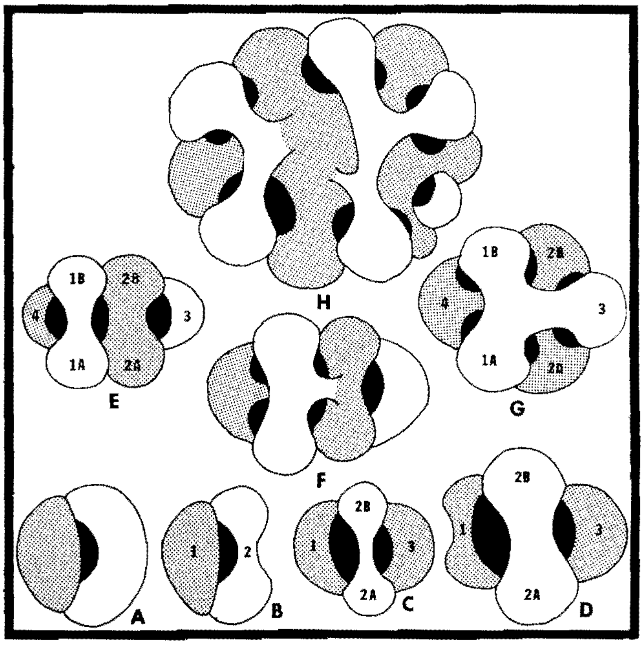
Planoglobulina carseyae (Plummer) is related to *P. brazoensis* Martin, but differs (1) in having a test which is subtriangular and expands uniformly in width in lateral view; (2) by the test in apertural view being acutely triangular and expanding uniformly but slowly in width; (3) by having five or six pairs of biserially arranged chambers prior to the initiation of multiserial development; and (4) by the terminal portion of the multiserial form consisting generally of but three chambers.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to the upper part of the *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Planoglobulina carseyae* (Plummer) is in an exposure of the uppermost Corsicana Formation, middle Maestrichtian, *G. gansseri* Subzone, *R. fructicosa* Zonule, along the southern bank of Walkers Creek, Milam County, Texas (see Appendix, Locality TX9).

PLATE 6

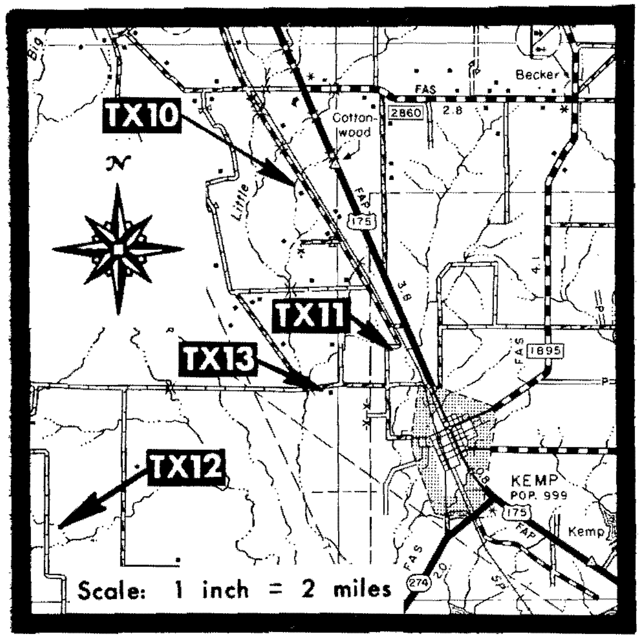
		Page
1–3, 4–5.	*Pseudoguembelina costulata* (Cushman) ..... 1–3, TX4AC-0C20; 4–5, TX4AC-0C21; all 170× except 3, 550×. Note the rather long, narrow test in lateral view and moderate to coarse, continuous longitudinal costae. 3, Enlargement showing the arched, rather narrow tubuliform lobes covering sutural supplementary apertures. Each lobe is costate and very finely perforate, and terminates in a poorly-developed, thickened lip.	24
6–7, 8–10.	*Pseudoguembelina excolata* (Cushman) ...... 6–7, TX3BA-21A51, 125×; 8–10, TX3BA-2, 8–9, 140×, 10, 415×. Note the broad, triangularly-shaped test and massive, widely-spaced longitudinal costae. 10, Enlargement showing the broad, somewhat overlapping, flattened to gently arched flaps covering sutural supplementary apertures. Apertural flaps have poorly-developed costae and are very finely perforate. Compare with Figure 3 of *Pseudoguembelina costulata* (Cushman).	25



TEXT FIGURE 9

Diagram showing the phylogenetic development of *Racemiguembelina fructicosa* (Egger) from *Pseudotextularia deformis* (Kikoine), and the development of the ponticulus. Terminal chambers of lower planar series are shaded.

Explanation.–Text figure 9A shows the top view of a typical *Pseudotextularia deformis* (Kikoine). Figure 9B, a transitional form between *P. deformis* and *Racemiguembelina powelli*, n. sp. (Pl. 11, figs. 1–3), shows the beginning of multiserial chamber development through the formation of a supplementary aperture (not shown) at the back side of the terminal chamber (labeled "2"). Figure 9C shows the development of a secondary chamber (labeled "3") from the supplementary aperture, with additional separation of chamber "2" into two distinct chambers labeled "2A" and "2B". Note the structurally simple ponticulus between chambers "2A" and "2B". This stage represents the initial and morphologically most simple form in *Racemiguembelina* development, and is typical of *R. powelli*, n. sp. Figures 9D–E (Pl. 11, figs. 5, 8, 11) represent further stages in ponticulus and supplementary chamber development similar to the development shown in figures 9B–C. Text figures 9F–G show the completion of ponticulus development in specimens of *Racemiguembelina* with six terminal chambers (Pl. 12, fig. 5). The specimen shown in figure 9H (Pl. 12, fig. 1), representing an advanced stage of *Racemiguembelina* development, results from the constriction and secondary chamber development (similar to the development shown in figures 9B–C) from each of the uppermost chambers in figure 9G (1A, 1B, and 3).



TEXT FIGURE 10

Map of a portion of Kaufman County showing the location of sites TX10 through TX13.

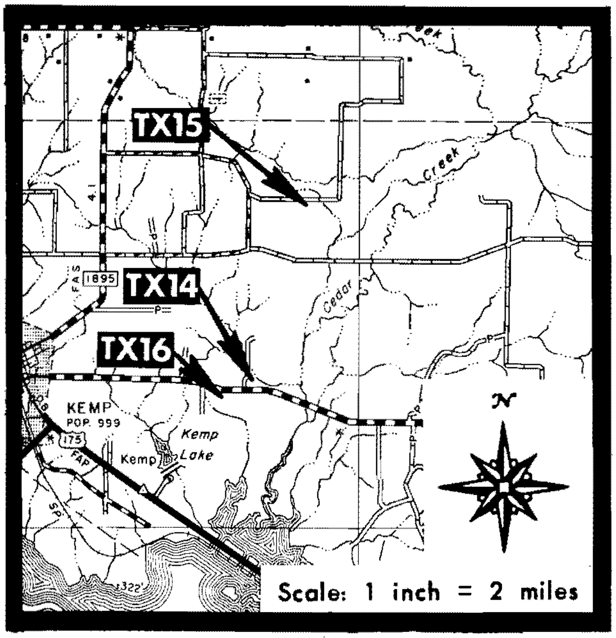
Planoglobulina carseyae (Plummer) has since been reported from the Maestrichtian, Papagallos Shale in Mexico (Pessagno, 1967, p. 272), Corsicana Marl in Texas (Cushman and Todd, 1943, p. 65; Loeblich, 1951, p. 109; Pessagno, 1967, p. 272), and Arkadelphia Marl in Arkansas (Cushman, 1949, p. 8; Pessagno, 1967, p. 272). This species has also been reported from the Maestrichtian of New Jersey (Jennings, 1936, p. 28; Olsson, 1960, p. 29) and New York (Perlmutter and Todd, 1965, p. I 14). Cushman and Hedberg (1941, p. 93) noted *P. carseyae* from the Maestrichtian Colon Shale of Columbia, and Hamilton (1953, p. 235) recorded this species from the Late Cretaceous of mid-Pacific Seamounts.

Planoglobulina carseyae (Plummer) has been reported as *P. acervulinoides* (Egger) by Kikoine (1948, p. 24) from the Maestrichtian of France, and by Said and Kerdany (1961, p. 134) and Said and Sabry (1964, p. 394) from the Maestrichtian of Egypt. El-Naggar (1971a, pl. 7, figs. a, d–e) reported *P. carseyae* as *H. elegans* (Rzehak) from the Maestrichtian type Sharawna Shale of Egypt. Its distribution and relative abundance in the Corsicana Formation of Texas is shown in text figs. 4–8.

Genus **Pseudoguembelina** Bronnimann and Brown, 1953

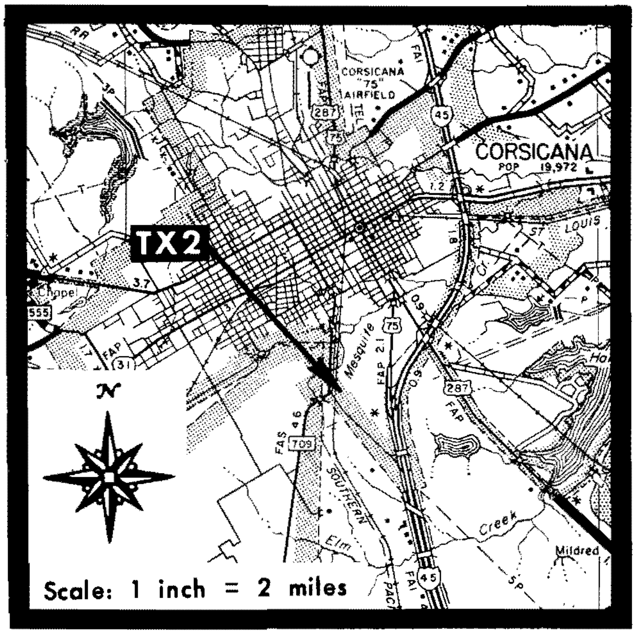
Type species.–*Guembelina excolata* Cushman, 1926.

Remarks.–Pessagno (1967, p. 265) noted that *Pseudoguembelina* differs from *Heterohelix* by possessing elongate, tubelike apertural flaps covering secondary sutural supplementary apertures. Loeblich and Tappan (1964, p. C656) failed to mention such flaps in their diagnosis of *Pseudoguembelina*.



TEXT FIGURE 11

Map of a portion of Kaufman County showing the location of sites TX14 through TX16.



TEXT FIGURE 12

Map of portion of Navarro County showing the location of site TX2.

Pseudoguembelina cornuta Seiglie

Plate 8, figures 7–8

1959. *Pseudoguembelina cornuta* SEIGLIE, pp. 60–61, pl. 4, figs. 1a–b, 2a–b, 3a–b, 4a–b, 5a–b, 6, 7.

Description.–Test biserial, generally triangular in outline, compressed laterally; in lateral view, pointed initial stage not lobate but becoming distinctly lobate terminally; initial chambers flattened to weakly inflated, increasing rapidly in size and degree in inflation as added; terminal five or six chambers inflated, initially globular, the ultimate two or three chambers becoming extended in the direction of growth; ultimate chamber often compressed laterally, and strongly extended axially, in lateral view resembling an elongate arch; initial sutures indistinct, flush, later sutures distinct, moderately depressed, curved; wall longitudinally costate; costae rather coarse, following the contour of the chambers; penultimate and ultimate chambers usually possessing finer and more closely spaced costae; primary aperture interiomarginal, a low arched opening extending laterally over the crest of the penultimate chamber, bordered by a thickened lip-like rim; each chamber with two accessory apertures, one on each side of the test, near the median line, and partially covered by thickened eyelid-like flaps extending longitudinally from the aperture in a tubuliform lobe to the crest of the antipenultimate chamber.

Remarks.–*Pseudoguembelina cornuta* Seiglie is similar to *P. palpebra* Bronnimann and Brown but differs in the axially elongate character of the ultimate chamber. Pessagno (1967, p. 267) and Brown (1969, p. 38) regarded *P. cornuta* Seiglie as a junior synonym of *P. palpebra*, although neither author figured typical specimens of *P. cornuta* Seiglie. The two forms are unquestionably closely related. In the present report they are regarded as separate species.

Pseudoguembelina cornuta Seiglie differs from *P. excolata* (Cushman) (1) by possessing globular and inflated chambers as seen in lateral view; (2) in the laterally compressed and axially extended ultimate chamber; (3) in having fine to medium rather than very coarse costae; and (4) by having accessory apertural flaps which are tubelike and highly arched.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–*Pseudoguembelina cornuta* Seiglie was originally described from the interval 1480 to 1503 feet in the Cristales No. 1 Well in the Jatibonico Basin about eight kilometers northeast of Majagua, Camaguey Province, and from an outcrop along the Via Blanca Road, two kilometers west of its intersection with the Camino Road leading toward Central Puerto, Matanzas Province, Cuba.

Although Seiglie (1959, p. 61) records *P. cornuta* from the transitional Campanian-Maestrichtian and early Maestrichtian, the presence of *Globotruncana gansseri* in the samples indicates that this interval is younger than early Maestrichtian.

During the course of this investigation, *Pseudoguembelina cornuta* Seiglie has been observed in the middle Maestrichtian (*R. fructicosa* Zonule) Papagallos Shale (see Appendix, Pessagno sample MX174), and in the late Maestrichtian, uppermost *A. mayaroensis* Subzone, Mendez Shale (ibid., sample MX78) of Mexico.

P. cornuta Seiglie is common in samples from the Corsicana Formation of North Central Texas (see text figs. 5–8). It has not been observed from the Corsicana Formation of Travis County, Texas (see Appendix, Locality TX25).

Pseudoguembelina costulata (Cushman)

Plate 6, figures 1–3, 4–5

1937. *Guembelina excolata* Cushman. VOORWIJK, p. 194, pl. 1, figs. 7–8.
1938. *Guembelina costulata* CUSHMAN, pp. 16–17, pl. 3, figs. 7a–b, 8, 9.
1943. *Guembelina costulata* Cushman. CUSHMAN and TODD, p. 64, pl. 11, fig. 13.
1946. *Guembelina costulata* Cushman. CUSHMAN, p. 108, pl. 46, figs. 10a–b, 11, 12.
1949. *Guembelina costulata* Cushman. CUSHMAN, p. 7, pl. 3, fig. 25.
1953. *Pseudoguembelina costulata* (Cushman). BRONNIMANN and BROWN, pp. 153–154, text-fig. 5.
1957. *Pseudoguembelina costulata* (Cushman). GALLITELLI, pp. 139–140, pl. 31, figs. 21, 22.
1960. *Pseudoguembelina excolata* (Cushman). OLSSON, p. 28, pl. 4, fig. 11.
1964. Not *Pseudoguembelina costulata* (Cushman). SAID and SABRY, pp. 392–394, pl. 3, fig. 19.
1965. *Pseudoguembelina costulata* (Cushman). PERLMUTTER and TODD, p. I 14, pl. 2, fig. 14.
1967. *Pseudoguembelina costulata* (Cushman). PESSAGNO, p. 266, pl. 79, fig. 1; pl. 88, figs. 8–9; pl. 90, fig. 3.
1969. *Pseudoguembelina costulata* (Cushman). FUNNELL et al., p. 24, pl. 1, figs. 11–12; not text-figs. 6a–b.

Description.–Test biserial, about 1 1/2 times as long as broad, laterally compressed, tapering throughout; initial portion of test somewhat pointed; in lateral view, outline only slightly lobate in later portion of test; chambers initially indistinct, later chambers slightly inflated, somewhat broader than high, increasing slowly in size as added; sutures initially indistinct, in later portion of test depressed and slightly curved; wall finely perforate, ornamented with moderate to coarse longitudinal costae, parallel to length of the test except in terminal one or two pair of chambers where costae approximate the chamber outline; primary aperture interiomarginal, a semicircular opening bordered by a slightly thickened lip; terminal sutural supplementary apertures indistinct, each chamber with two apertures on either side of the test near the median line, covered by gently arched and tubuliform lobes (Pl. 6, fig. 3).

Remarks.–*Pseudoguembelina costulata* (Cushman) differs from *P. excolata* (Cushman) in being smaller; having a narrower test in lateral view; having somewhat finer costae; and by having narrower flaps over its supplementary apertures.

The specimen figured by Voorwijk (1937, pl. 1, figs. 7–8) as *Guembelina excolata* Cushman is assignable to *P. costulata* (Cushman). The specimen figured by Said and Sabry (1964, pl. 3, fig. 19) as *P. costulata* (Cushman) is assignable to *P. palpebra* Bronnimann and Brown.

It has been observed that individuals of this species in upper Campanian strata of the western Gulf Coastal Plain area generally possess finer and more closely spaced costae. However, Maestrichtian individuals tend to become more heavily costate. The specimens figured herein, possessing rather widely spaced and coarse costae, are typical of individuals from the Corsicana Formation, and agree well in gross morphology as well as surficial ornamentation with the holotype of the species.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, lower part of *P. elegans* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *P. costulata* occurs in the lower part of the "Upper Taylor Marl" exposed in a gully north of the road and west of the iron bridge over a branch of Kickapoo Creek, 1.9 miles northwest of Annona,

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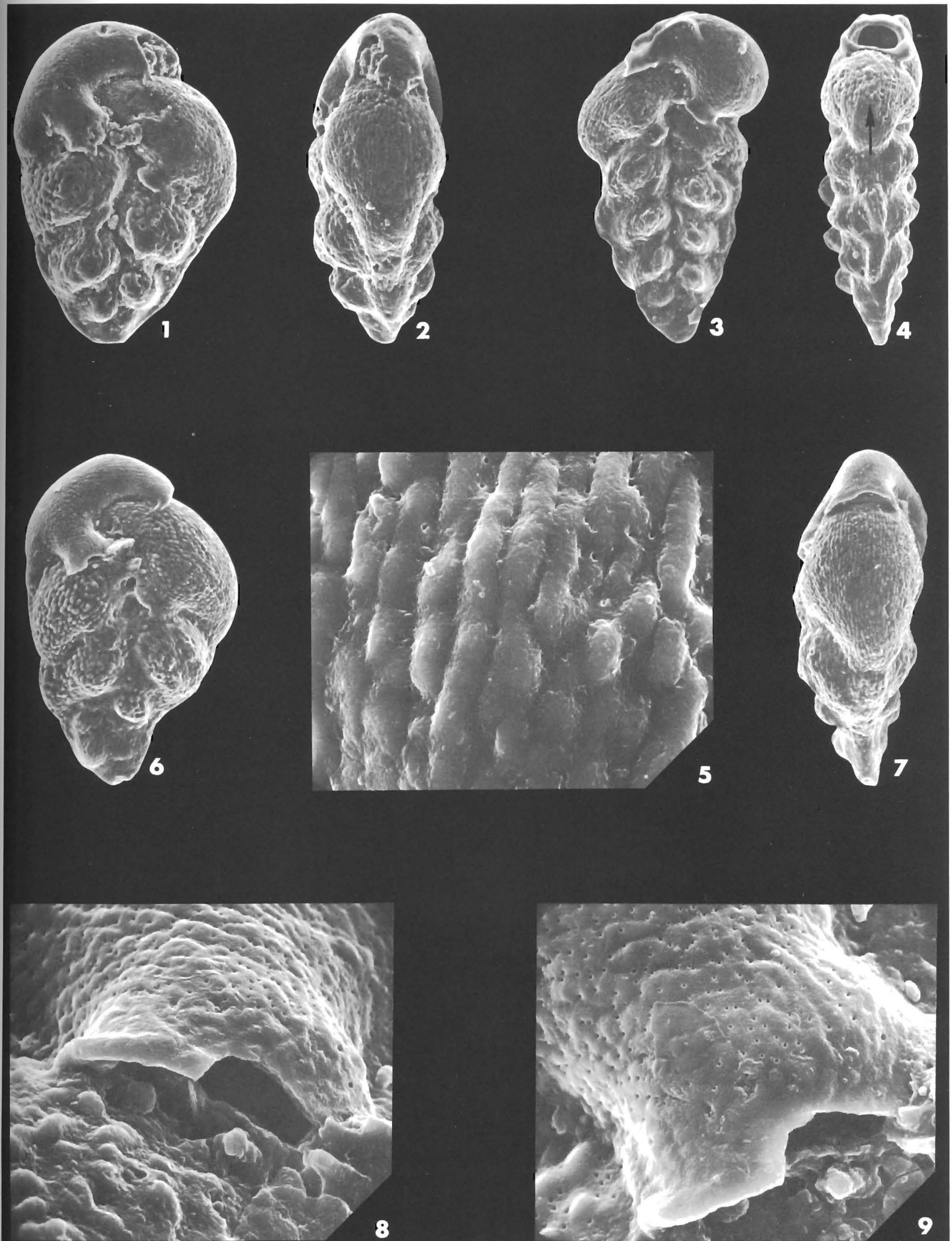
PLATE 7

Page

1–2. *Pseudoguembelina kempensis* s.s. Esker 26
TX9AG-0C22. Megalospheric form of Esker. 1, Note the rather broad test and inflated, crescent-shaped terminal chambers with arched tubuliform lobes covering accessory apertures. 2, Apertural view showing highly inflated chambers and fine longitudinal costae; 210×.

3–5. *Pseudoguembelina kempensis* s.l. Esker 26
TX20XA-0C24; 3–4, 155×, 5, 1375×. Microspheric form of Esker. 3–4, Note rather long, narrow test; inflated chambers resulting in a knobby appearance along the periphery of the test; and the highly arched primary aperture. 5, Enlargement showing fine longitudinal costal ornamentation.

6–9. *Pseudoguembelina kempensis* s.s. Esker 26
TX20XA-0C30; 6–7, 170×, 8–9, 1050×. 6, Note the extension of the ultimate chamber over the crest of the penultimate chamber and the arched, tubuliform lobe covering an accessory aperture. 7, Apertural view showing costal ornamentation and the broad, low-arched primary aperture characteristic of *P. kempensis* s.s. 8–9, Enlargements of the chamber lobe showing fine pores and the terminal, poorly-developed, imperforate thickened lip.



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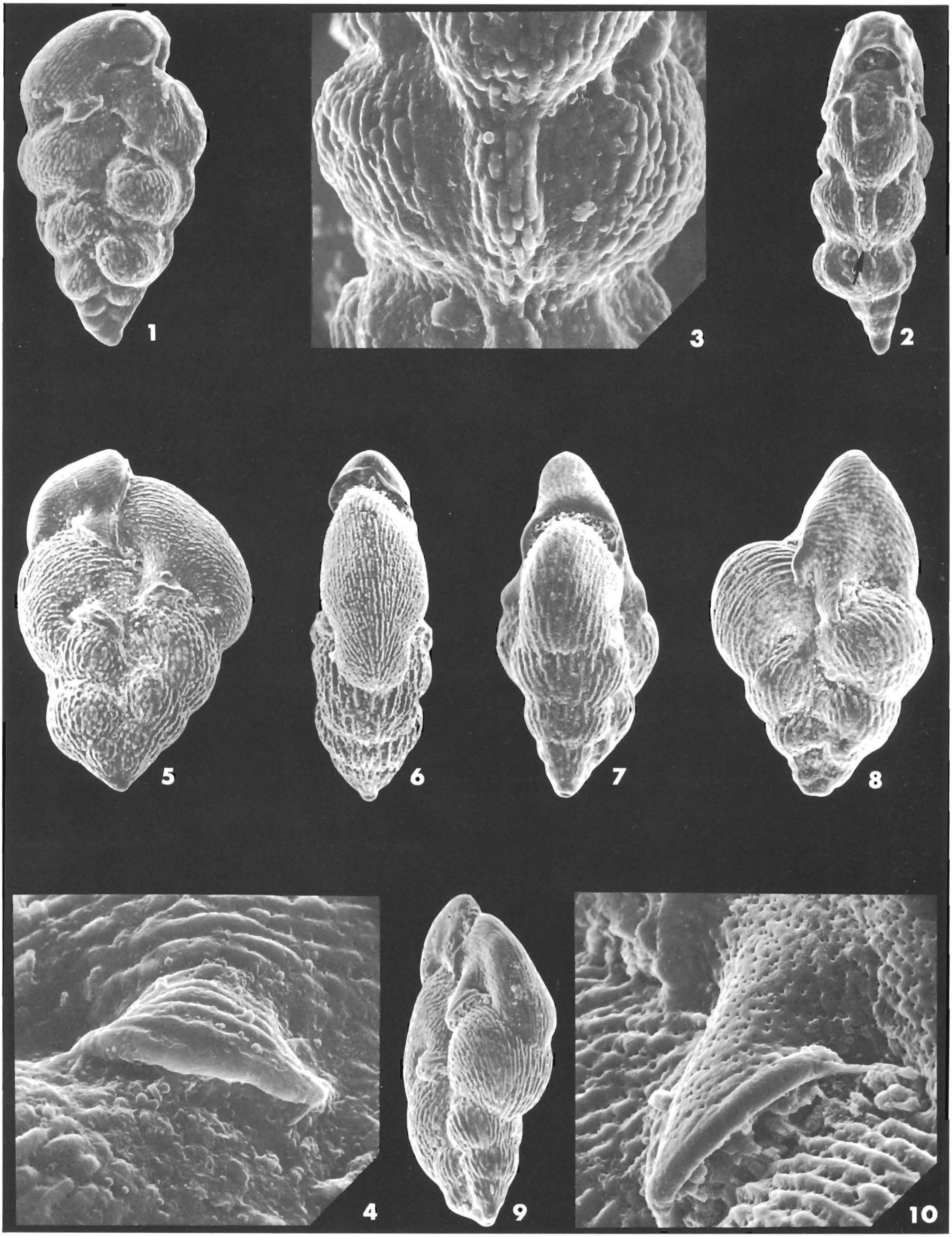

SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

Red River County, Texas. Based on the stratigraphic position of this locality in the Northeast Texas area, the outcrop probably is late Campanian in age.

This species has since been reported from the reworked Upper Cretaceous to Recent faunas of the mid-Pacific guyot area (Hamilton, 1953, pp. 208–209); Maestrichtian of Egypt (Ansary and Fakhr, 1958, pp. 119–120); late Maestrichtian from Galicia Bank off the western coast of Spain (Funnell, et al., 1969, p. 19); late Campanian through early Maestrichtian portions of the Parguera Limestone and Rio Yauco Formation of Puerto Rico (Pessagno, 1960, p. 91; 1962, pp. 355, 358); Upper Cretaceous of Haiti (Ayala, 1959, pp. 4–7); Maestrichtian of Cuba (Voorwijk, 1937, p. 191; Bronnimann and Brown, 1953, p. 150); and the late Campanian and Maestrichtian portion of the Mendez Shale of Mexico (Pessagno, 1967, p. 266). *P. costulata* has been reported from throughout the late Campanian and Maestrichtian of Texas, Arkansas, Mississippi, Alabama, etc., by numerous authors (see Cushman, 1946, p. 108; Pessagno, 1967, p. 266).

Pseudoguembelina excolata (Cushman)

Plate 6, figures 6–7, 8–10

1926. *Guembelina excolata* CUSHMAN, p. 20, pl. 2, fig. 9.
1926. *Textularia costata* CARSEY, p. 26, pl. 1, fig. 4.
1927a. *Guembelina excolata* Cushman. CUSHMAN, p. 157, pl. 28, fig. 13.
1931. *Guembelina excolata* Cushman. PLUMMER, pp. 176–177, pl. 8, fig. 10.
1937. Not *Guembelina excolata* Cushman. VOORWIJK, p. 194, pl. 1, figs. 7–8.
1943. *Guembelina excolata* Cushman. CUSHMAN and TODD, p. 64, pl. 11, figs. 15a–b.
1946. *Guembelina excolata* Cushman. CUSHMAN, pp. 108–109, pl. 46, figs. 16a–b.
1953. *Pseudoguembelina excolata* (Cushman). BRONNIMANN and BROWN, p. 153, text-figs. 1, 2, 3, 4.
1957. Not *Pseudoguembelina excolata* (Cushman). GALLITELLI, pp. 139–140, pl. 31, fig. 23.
1960. Not *Pseudoguembelina excolata* (Cushman). OLSSON, p. 28, pl. 4, fig. 11.
1964. Not *Pseudoguembelina excolata* (Cushman). LOEBLICH and TAPPAN, p. C656, fig. 525: 5, 6.
1967. *Pseudoguembelina excolata* (Cushman). PESSAGNO, pp. 266–267, pl. 68, figs. 4, 5; pl. 90, fig. 5.
1969. *Pseudoguembelina excolata* (Cushman). BROWN, pp. 37–38, pl. 1, figs. 11, 12a–b.
1969. Not *Pseudoguembelina excolata* (Cushman). FUNNELL, et al., pp. 24–25, pl. 2, figs. 1–2.

Description.–Test biserial, almost as broad as long, tapering throughout, triangular in outline, somewhat laterally compressed; in lateral view pointed initial stage not lobate, becoming weakly lobate terminally; initial chambers indistinct, later chambers slightly inflated, increasing moderately in size as added, somewhat broader than high; sutures initially indistinct, becoming depressed and curved between the terminal two to three pairs of chambers; wall finely perforate, with coarse longitudinal costae; costae widely spaced in the terminal portion of the test, following the contour of the chambers; primary aperture interiomarginal, a wide and highly-arched semicircular opening with a slight lip and thickened flanges; flaps covering sutural supplementary apertures large, wide and distinct terminally; each chamber with an accessory aperture on either side of the test, with gently arched flaps extending from the aperture longitudinally over the crest of the antipenultimate chamber, terminating in a somewhat thickened and flattened flange near the median line (Pl. 6, figs. 8, 10).

Remarks.–*Pseudoguembelina excolata* (Cushman) differs from *P. cornuta* Seiglie and *P. palpebra* Bronnimann and Brown in the triangular and more uniformly tapering test, less inflated and more reniform-shaped chambers, much coarser and more widely-spaced costae, and in the flattened to gently arched flaps covering sutural supplementary apertures.

As noted by Pessagno (1967, p. 267), the specimens figured as *P. excolata* by Gallitelli (1957, pl. 31, fig. 23) and by Loeblich and Tappan (1964, fig. 525; 5, 6) are assignable to *P. palpebra* Bronnimann and Brown. The

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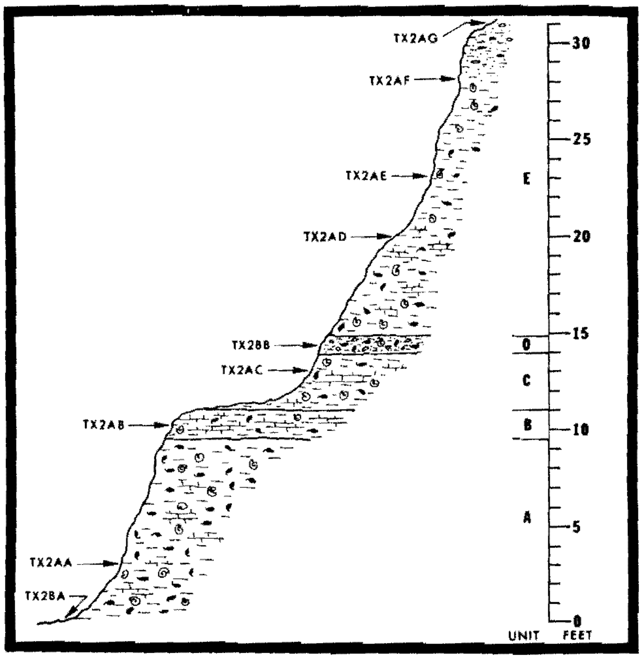
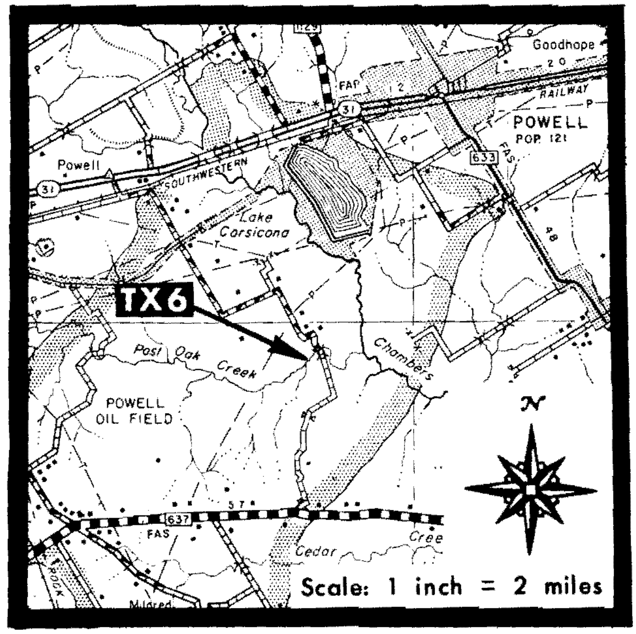
PLATE 8

		Page
1–4.	*Pseudoguembelina kempensis* s.l. Esker .... TX20XA-0C28. Microspheric form of Esker. 1–2, Note the highly arched primary aperture and strongly inflated medial and terminal chambers; 190×. 3, Enlargement showing the strongly constricted chambers resulting in a keel-like ridge along the peripheral margin in lateral view; 620×. 4, Enlargement of chamber lobe showing fine costal ornamentation, widely-spaced pores, and terminal thickened lip.	26
5–6.	*Pseudoguembelina palpebra* Bronnimann and Brown TX4AB-6A44. Note the rapid inflation of initial chambers, the low and broadly arched primary aperture, and the broad tubuliform lobes covering sutural supplementary apertures; 105×.	28
7–8.	*Pseudoguembelina cornuta* Seiglie .... TX4AC-20CA39. Note the strong lateral compression and distinct axial extension of the ultimate chamber; 145×. Compare with Figures 5–6, 9 of *P. palpebra* Bronnimann and Brown.	23
9–10.	*Pseudoguembelina palpebra* Bronnimann and Brown TX4AC-20AA37. 9, Oblique view showing laterally compressed terminal chambers and discontinuous, fine longitudinal costal ornamentation; 125×. 10, Enlargement of lobe showing the fine, rather closely-spaced pores and thickened terminal lip; 585×. Compare pore pattern with Figure 4 of *P. kempensis* Esker.	28



TEXT FIGURE 13

Profile of measured section at the alternate type locality of the Corsicana Formation (Locality TX2) showing the lithology and stratigraphic position of samples.



TEXT FIGURE 14

Map of a portion of Navarro County showing the location of site TX6.

specimen figured by Olsson (1960, pl. 4, fig. 11) as *P. excolata* is properly assignable to *P. costulata* (Cushman).

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Pseudoguembelina excolata* (Cushman) occurs in the Mendez Shale along the eastern bank of the Tamuin River, five kilometers southeast of Tamuin, San Luis Potosi, Mexico (Cushman, 1926, p. 20). The presence of *Racemiguembelina fructicosa* (Egger) from the type area of *P. excolata* (ibid., pp. 26–29) dates this locality in the Mendez as being late Maestrichtian, uppermost *G. gansseri* Subzone (*R. fructicosa* Zonule) or *A. mayaroensis* Subzone. Pessagno (1967, p. 267) noted that the type locality of *P. excolata* is in close proximity to and along strike with other outcrops which are assignable to the upper Maestrichtian, *A. mayaroensis* Subzone.

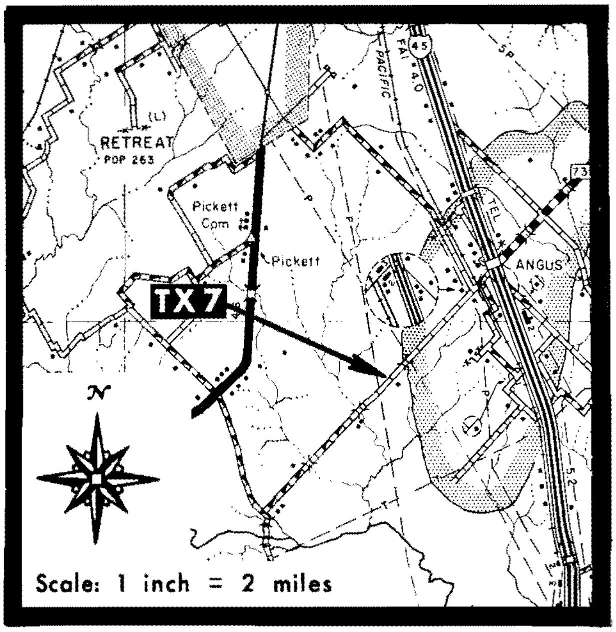
Said and Kerdany (1961, p. 323) report *P. excolata* from the Maestrichtian of Egypt. This species has also been noted from the Maestrichtian Colon Shale of Colombia (Cushman and Hedberg, 1941, p. 92); the Maestrichtian of Cuba (Bronnimann and Brown, 1953, p. 150); and reworked Upper Cretaceous to Recent faunas from mid-Pacific flat-topped seamounts (Hamilton, 1953, pp. 208–209). *P. excolata* is well known in the Maestrichtian of Mexico (Cushman, 1927a, p. 157; White, 1929, p. 34; Pessagno, 1967, p. 267) and the middle and late Maestrichtian of Texas and Arkansas (Cushman, 1938, p. 17; Cushman and Todd, 1943, p. 64; Cushman, 1946, pp. 108–109; Pessagno, 1967, p. 267). *P. excolata* is common in samples from the Corsicana Formation studied during the course of this investigation (see text figs. 4–8).

Pseudoguembelina kempensis Esker

Plate 7, figures 1–2, 3–5, 6–9;
Plate 8, figures 1–4

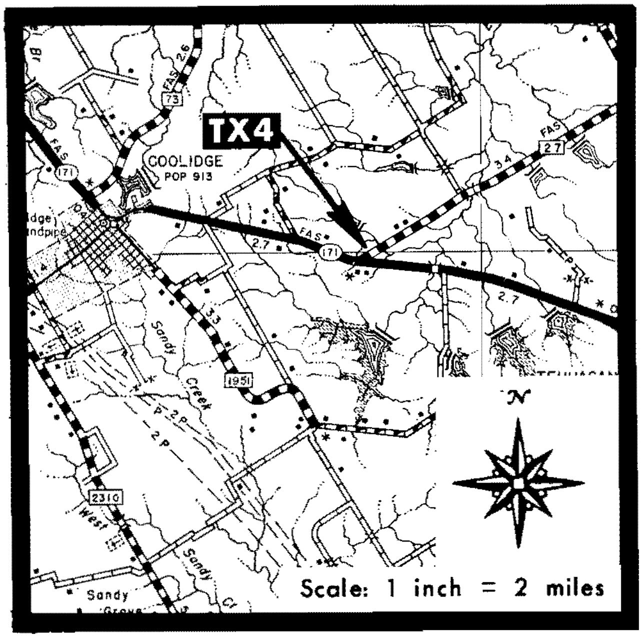
1968. *Pseudoguembelina kempensis* ESKER, pp. 168–169, text-figs. 1–2, 3, 4–5.

Description.–Test biserial, laterally compressed, slightly lobate, rarely having a small planispirally coiled initial stage; early chambers indistinct, flattened to weakly inflated, later chambers strongly inflated, about as broad as high, increasing rapidly in size as added; terminal two or three chambers somewhat crescent-shaped, greater in width than height, extending apically over the crest of the preceding chamber on the same side of the test and abapically across the axis of biseriality onto the crest of the preceding chamber; in lateral view, terminal two or three pairs of chambers strongly constricted along the peripheral margin of the test, forming a keel-like ridge extending from the basal portion of the chamber over the



TEXT FIGURE 15

Map of a portion of Navarro County showing the location of site TX7.



TEXT FIGURE 16

Map of a portion of Limestone County showing the location of site TX4.

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crest of the preceding chamber and merging with the previous chamber ridge; in apertural view, initial two or three pairs of biserial chambers weakly inflated, suddenly becoming highly inflated, ovate, and two or three times greater in width than height, resulting in a distinct knobby appearance along the peripheral margin of the test; sutures initially indistinct, flush, later becoming rather broad and strongly depressed; wall finely perforate, longitudinally costate; costae fine, closely spaced, discontinuous, following the contour of the chamber surfaces; ultimate chamber usually more finely costate and rarely somewhat smooth; primary aperture interiomarginal, a broad, rather highly arched semicircular opening bordered by a slightly thickened lip; terminal two or three chambers with distinct accessory apertures, each chamber with two accessory apertures, one on each side of the test, near the median line; accessory apertures covered by low and broadly arched flaps extending in a low tubuliform lobe from near the mid-portion of the terminal chamber to the crest of the antipenultimate chamber near the median line.

Remarks.–Pseudoguembelina kempensis Esker exhibits variation in test, chamber, and apertural morphology. Two distinct forms exist within this species; a short, rather broad form herein referred to as *P. kempensis* s.s. (megalospheric form of Esker, 1968, p. 168), and a long, narrow form (microspheric form of Esker, ibid.) herein referred to as *P. kempensis* s.l.

Pseudoguembelina kempensis s.s. is distinguished by having a test which is about one and one-half times greater in length than width in lateral view (Pl. 7, figs. 1, 6), fewer chambers, and terminal chambers which are larger and crescent-shaped; its terminal chambers in apertural view are greater in height than width and tend to overlap the preceding chambers. Its primary aperture is low and slit-like. Accessory apertures have broad, arched tubuliform lobes (Pl. 7, figs. 8, 9).

Individuals belonging to the narrow form, *Pseudoguembelina kempensis* s.l., are distinguished by having a test which is about twice as long as broad (Pl. 7, fig. 3; Pl. 8, fig. 1), somewhat constricted terminal chambers which form a ridge along the peripheral margin of the test (Pl. 7, fig. 4; Pl. 8, figs. 2, 3), a highly arched, semicircular, primary aperture, and more weakly developed lobes terminating in flaps covering accessory apertures (Pl. 7, fig. 3; Pl. 8, figs. 1, 4). Although the two forms are distinct, they are referred to the same species since, (1) gradational individuals exist between the two end members, and (2) neither form has been observed to occur exclusive of the other; that is, both forms have the same stratigraphic range.

Although Esker (1968, p. 168) did not recognize the fine longitudinal costal ornamentation in this species (Pl. 7, fig. 5; Pl. 8, fig. 3), *Pseudoguembelina kempensis* is distinguished from other species of *Pseudoguembelina* in having (1) inflated chambers in lateral view which impart a knobby appearance to the test in both lateral as well as apertural views, and (2) chambers which are strongly constricted along the peripheral margin of the test resulting in a keel-like appearance in lateral view.

The broad form of *P. kempensis* Esker suggests a relationship to *Pseudoguembelina palpebra* Bronnimann and Brown in that it possesses (1) crescent-shaped chambers in lateral view which overlap previous chambers along the peripheral margin of the test; (2) a low, wide, slit-like primary aperture; and (3) tubuliform lobes terminating in eyelid-like flaps concealing accessory apertures. *Pseudoguembelina kempensis* s.s. differs from *P. palpebra* by having (1) a triangular-shaped, more widely flaring test in lateral view; (2) inflated chambers as observed in apertural view; (3) much less laterally compressed terminal chambers; (4) laterally compressed initial chambers along the peripheral margin resulting in a keel-like ridge; and (5) in being more finely costate.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Pseudoguembelina kempensis* Esker is in an exposure of the uppermost Corsicana Formation, middle Maestrichtian (*R. fructicosa* Zonule), along the southern bank of Walkers Creek, Milam County, Texas (see Appendix, Locality TX9). *Pseudoguembelina kempensis* has been observed in samples from all localities exposing the Corsicana Formation of Texas. *Pseudoguembelina kempensis* Esker has been observed in the middle Maestrichtian portion of the Escondido Formation (*R. fructicosa* Zonule) exposed along the western bank of Seco Creek (Rowe Ranch), about three miles north of D'Hannis, Medina County, Texas. In Mexico, *P. kempensis* occurs in the Papagallos Shale, middle Maestrichtian, *R. fructicosa* Zonule, (see Appendix, Pessagno sample MX174), and in the Mendez Shale at its type locality near Mendez Station, late Maestrichtian, *A. mayaroensis* Subzone (Pessagno sample MX206). *Pseudoguembelina kempensis* is common to abundant in samples from the late Maestrichtian (*A. mayaroensis* Subzone) Guayaguayare Formation of Trinidad.

Pseudoguembelina palpebra
Bronnimann and Brown

Plate 8, figures 5–6, 9–10

1953. *Pseudoguembelina palpebra* BRONNIMANN and BROWN, p. 155, text-figs. 9a–b, 10a–b.
1957. *Pseudoguembelina excolata* (Cushman). GALLITELLI, p. 139, pl. 31, fig. 23.
1964. *Pseudoguembelina excolata* (Cushman). LOEBLICH and TAPPAN, p. C656, fig. 525: 5, 6.
1964. *Pseudoguembelina costulata* (Cushman). SAID and SABRY, pp. 392–394, pl. 3, fig. 19.
1967. *Pseudoguembelina palpebra* Bronnimann and Brown. PESSAGNO, p. 267, pl. 78, figs. 1–2, 3; pl. 89, figs. 3–4.
1969. *Pseudoguembelina palpebra* Bronnimann and Brown. BROWN, p. 38, pl. 1, figs. 9a–b, 10a–b.

Remarks.–Pseudoguembelina palpebra Bronnimann and Brown is morphologically identical to *P. cornuta* Seiglie except in the character of the ultimate chamber. The ultimate chamber of *P. palpebra* in lateral view is low and somewhat crescent-shaped (Pl. 8, figs. 5–6, 9), exceeding only slightly the height of the penultimate chamber, whereas that of *P. cornuta* is highly arched (Pl. 8, figs. 7–8).

Although *P. palpebra* and *P. cornuta* Seiglie are morphologically similar, the distinctive nature of the final chamber of *P. cornuta* as well as its different range warrants its separate identity. No transitional forms have been encountered in samples studied during the course of this investigation.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–P. palpebra was initially described by Bronnimann and Brown (1953, p. 150) from the construction pit of the Gran Templo Nacional Masonico at the northwest corner of Paseo Carlos III and Calzada de Belascoain (Padre Varela), Habana, Cuba, late Maestrichtian (*Abathomphalus mayaroensis* Subzone) in age.

Pessagno (1967, p. 267) noted *P. palpebra* in the upper part of the Mendez Shale of Mexico, the Corsicana Marl

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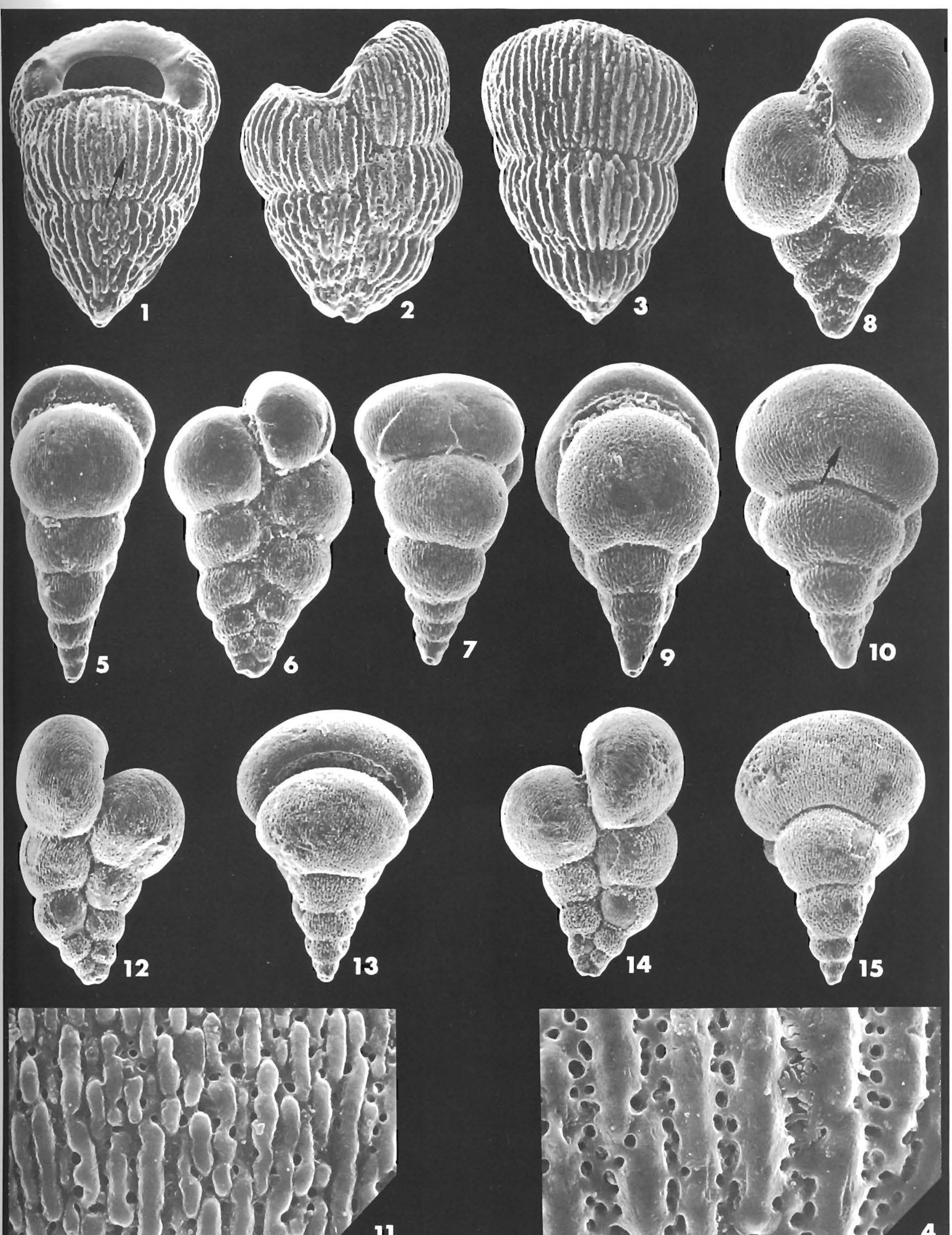
PLATE 9

		Page
1–4.	*Pseudotextularia deformis* (Kikoine) .... TX20XA-23BA58. 1–3, Note the rapid expansion in chamber width versus height in apertural and abapertural views, the highly arched primary aperture, and the coarse, widely-spaced discontinuous costae; 125×. 4, Enlargement showing widely-spaced costae and two or more irregular rows of pores in intercostal areas; 690×.	29
5–7.	*Pseudotextularia elegans* s.s. (Rzehak) .... TX4AC-18B60. Note the gradual expansion in chamber width in apertural and abapertural views; the low, broadly-arched primary aperture; and fine longitudinal costae; 120×.	30
8–11.	*Pseudotextularia elegans* s.s. (Rzehak) transitional to *P. elegans* s.l. (Rzehak) .... TX4AC-18A59. 8–10, Individual showing moderate expansion in chamber width in apertural and abapertural views; 120×. 11, Enlargement showing fine, discontinuous costal ornamentation and irregular pore-pattern; 690×.	30
12–15.	*Pseudotextularia elegans* s.l. (Rzehak) .... TX3BA-24B13. Note the broadly angular test due to a rapid increase in chamber width in apertural and abapertural views; the low, broad aperture; and the fine, closely-spaced, longitudinal costae; 105×.	30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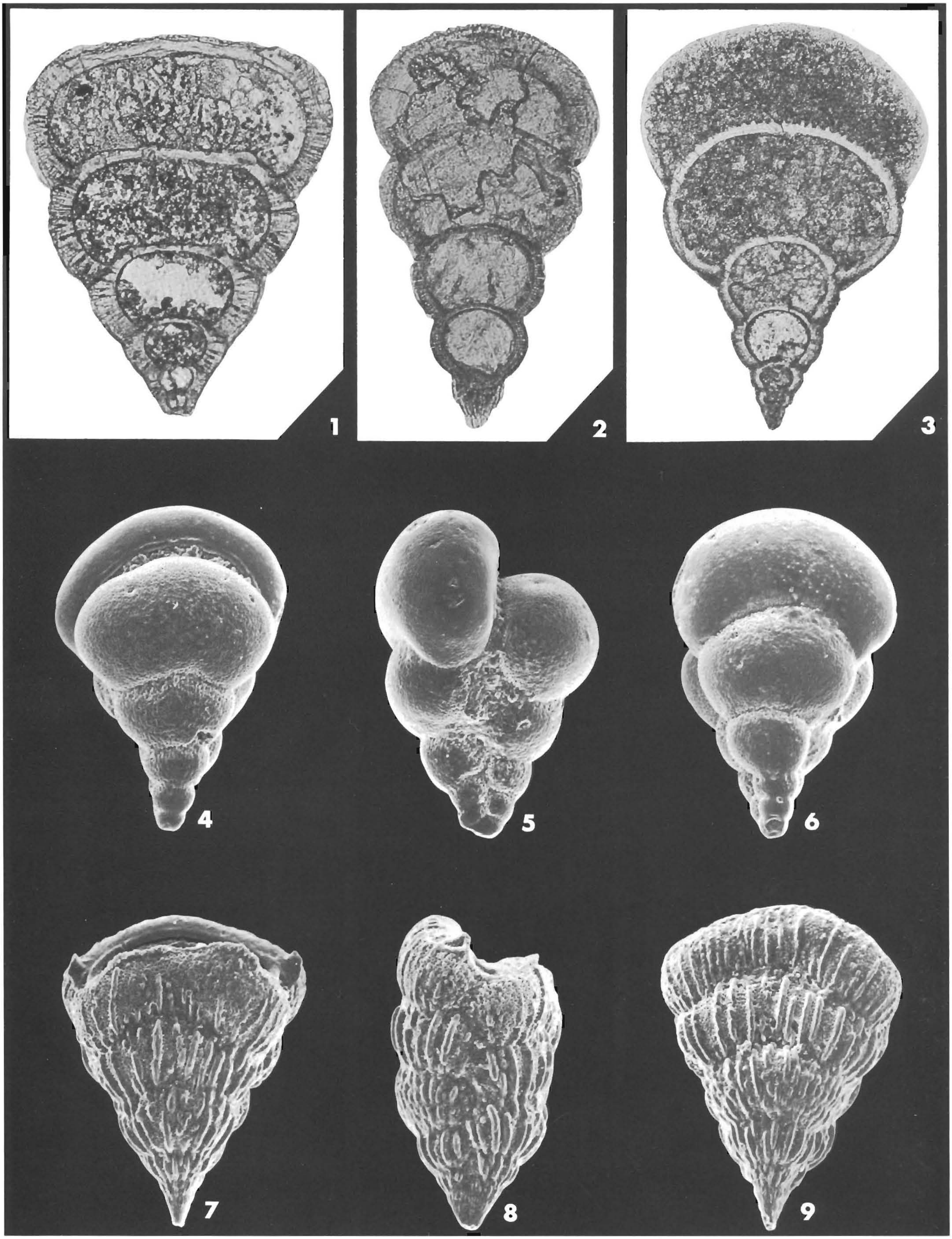

SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

and Kemp Clay of Texas, and the Arkadelphia Marl of Arkansas.

Documented stratigraphic occurrences of *P. palpebra* indicate that it is restricted to the middle and late Maestrichtian.

Genus Pseudotextularia Rzehak, 1891

Type species.–Cuneolina elegans Rzehak, 1891

Remarks.–The diagnosis of Loeblich and Tappan (1964, p. C656) is followed herein.

Pseudotextularia deformis (Kikoine)

Plate 9, figures 1–4;
Plate 10, figure 1

1926. *Pseudotextularia* sp. *a*. PLUMMER, p. 35, pl. 2, figs. 1a–b.
1948. *Guembelina striata* (Ehrenberg) var. *deformis* KIKOINE, p. 20, pl. 1, figs. 8a–c.
1953. *Pseudotextularia elegans* Rzehak cf. var. *deformis* (Kikoine). DE KLAZ, pp. 232–233, pl. 5, figs. 3a–b.
1959. *Pseudotextularia bronnimanni* SEIGLIE, pp. 57–58, pl. 1, figs. 5a–b, 6a–b, 7a–b, 8a–b; text-fig. 4.
1960. *Pseudotextularia elegans* (Rzehak). OLSSON, p. 28, pl. 4, figs. 9–10.
1967. *Pseudotextularia deformis* (Kikoine). PESSAGNO, p. 269, pl. 90, fig. 16; pl. 92, figs. 19–21; pl. 97, figs. 16, 17; pl. 98, figs. 15, 17, 18.
1969. *Pseudotextularia elegans* (Rzehak). BROWN, pp. 47–54, text-figs. 9a–b, 10a–b; not pl. 2, figs. 4a–b; not pl. 3, figs. 2–3; not text-figs. 13a–c, 14.
1969. *Pseudotextularia elegans* (Rzehak). FUNNELL, et al., p. 23, pl. 1, figs. 9–10; text-figs. 5a–b.
1969. *Pseudoguembelina excolata* (Cushman). FUNNELL, et al., pp. 24–25, pl. 2, figs. 1–2.
1971a. *Heterohelix elegans* (Rzehak). EL-NAGGAR, pl. 7, fig. b.

Remarks.–The description of this species by Pessagno (1967, p. 269) is complete and will not be duplicated herein.

Pseudotextularia deformis (Kikoine) is distinguished (1) by the broad, triangularly shaped test in apertural view, (2) chambers in apertural view which expand rather slowly in height but rapidly in width, (3) by possessing planiform to gently curved septal partitions (Pl. 10, fig. 1), (4) in possessing coarse, widely spaced, and discontinuous costae over the entire test, and (5) in having a highly arched primary aperture.

Pseudotextularia deformis (Kikoine) probably evolved from *Pseudotextularia elegans* (Rzehak) in the middle Maestrichtian. Several transitional individuals in the Corsicana Formation have retained the very low and broadly-arched aperture characteristic of *P. elegans* (Pl. 10, figs. 7–9).

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to *A. mayaroensis* Subzone.

Occurrence.–Kikoine (1948, p. 20) described *Guembelina striata* var. *deformis* from the Maestrichtian near Hendaye and south of Gan, southwestern France.

Prior to Kikoine's formal designation of this species, Plummer (1926, p. 35, pl. 2, figs. 1a–b) recorded this form as *Pseudotextularia* sp. *a* from the "Navarro Clays" exposed along Walkers Creek, Milam County, Texas (see Appendix, Locality TX9).

Pessagno (1967, p. 269) noted *Pseudotextularia deformis* in the middle and late Maestrichtian Papagallos Shale and Mendez Shale of Mexico; middle Maestrichtian Corsicana Marl and Kemp Clay of Texas; Arkadelphia Marl of Arkansas; and in the late Maestrichtian, Guayaguayare Formation of Trinidad.

Pseudotextularia deformis has been recorded as *P. elegans* (Rzehak) from the middle and late Maestrichtian, Redbank and New Egypt Formations of New Jersey (Olsson, 1960, p. 28); Monmouth Group (Maestrichtian) from shallow subsurface borings in Suffolk County, New York (Perlmutter and Todd, 1965, p. I 14); and from the late Maestrichtian, *A. mayaroensis* Subzone, in samples from Galicia Bank, west of Spain (Funnell, et al., 1969, p. 23). Seiglie (1959, pp. 57–58) described this species as *Pseudotextularia bronnimanni* from the middle and late Maestrichtian of Cuba.

Pseudotextularia deformis (Kikoine) is an abundant element of the Corsicana fauna (see text figs. 4–8), and

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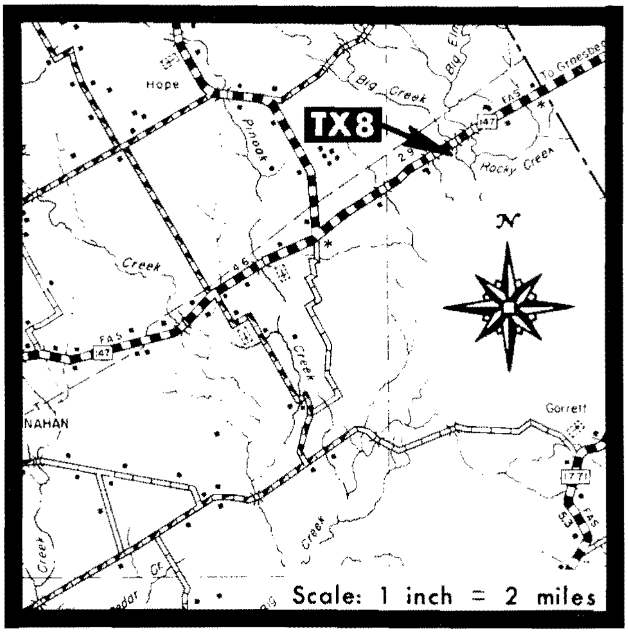
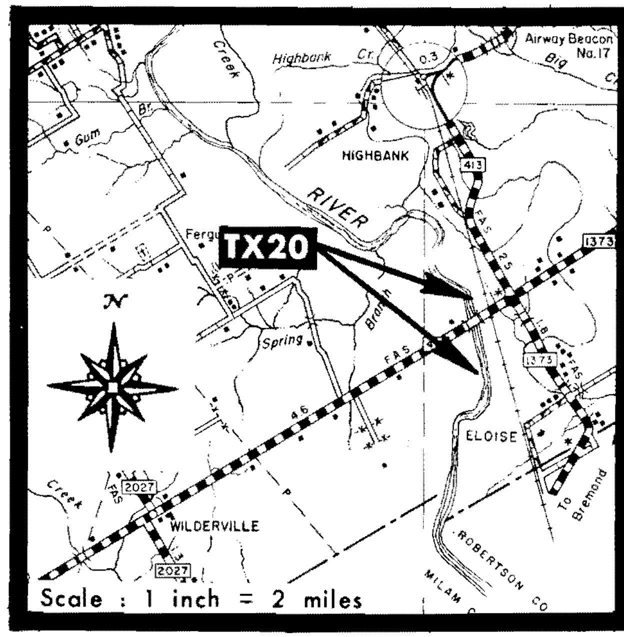
PLATE 10

		Page
1.	*Pseudotextularia deformis* (Kikoine) . . . . PE 1131; MX174, Papagallos Shale. Note the planiform septal partitions and thickened chamber walls; 180×.	29
2.	*Pseudotextularia elegans* s.s. (Rzehak) . . . . PE 1139; TX291-C, "Upper Taylor Marl" (see Pessagno, 1967, p. 380). Note the narrow test, gradual expansion in chamber width, arched septal partitions, and thin chamber walls; 160×.	30
3.	*Pseudotextularia elegans* s.l. (Rzehak) . . . . PE 1137; MX5, Mendez Shale (see Pessagno, 1969, p. 45). Note the rapid increase in test width, lobate periphery, highly-arched septal partitions, and thin chamber walls; 115×. Compare with Figure 1 of *P. deformis* (Kikoine).	30
4–6.	*Pseudotextularia* sp. aff. *P. elegans* s.l. (Rzehak) . . TX9AG-30B22. Individual exhibiting variation in having a smooth to faintly costate test surface; 115×. Compare with *P. elegans* s.l. (Pl. 9, figs. 12–15).	30
7–9.	*Pseudotextularia elegans* s.l. (Rzehak) transitional to *P. deformis* (Kikoine) . . . . TX20XA-23AA57. Note the low, broad aperture and highly arched sutures in apertural and abapertural views characteristic of *P. elegans*, and the weakly-lobate peripheral outline and coarse, widely-spaced costae characteristic of *P. deformis*; 95×.	30



TEXT FIGURE 17

Map of a portion of Falls County showing the location of site TX8.



TEXT FIGURE 18

Map of a portion of Falls County showing the location of site TX20.

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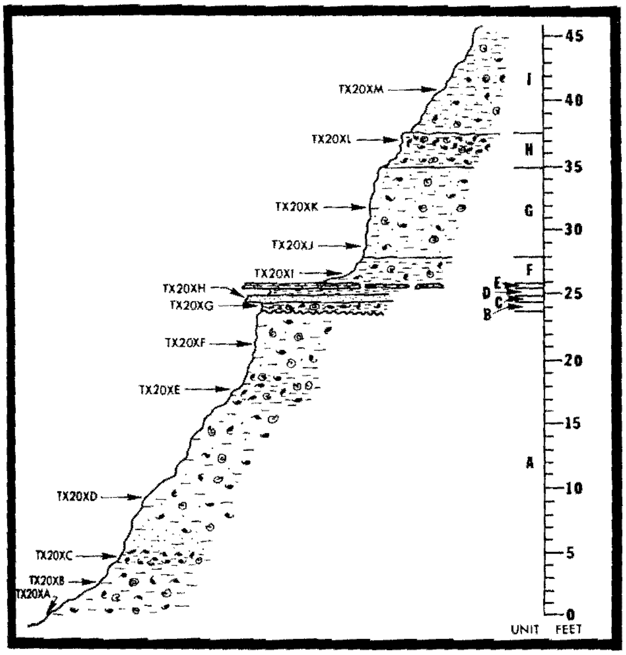
present evidence indicates this species is an important guide fossil for strata of middle and late Maestrichtian age.

Pseudotextularia elegans (Rzehak)

Plate 9, figures 5–7, 8–11, 12–15;
Plate 10, figures 2, 3, 4–6.

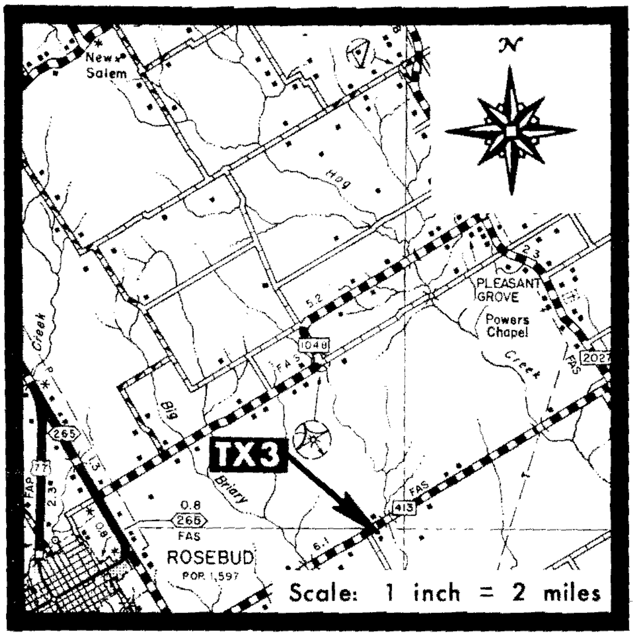
1891. *Cuneolina elegans* RZEHAK, p. 4.
1895. *Pseudotextularia varians* RZEHAK, p. 217, pl. 7, figs. 1a–b; not figs. 2, 3.
1929. *Guembelina elegans* (Rzehak). WHITE, pp. 34–35, pl. 4, figs. 8a–b.
1938. *Guembelina plummerae* Loetterle. CUSHMAN, pp. 15–16, pl. 3, figs. 3a–b, 4, 5a–b.
1946. *Guembelina plummerae* Loetterle. CUSHMAN, p. 104, pl. 45, figs. 1a–b, 2a–b.
1956. *Bronnimannella plummerae* (Loetterle). GALLITELLI, p. 35, pl. 7, figs. 1a–c, 2a–c.
1957. *Pseudotextularia elegans* (Rzehak). GALLITELLI, pp. 138–139, pl. 33, figs. 6a–c.
1959. *Pseudotextularia elegans* (Rzehak). SEIGLIE, pp. 55–56, pl. 1, figs. 1a–b, 3a–b; text-fig. 4.
1959. *Pseudotextularia elongata* SEIGLIE, pp. 58–59, pl. 1, figs. 2a–b, 4a–b; pl. 2, figs. 1a–b, 2a–b, 4a–b, 6a–b; pl. 3, figs. 1a–b; text-fig. 4.
1960. Not *Pseudotextularia elegans* (Rzehak). OLSSON, p. 28, pl. 4, figs. 9–10.
1964. *Pseudotextularia elegans* (Rzehak). LOEBLICH and TAPPAN, p. C656, figs. 525: 7a–c.
1967. *Pseudotextularia elegans elegans* (Rzehak). BANDY, p. 24, text-fig. 12 (12).
1967. *Pseudotextularia elegans* (Rzehak). PESSAGNO, pp. 268–269, pl. 75, figs. 12–14, 15–17; pl. 85, figs. 10–11; pl. 88, figs. 14–16; pl. 89, figs. 10–11; pl. 97, fig. 18; pl. 98, figs. 19, 20.
1969. Not *Pseudotextularia elegans* (Rzehak). BROWN, pp. 47–54, pl. 2, figs. 4a–b; pl. 3, figs. 2–3; text-figs. 9a–b, 10a–b, 13a–c, 14.
1969. *Pseudotextularia cushmani* Brown, pp. 55–56, pl. 2, figs. 2a–b, 3a–b; pl. 3, figs. 4a–b.
1969. Not *Pseudotextularia elegans* (Rzehak). FUNNELL, et al., p. 23, pl. 1, figs. 9–10; text-figs. 5a–b.
1971a. Not *Heterohelix elegans* (Rzehak). EL-NAGGAR, pl. 7, figs. a, b, d–e.

Description.–Test biserial, often slightly curved in lateral view; initial chambers flattened to weakly inflated, greater in width than height, non-lobate, increasing gradually in size as added; terminal two or three pairs of chambers becoming globular to subcircular, distinctly lobate; the ultimate chamber sometimes offset from the normal biserial alignment toward the median line of the test; in apertural and abapertural views initial chambers globular, rapidly becoming greater in thickness than height; terminal one or two chambers arcuate, the thickness often more than twice the height, strongly lobate; sutures flush initially, becoming strongly depressed, in lateral view straight to slightly curved, perpendicular to the median line of the test; in apertural and abapertural views sutures initially straight, sutures and septa becoming curved and highly arched abapically; wall finely costate, costae closely spaced, discontinuous, generally following the contour



TEXT FIGURE 19

Profile of measured section at Locality TX20 showing the lithology and stratigraphic position of samples.



TEXT FIGURE 20

Map of a portion of Falls County showing the location of site TX3.

of the chambers; wall finely perforate; aperture interio-marginal, a low and broad slit-like arch extending over the crest of the penultimate chamber.

Remarks.–Pseudotextularia elegans (Rzehak) exhibits a rather large degree of variation in test morphology. The shape of the test as observed in lateral view varies from being uniformly biserial about a straight median line, to a test which is broadly arcuate. As noted previously, the ultimate chamber is sometimes offset toward the median line of the test. In apertural view, the shape of the test varies from a narrow form (*P. elegans* s.s.), due to a progressive and gradual increase in chamber thickness (Pl. 9, figs. 5–7), to a thick and broadly angular form (*P. elegans* s.l.), whose chambers increase rapidly in thickness (Pl. 9, figs. 12–15). Very rare individuals in the Corsicana Formation exhibit additional variation in being faintly costate to smooth, yet retain the characteristics diagnostic of this species (Pl. 10, figs. 4–6).

The taxonomic history of *Pseudotextularia elegans* (Rzehak) is confused and has led many workers to include in *P. elegans* individuals which clearly differ from the morphological concept of the species embodied in the lectotype selected by White (1929, pp. 34–35).

Pseudotextularia was first used by Rzehak (1886, p. 8), but no species were placed in the genus until Rzehak (1891, p. 4) described *Cuneolina elegans.* As noted by Ellis and Messina (1940), Rzehak (ibid.) stated that this species should perhaps be placed in *Pseudotextularia. Cuneolina elegans,* thus, becomes the type species of *Pseudotextularia* (see Ellis and Messina, 1940).

Rzehak (1895, p. 217) later described *Pseudotextularia varians,* but included in his synonymy the earlier described *Cuneolina elegans. Pseudotextularia varians* is thus a junior synonym of *P. elegans.* Rzehak (ibid.) figured both biserial (pl. 7, figs. 1a–b) and multiserial (pl. 7, figs. 2, 3) forms, and considered the biserial form to represent an immature individual whose adult stage became proliferated.

White (1929, pp. 34–35) restricted the biserial form of *P. elegans* (Rzehak, 1895, pl. 7, figs. 1a–b) to *Guembelina elegans* (Rzehak), but incorrectly retained the name *Pseudotextularia varians* for the proliferated form figured by Rzehak (ibid., pl. 7, figs. 2, 3).

Pessagno (1967, pp. 268–269) noted a form which differed from the lectotype of *P. elegans* in expanding much more rapidly in thickness as seen in apertural and abapertural views. Pessagno (ibid.) observed that although the difference between the two forms was readily apparent, gradations existed between the two end members. Pessagno (ibid.) chose to refer to the more narrow form (in apertural view), corresponding with the lectotype, as *P. elegans* s.s., and referred to the more robust form as *P. elegans* s.l.

Brown (1969, pp. 55–56) proposed the name *Pseudotextularia cushmani* for a form similar in concept to *P.*

elegans s.l. of Pessagno. Although the description of *P. cushmani* is inadequate, the individuals figured by Brown (ibid., pl. 2, figs. 2a–b, 3a–b; pl. 3, figs. 4a–b) leave no doubt that *P. cushmani* is the robust and thickened form of *P. elegans* (Rzehak). *Pseudotextularia cushmani* is regarded as a junior synonym of *P. elegans* since gradational forms exist between the two end members throughout their common stratigraphic range.

The species described by Loetterle (1937, pp. 33–34) as *Guembelina plummerae* is closely allied to *P. elegans*, but differs in having a highly arched aperture. Brown (1969, p. 57) gives the range of *P. plummerae* as Coniacian to Santonian. It seems probable that *P. plummerae* gave rise to *P. elegans* in the early Campanian through an increase in chamber width as seen in apertural and abapertural views, and corresponding decrease from highly arched to a low, broad aperture.

The specimens figured by El-Naggar (1971a, pl. 7, figs. a, d–e) as *Heterohelix elegans* (Rzehak) belong to *Planoglobulina carseyae* (Plummer). The other figured individual (ibid., fig. b), from the single view presented, appears to belong to *Pseudotextularia deformis* (Kikoine).

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone, lower *P. glabrata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Pseudotextularia elegans* is in a quarry exposure near Bruderndorf, north of Vienna, Austria. Gohrbandt (1967, pp. 68–70) reexamined the stratigraphic units and associated microfauna at the type locality, and found the site to be late Paleocene in age (*Globorotalia pseudomenardii* Zone). Gohrbandt (ibid.) attributed the presence of *P. elegans* to be due to reworking.

Pseudotextularia elegans (Rzehak) has been reported from the Mendez Shale of Mexico (White, 1929, p. 35; Pessagno, 1967, p. 268; 1969), and throughout the Campanian and Maestrichtian of Texas and Arkansas (Pessagno, 1969). This species is also known from the Campanian and Maestrichtian of Puerto Rico (Pessagno, 1960, p. 95; 1962, p. 356) and Cuba (Seiglie, 1959, pp. 55, 59). Both *P. elegans* s.s. and *P. elegans* s.l. are common throughout the Corsicana Formation of Texas (see text figs. 4–8).

Genus **Racemiguembelina** Gallitelli, 1957

Type species.–*Guembelina fructicosa* Egger, 1899.

Emended diagnosis.–The diagnoses of Gallitelli (1957, p. 142) and Loeblich and Tappan (1964, p. C656) are accepted herein with the following modification. Each terminal chamber of *Racemiguembelina* possessing an interiomarginal, broad and highly arched aperture opening into the central portion of the test; apertures covered by a distinctive cover plate, herein termed *ponticulus*, extending from the upper portion of a given apertural face to chambers which lie in the same plane on the opposite side of the test; ponticuli bordered by large, infralaminal accessory apertures; successive ponticuli arranged in a planar series, although in larger tests the ponticulus may extend only partially into the central cavity of the test and then terminate by merging with the ponticulus immediately below (Pl. 12, figs. 1, 3, 5, 7).

Remarks.–Detailed examination of well-preserved specimens of *Racemiguembelina powelli* Smith and Pessagno, n. sp., and *R. fructicosa* (Egger), has shown a phylogenetic trend from *Pseudotextularia deformis* (Kikoine) through transitional forms to *R. powelli*, n. sp. Further development of supplementary chambers results in more advanced multichambered forms similar to the lectotype of *R. fructicosa* (Egger, 1899, pl. 14, figs. 8–9).

Although the ponticulus (as well as multiserial chamber development) in advanced stages of *Racemiguembelina* is complex, its ontogenetic development can be understood by examining morphologically simple forms leading to the more complex stages of development (see text fig. 9).

Racemiguembelina exhibits rather unusual and complex morphological features in the terminal multiserial portion

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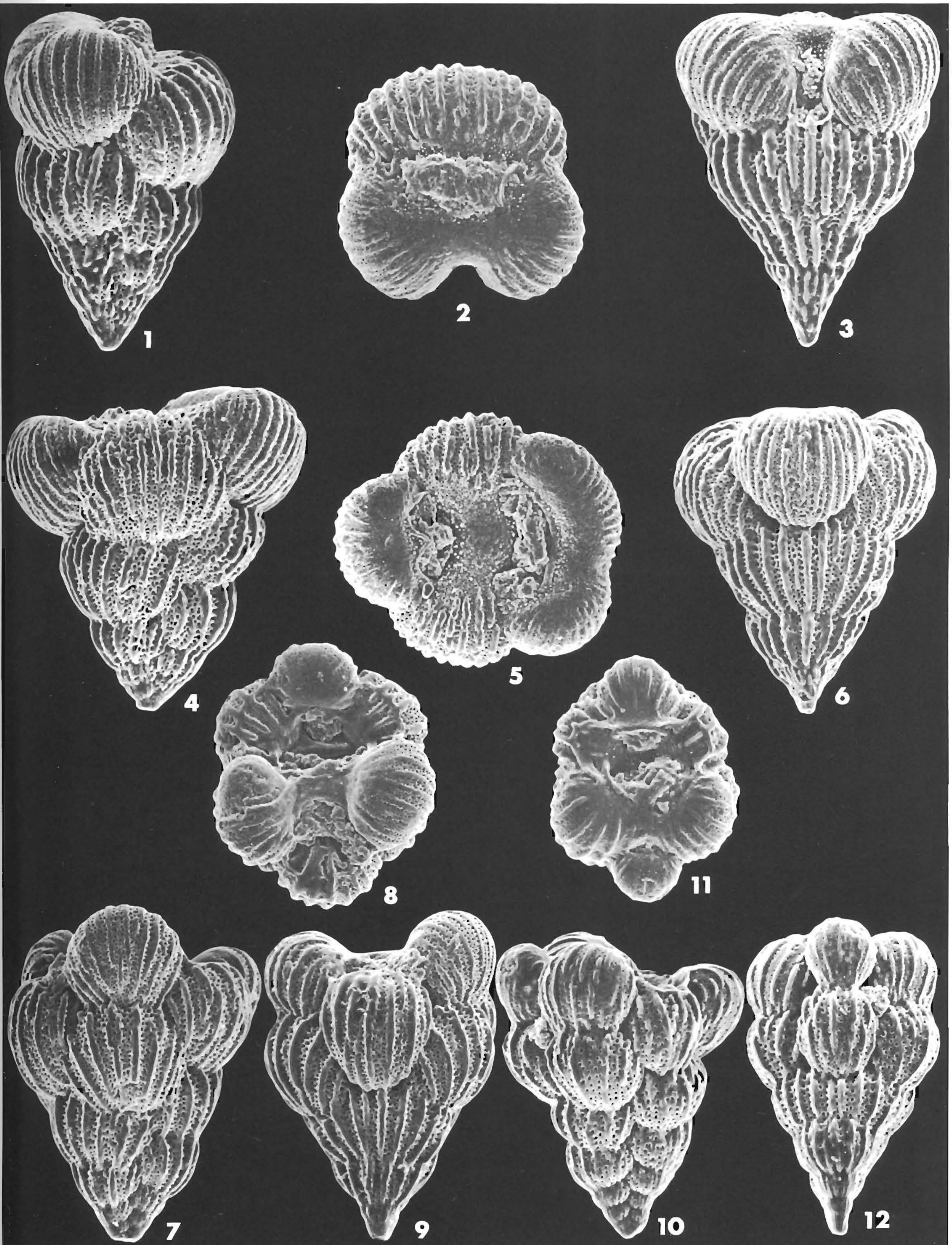
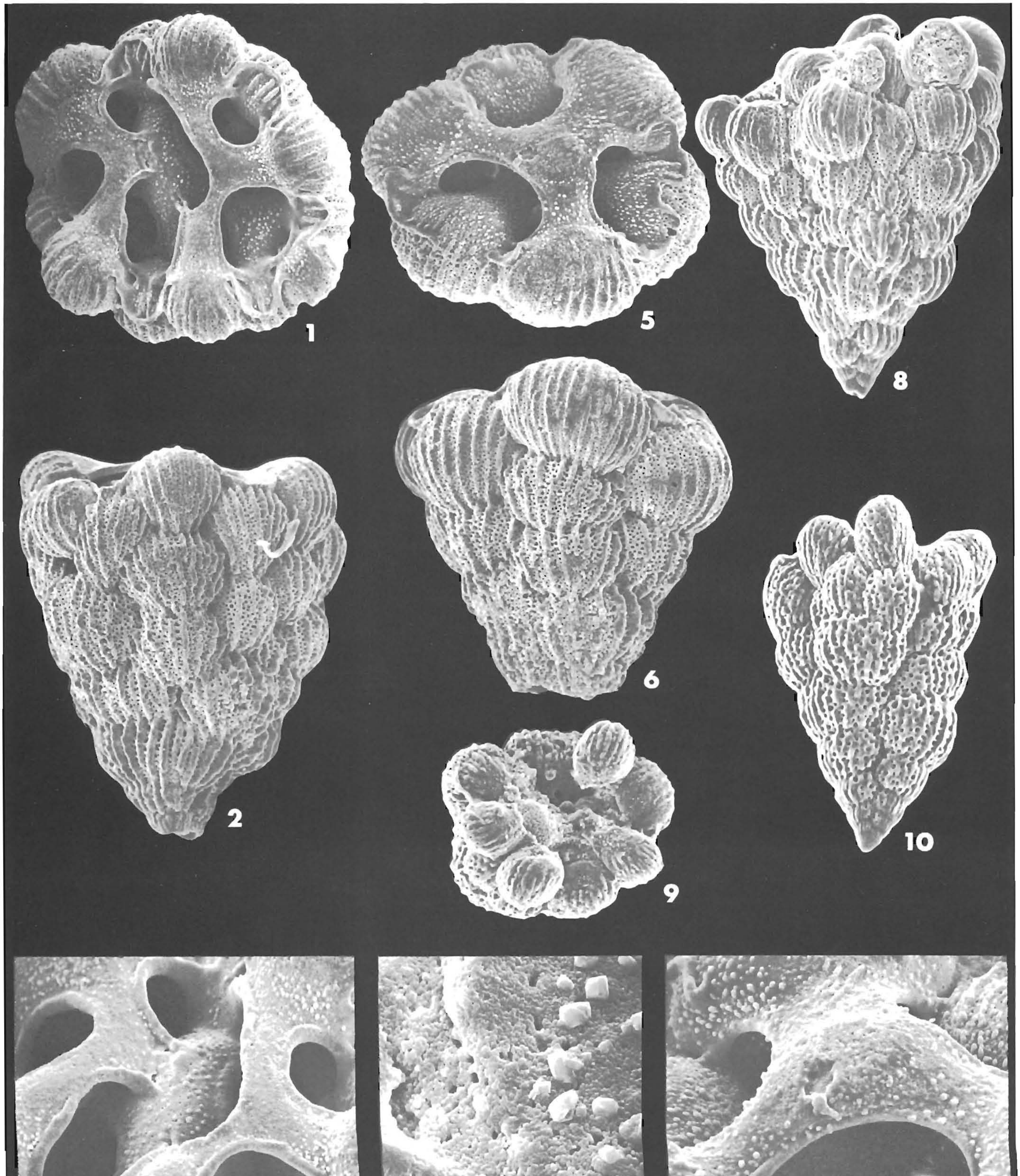
PLATE 11

		Page
1–3.	*Pseudotextularia deformis* (Kikoine) transitional to *Racemiguembelina powelli* Smith and Pessagno, n. sp.	32
	TX2AA-0F18. Specimen with massive, widely-spaced costae and planiform sutures typical of *P. deformis*. 2–3, Note the constriction and development of a small accessory aperture (filled with matrix) at the back side of the terminal chamber; 140×.	
4–6.	*Racemiguembelina powelli* Smith and Pessagno, n. sp.	35
	TX20XB-0F7. Paratype (USNM 170536) showing the length of the initial biserial stage, lobate peripheral margin, globular and strongly inflated chambers terminally, and massive, widely-spaced costae; 120×.	
7–9.	*Racemiguembelina powelli* Smith and Pessagno, n. sp.	35
	TX20XB-0F15. Holotype (USNM 170535). 7–9, Note that the chambers in the terminal multiserial portion of the test lie in three horizontal planes. Pores are aligned in three or four irregular vertical columns in intercostal areas. 8, Note that in top view the test is broadly ovate with remnants of ponticuli extending across the central cavity; 120×.	
10–12.	*Racemiguembelina powelli* Smith and Pessagno, n. sp.	35
	TX20XB-0F11. Paratype (USNM 170537) showing the initial biserial portion comprising about one-half the length of the test. Note the lobate peripheral outline and columnar alignment of chambers; 155×.	



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS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of the test. Investigations to date indicate that the terminal portion of the test consists of an even number (i.e., four, six, twelve, etc.) of chambers. The terminal chambers, as observed in top view, lie in two distinct planes, so that a chamber in one plane is bounded on either side by chambers in the plane either above or below (Pl. 11, figs. 5, 8, 11; pl. 12, figs. 1, 5). In lateral view the chambers tend to be aligned in columns rather than being distributed at random, although exceptions exist.

The new term *ponticulus* (-i) (Latin (M.) = little bridge; diminutive of pons, a bridge) is proposed for the umbilical cover plate in the genus *Racemiguembelina* Gallitelli, 1957. The distinctive and unique ponticuli in *Racemiguembelina*, although previously figured (Gallitelli, 1957, pl. 32, figs. 14b, 15b; Loeblich and Tappan, 1964, fig. 525: 8b; Brown, 1969, pl. 2, fig. 4b, text-fig. 14), have not been adequately described.

The ponticulus is a broad, bridge-like cover-plate (whether concave, planar, or more often slightly convex) which is a continuous extension from the upper portion of a given apertural face across the central cavity to the upper apertural face of terminal chambers which lie in the same plane on the opposite side of the test (Pl. 12, figs. 1, 3, 5, 7). Each ponticulus is bordered by large, semicircular infralaminal accessory apertures each situated immediately above and exposing chambers in the plane below the ponticulus (Pl. 12, figs. 1, 3, 5, 7). The ponticulus is very finely perforate. Individual pores are widely spaced and quite small (1.3 to 2.0 microns in diameter, Pl. 12, fig. 4).

The alternation of chambers into two separate planes is maintained as additional chambers are added in the terminal portion of the test. In larger tests, consisting of more than six terminal chambers, the ponticulus no longer extends from one side of the test to the opposite side (Pl. 12, figs. 5, 7). Rather, it extends only partially out into the central cavity of the test and then terminates by merging with the ponticulus immediately below (Pl. 12, figs. 1, 3).

The mode of formation of the vertical stacking and unusual alternating planar arrangement of chambers in *Racemiguembelina* deserves further study beyond the scope of the present investigation. The ponticulus may represent a protective covering or a structure providing strength to the test. Although the significance of these structures is unknown at present, *Racemiguembelina* is unique in morphology among the Heterohelicidae.

Racemiguembelina fructicosa (Egger)

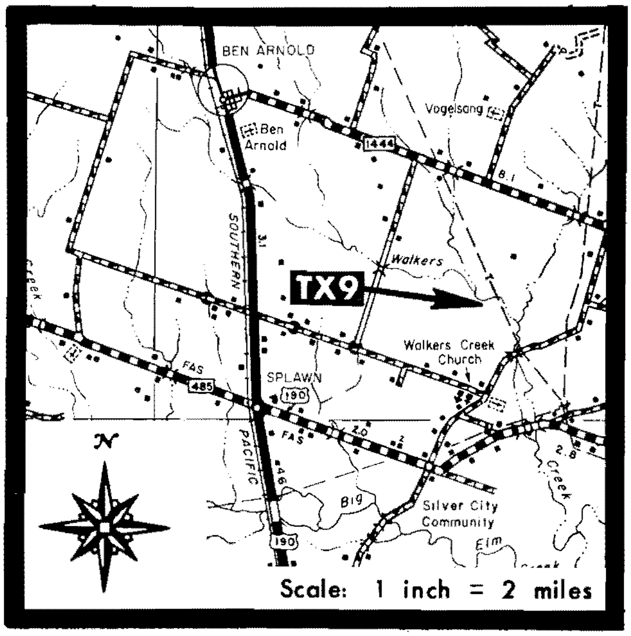
Plate 12, figures 1–4, 5–7, 8

1895. *Pseudotextularia varians* RZEHAK, p. 217, pl. 7, figs. 2, 3; not figs. 1a–b.
1899. *Guembelina fructicosa* EGGER, p. 35, pl. 14, figs. 8–9; not figs. 24, 25–26.
1899. *Guembelina acervulinoides* EGGER, p. 36, pl. 14, fig. 20 (?); not figs. 14–16, 17–18, 21–22.
1929. *Pseudotextularia varians* Rzehak. WHITE, p. 40, pl. 4, figs. 15a–b.
1929. *Pseudotextularia varians* var. *mendezensis* WHITE, p. 41, pl. 4, figs. 16a–b.
1938. *Pseudotextularia varians* RZEHAK. pp. 21–22, pl. 4, figs. 1a–b(?), 4; not figs. 2a–b, 3a–b.
1946. *Pseudotextularia varians* Rzehak. CUSHMAN, p. 110, pl. 47, figs. 4a–b(?), 6, 9a–b; not figs. 5a–b, 7a–b.
1948. *Pseudotextularia varians* Rzehak. KIKOINE, p. 23, pl. 2, figs. 4a–c.
1957. Not *Racemiguembelina fructicosa* (Egger). GALLITELLI, pp. 142–143, pl. 32, figs. 14a–b, 15a–b.
1962. Not *Pseudotextularia fructicosa* (Egger). BERGGREN, pp. 22–24, pl. 6, figs. 6a–b.
1964. Not *Racemiguembelina fructicosa* (Egger). LOEBLICH and TAPPAN, p. C656, fig. 525: 8a–b.
1967. Not *Racemiguembelina fructicosa* (Egger). PESSAGNO, p. 270, pl. 90, figs. 14–15.
1969. Not *Racemiguembelina fructicosa* (Egger). PESSAGNO and BROWN, p. 116, pl. 1, figs. 1–4.

Description.–Test with short biserial initial stage, in later stages becoming proliferated by development of supplementary chambers resulting in a conically-shaped test; top view of test circular to oval, composed of a varying number of globular supplementary chambers; initial chambers indistinct, flattened, increasing gradually in

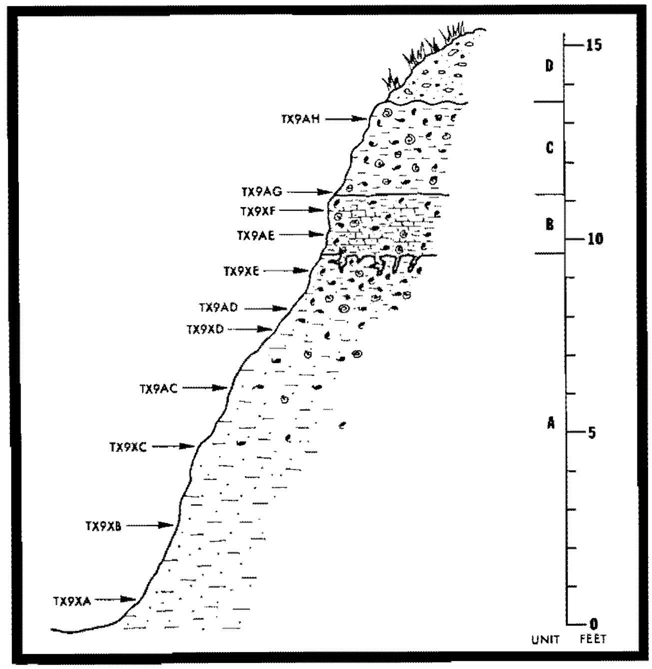
PLATE 12

		Page
1–4.	*Racemiguembelina fructicosa* (Egger) . . . . JOIDES Leg III, Station 21, Barrel 3, Section 1, 0–2 cm., Rio Grande Rise, *A. mayaroensis* Subzone. 1–2, Note the short initial biserial portion of the test, numerous small chambers in the terminal multiserial portion of the test lying in at least six horizontal planes, medium and rather closely-spaced costae, and excellently preserved ponticuli; 105×. 3, Enlargement of ponticuli showing infralaminal accessory apertures. Note the thickened lips of each accessory aperture; 190×. 4, Enlargement of a portion of the ponticulus showing small pores; 690×.	33
5–7.	*Racemiguembelina fructicosa* (Egger) . . . . Locality as above. 5–6, 120×. 5, Top view showing ponticuli extending from a chamber across the central cavity to chambers lying in the same plane on the opposite side of the test. 7, Enlargement of ponticuli showing infralaminal accessory apertures. Note the convex upper ponticulus, and concave lower ponticulus; 240×.	33
8.	*Racemiguembelina fructicosa* (Egger) . . . . TX20XB-0F14. Note the numerous, small, globular to spherical chambers; 105×.	33
9–10.	*Racemiguembelina* sp. a . . . . TX3BA-5. Note the closely-spaced costae with large pores aligned in a single irregular column in intercostal areas; 140×.	37



TEXT FIGURE 21

Map of a portion of Milam County showing the location of site TX9.



TEXT FIGURE 22

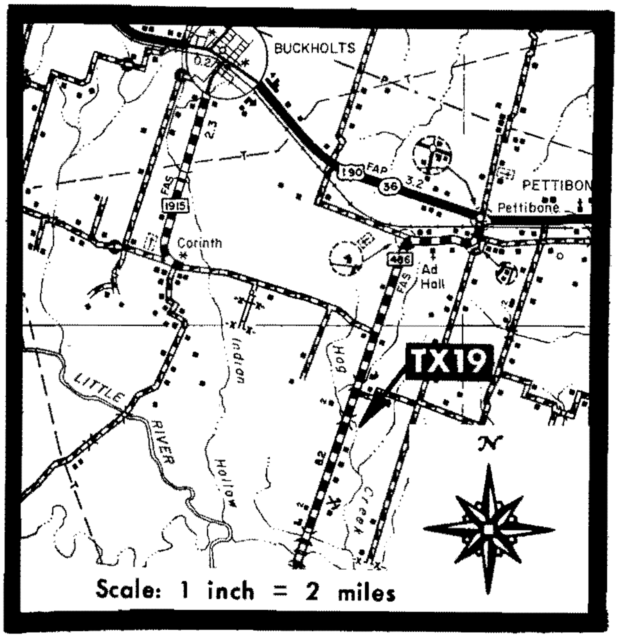
Profile of measured section at Locality TX9 showing the lithology and stratigraphic position of samples.

size as added, rapidly becoming globular, inflated, and increasing only slightly in size as added; terminal chambers often smaller in size than preceding chambers; sutures initially flush, later depressed, curved; wall coarsely costate; costae massive, closely spaced, discontinuous, vertically arranged on chamber surfaces; wall coarsely perforate, pores closely spaced; each terminal chamber possessing a basal, rather wide and highly arched aperture opening into the central cavity of the test; apertures covered by ponticuli in well-preserved specimens.

As noted in the discussion of *Pseudotextularia elegans* (Rzehak) herein, Rzehak (1895, p. 217) described both biserial and multiserial forms under *Pseudotextularia varians*. Ellis and Messina (1940) and Gallitelli (1957, p. 142) noted that the name *P. varians* is a junior synonym of *Cuneolina elegans* Rzehak (1891, p. 2), and therefore cannot be retained as the name of the many-chambered form illustrated by Rzehak (1895, pl. 7, figs. 2, 3). The earliest valid name for this species is thus *Guembelina fructicosa* Egger, 1899. Pessagno (1967, p. 270) designated figures 8–9 of Egger (1899, pl. 14) as the lectotype.

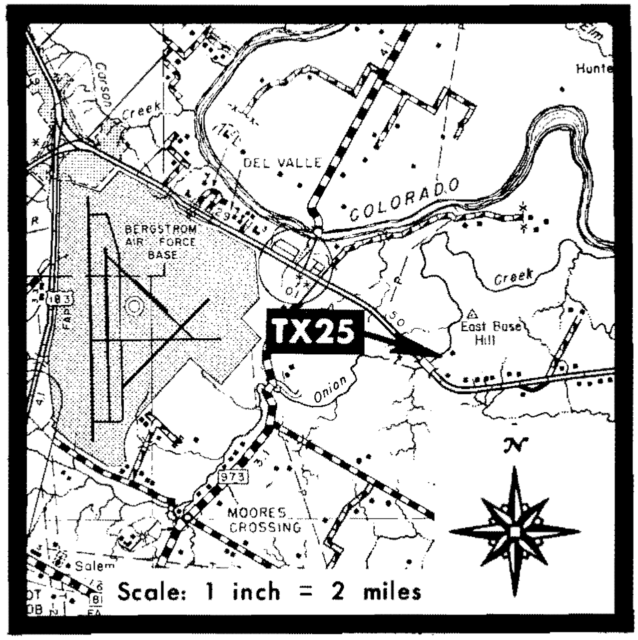
Brown (1969, pp. 43–54) presented a discussion of *Pseudotextularia* in which he concluded that *Pseudotextularia elegans* (Rzehak) and *Racemiguembelina fructicosa* (Egger), as well as several other species, are intrapopulation variants of *P. elegans* (Rzehak).

The present investigators feel that the conclusion reached by Brown is erroneous. Although Brown (ibid., p. 53) acknowledged that the various forms (i.e., *Pseudotextularia deformis* (Kikoine), *P. elegans* (Rzehak), *P. intermedia* de Klasz, and *Racemiguembelina fructicosa* (Egger) are morphologically distinct, he erroneously considered all of these forms to be restricted to the Maestrichtian. *Pseudotextularia elegans* first appeared in the early Campanian. Furthermore, it is common to abundant in the middle and late Campanian as well as Maestrichtian strata of the western Gulf Coastal Plain. Although *P. deformis*, *P. intermedia*, and *R. fructicosa* are restricted to the Maestrichtian, their ranges are quite different and are of great biostratigraphic importance. For example, *Pseudotextularia deformis* (Kikoine) appears initially in the basal portion of the *G. gansseri* Subzone; it is, in fact, an important marker for defining the base of this Subzone. *Racemiguembelina fructicosa* (Egger) makes its initial appearance in the upper portion of the *G. gansseri* Subzone, and is certainly one of the most important species in differentiating the lower (*G. aegyptiaca* Zonule) and upper (*R. fructicosa* Zonule) portions of the *G. gansseri* Subzone. *Pseudotextularia intermedia* de Klasz, also considered by Brown to be synonymous with *P. elegans*, has not been reported from the *G. gansseri* Subzone in the western Gulf Coastal Plain. Although its range is somewhat uncertain, to date it is known only from the lower part of the late Maestrichtian, *A. mayaroensis* Subzone.



TEXT FIGURE 23

Map of a portion of Milam County showing the location of site TX19.



TEXT FIGURE 24

Map of a portion of Travis County showing the location of site TX25.

The discussion presented above should indicate that the forms considered by Brown to be synonymous with *Pseudotextularia elegans* (Rzehak) are not individual variants of the same species. Rather, they are distinct species with differing stratigraphic range, and are of important biostratigraphic value in the middle and late Maestrichtian.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to the upper part of the *A. mayaroensis* Subzone.

Occurrence.–According to Ellis and Messina (1940) no type locality was designated for this species, although several stratigraphic horizons and geographic localities were given, all from the Upper Cretaceous of the Bavarian Alps in Germany (Egger, 1899, p. 35).

R. fructicosa (Egger) has been recorded from the Mendez Shale of Mexico by Cushman (1926, p. 17; 1927a, p. 157) and White (1929, pp. 40–41). It has also been recorded from the late Maestrichtian of Cuba (Seiglie, 1959, p. 56), and France (Kikoine, 1948, p. 23; Dupeuble, 1969, p. 153).

During the present investigation, *R. fructicosa* has been observed in the middle Maestrichtian (*R. fructicosa* Zonule) Corsicana Formation of Texas (see text figs. 5–8), Arkadelphia Formation of Arkansas (see Appendix), Papagallos and Mendez Formations of Mexico (see Appendix), and in sediments from the Rio Grande Rise, JOIDES Leg III (see Appendix). It has also been observed in the late Maestrichtian (*A. mayaroensis* Subzone) Mendez Formation of Mexico, Guayaguayare Formation of Trinidad, and in late Maestrichtian sediments from the Rio Grande Rise, JOIDES Leg III (see Appendix).

All available records indicate this species to be a distinctive and important guide fossil for the middle to late Maestrichtian.

Racemiguembelina powelli Smith and Pessagno, n. sp.

Plate 11, figures 4–6, 7–9, 10–12

1938. *Pseudotextularia varians* Rzehak. CUSHMAN, pp. 21–22, pl. 4, figs. 1a–b(?); not figs. 2a–b, 3a–b, 4.
1943. *Pseudotextularia varians* Rzehak. CUSHMAN and TODD, p. 65, pl. 11, fig. 17.
1946. *Pseudotextularia varians* Rzehak. CUSHMAN, p. 110, pl. 47, figs. 4a–b(?); not figs. 5a–b, 6, 7a–b.
1946. *Planoglobulina acervulinoides* (Egger). CUSHMAN, p. 111, pl. 47, figs. 15a–b; not figs. 12a–b, 13a–b, 14a–b.
1957. *Racemiguembelina fructicosa* (Egger). GALLITELLI, pp. 142–143, pl. 32, figs. 14a–b, 15a–b.
1964. *Racemiguembelina fructicosa* (Egger). LOEBLICH and TAPPAN, p. C656, fig. 525: 8a–b.
1967. *Racemiguembelina fructicosa* (Egger). PESSAGNO, p. 270, pl. 90, figs. 14–15.
1969. *Pseudotextularia elegans* (Rzehak). BROWN, pp. 43–54, pl. 2, figs. 4a–b; pl. 3, figs. 2–3(?); text-fig. 14; not text-figs. 9a–b, 10a–b, 13a–c.
1969. *Racemiguembelina fructicosa* (Egger). PESSAGNO and BROWN, p. 116, pl. 1, figs. 1–4.

Description.–Initial one-half to two-thirds of test biserial, in later stage becoming multiserial due to chamber proliferation, resulting in a conically-shaped test; in lateral view, multiserial portion of test consisting of chambers lying in two or three planes only; top view of test broadly ovate to circular, consisting of from four to eight globular chambers; initial three or four pairs of chambers indistinct; flattened, increasing gradually in size, becoming strongly inflated and increasing rapidly in size in the median portion of the test; terminal chambers large, globular, strongly inflated, increasing slightly, or showing no increase in size as added; sutures initially flush to slightly depressed, becoming curved and deeply depressed; wall coarsely perforate and costate; pores closely spaced, aligned in three to four irregular vertical columns in intercostal areas; costae massive, highly raised, widely spaced, vertically arranged in a discontinuous pattern on chamber surfaces; each terminal chamber possessing a basal, rather wide and highly arched aperture opening into the central portion of the test; apertures covered by ponticuli in well-preserved specimens.

Remarks.–*Racemiguembelina powelli* Smith and Pessagno, n. sp., differs from *R. fructicosa* (Egger) (1) by having a well-developed biserial stage comprising one-half or more of the test, (2) by having larger medial and terminal chambers and more strongly depressed sutures, resulting in a much more strongly lobate test as observed in lateral view (Pl. 11, figs. 4, 7, 10), (3) by having fewer chambers in the terminal multiserial portion of the test (four to twelve as opposed to eighteen or more in *R. fructicosa*) which lie in only two or three planes as observed in lateral view (Pl. 11, figs. 4, 7, 10), and (4) by having more massive and widely-spaced costae.

Existing morphologic and stratigraphic evidence suggests that *Racemiguembelina powelli*, n. sp., represents the earliest stage of *Racemiguembelina* development in the *Pseudotextularia deformis-Racemiguembelina fructicosa* bioseries. There is little doubt that *R. powelli*, n. sp., evolved from *Pseudotextularia deformis* (Kikoine). Transitional forms have been encountered (Pl. 11, figs. 1–3) which possess a constricted ultimate chamber and a basal, supplementary aperture as observed in abapertural view (Pl. 11, fig. 3). In both chamber shape and arrangement, as well as pore pattern and costal ornamentation, the transitional forms are otherwise similar to *Pseudotextularia deformis.*

Racemiguembelina powelli, n. sp., is a morphologically distinct species which has been found to have important stratigraphic value in the middle Maestrichtian strata of Texas. It is the only species of *Racemiguembelina* known to occur in the Corsicana Formation (*G. aegyptiaca* Zonule) of Travis County, Texas (see text fig. 4). Detailed examination has shown that *R. powelli*, n. sp., gave rise through transitional forms to *R. fructicosa*, one of several species which distinguish the assemblage of the *Racemiguembelina fructicosa* Zonule (see text fig. 3).

Racemiguembelina powelli Smith and Pessagno, n. sp., is named in honor of Dr. J. Dan Powell in recognition of his contributions toward a better understanding of the Cretaceous stratigraphy and paleontology of the Gulf Coastal Plain.

Dimensions.–Holotype measures 446μ in length and 371μ in maximum thickness. Six paratypes vary from 333μ to 480μ in length, and 280μ to 480μ in thickness.

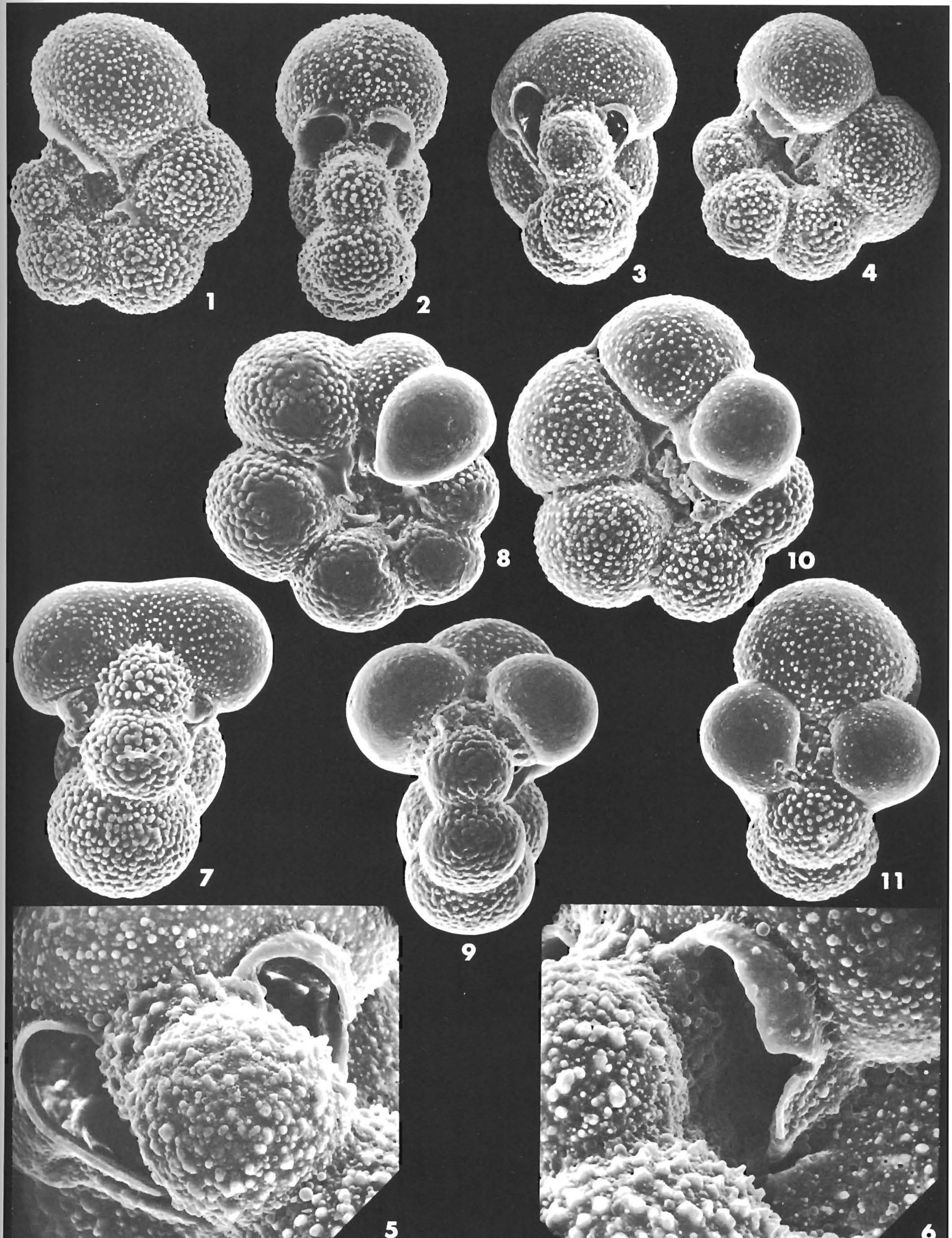
Type locality.–Exposures of Corsicana Formation along eastern bank of Brazos River north of Farm Road 413 bridge, about 0.5 miles southwest of the intersection of Farm Roads 413 and 1373 in southeastern portion of Falls County, Texas. Type sample TX20XB, from dark gray, conchoidal fracturing, calcareous mudstone (see Appendix, Locality TX20).

Deposition of types.–The holotype (USNM 170535) and figured paratypes (USNM 170536–170537) will be deposited in the collections of the U.S. National Museum. Unfigured paratypes (CS 1–3) will be deposited in the Pessagno Collection, Geosciences Division, The University of Texas at Dallas.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G.*

PLATE 13

		Page
1–2.	*Globigerinelloides multispina* (Lalicker) .... TX3BA-26AB1. Individual in an early stage of biapertural development; 210×. Compare with *G. prairiehillensis* Pessagno (Pl. 14, figs. 1–2, 3–4).	38
3–6.	*Globigerinelloides multispina* (Lalicker) .... TX3BA-10. 3–4, Note the more umbilical position of the apertures extending only to the sides of the initial chamber of the final whorl; 210×. 5, Enlargement showing the large and highly arched apertures; 620×. 6, Enlargement of an aperture showing the well-developed, imperforate apertural flap; 690×.	38
7.	*Globigerinelloides multispina* (Lalicker) .... TX2AA-0E40. Apertural view of a uniserial, biapertural individual which is transitional to the biserial, biapertural form of this species. Note the broad terminal chamber and near-umbilical position of the apertures; 190×.	38
8–9.	*Globigerinelloides multispina* (Lalicker) .... TX2AA-0E42. Individual in the early stage of biserial development. Note the completely divided ultimate chamber. Although partially concealed by matrix, each aperture extends upon the crest of the initial chamber of the final whorl; 170×.	38
10–11.	*Globigerinelloides multispina* (Lalicker) .... TX2AA-0E41. Individual representing the terminal stage in biserial, biapertural development. Note the completely divided ultimate chamber offset toward the umbilicus, and somewhat umbilical position of the aperture; 190×.	38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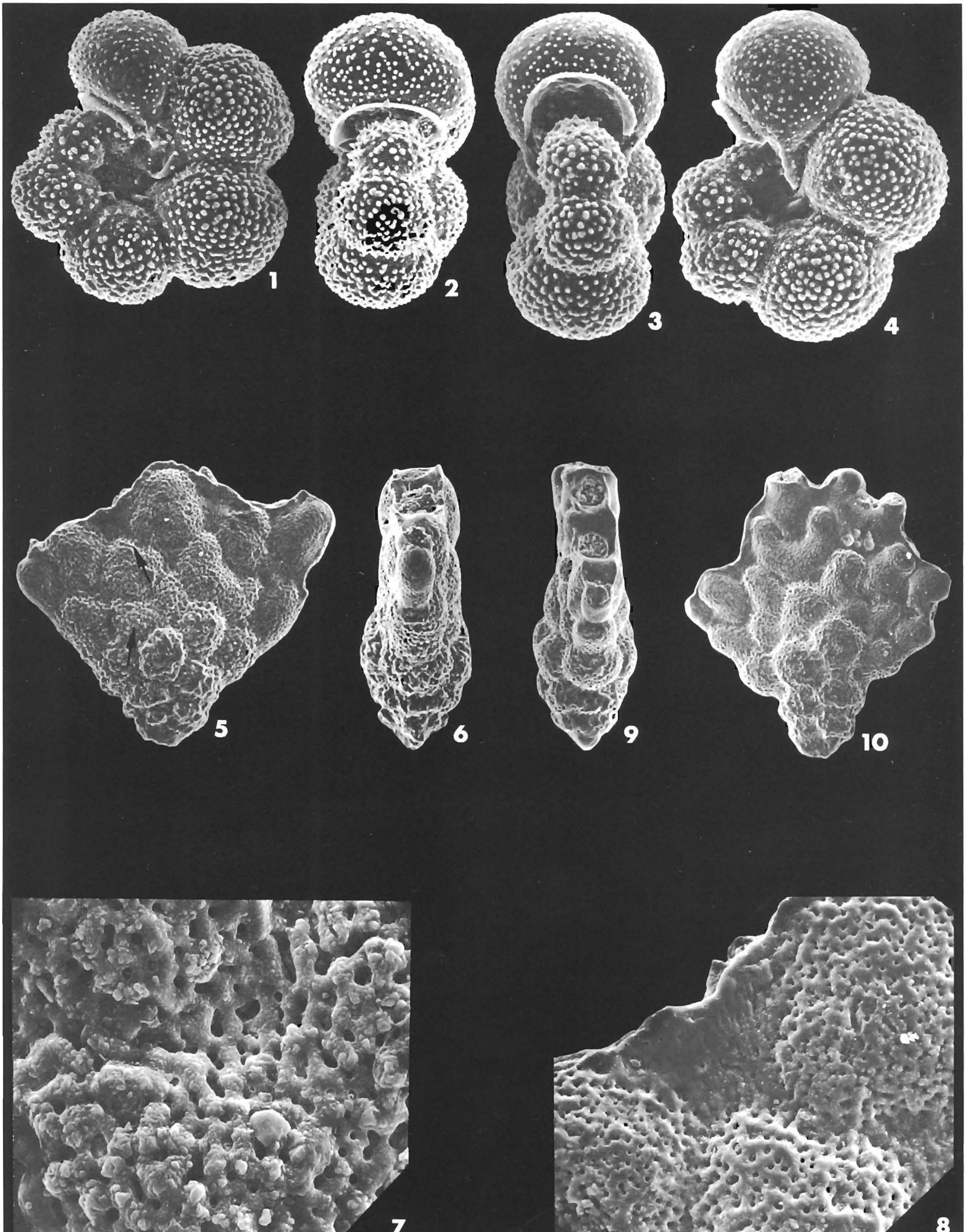
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gansseri Subzone, *G. aegyptiaca* Zonule, to the upper part of the *A. mayaroensis* Subzone.

Occurrence.–Racemiguembelina powelli, n. sp., has been previously figured under a variety of names from the late Maestrichtian of Cuba (Seiglie, 1959); Mendez Shale of Mexico (Cushman, 1938; 1946); Corsicana and Kemp Formations of Texas (Cushman and Todd, 1943; Gallitelli, 1957; Loeblich and Tappan, 1964; Pessagno, 1967; Brown, 1969; Pessagno and Brown, 1969); and the Prairie Bluff Chalk of Alabama (Cushman, 1946). It has also been recorded from the late Maestrichtian of Cuba (Voorwijk, 1937, p. 194); Galicia Bank, a seamount off the western coast of Spain (Funnell, et al., 1969, p. 26); Egypt (Said and Kerdany, 1961, p. 334); and from a mixed Upper Cretaceous to Recent fauna from a flat-topped seamount west of Hawaii (Hamilton, 1953, p. 235).

During the present investigation, *Racemiguembelina powelli*, n. sp., has been observed in the middle Maestrichtian (*G. aegyptiaca* Zonule) Corsicana Formation of Travis County, Texas; middle Maestrichtian (*R. fructicosa* Zonule) Papagallos Shale of Mexico, Escondido Formation of West Texas, Corsicana Formation of North Central Texas, and Arkadelphia Marl of Arkansas; and the late Maestrichtian (*A. mayaroensis* Subzone) Mendez Shale of Mexico. The distribution and abundance of *R. powelli* in the Corsicana Formation of Texas is shown in text figs. 4–8.

Racemiguembelina sp. a

Plate 12, figures 9–10.

*Remarks.–*This form is very similar to *Racemiguembelina fructicosa* (Egger), but varies from the latter in having chambers which are generally smaller than *R. fructicosa*, less massive and much more closely spaced costae, and in having larger pores aligned in a single row in intercostal areas.

The purpose here is to figure the form principally for the benefit of future workers. Additional geographic and stratigraphic knowledge may prove it a distinct new species.

To the writers knowledge, this form is known only from the Corsicana Formation in North Central Texas (see text fig. 6).

Genus **Ventilabrella** Cushman, 1928

Type species.–Ventilabrella eggeri Cushman, 1928

*Remarks.–*The emended definition of Martin, (1972, pp. 83–84) is followed herein. As emended, *Ventilabrella* is characterized by a multiserial, laterally compressed, flabelliform test with fine to medium longitudinal costae or vermicular ornamentation.

Ventilabrella multicamerata de Klasz

Plate 14, figures 5–8, 9–10

1899. *Guembelina acervulinoides* EGGER, p. 36, pl. 14, figs. 21–22; not figs. 14–16, 17–18, 20.
1929. *Planoglobulina acervulinoides* (Egger). WHITE, p. 33, pl. 4, fig. 6.
1953. *Ventilabrella multicamerata* DE KLASZ, p. 230, pl. 5, figs. 1a–b.
1967. Not *Planoglobulina multicamerata* (de Klasz). PESSAGNO, p. 272, pl. 89, fig. 15.
1972. *Ventilabrella multicamerata* de Klasz. MARTIN, p. 88, pl. 3, figs. 1a–b, 2.

*Remarks.–*The description given by Martin, (1972, p. 88) is followed herein. *Ventilabrella multicamerata* s.s. de Klasz is distinguished from other species of *Ventilabrella* by the relatively short initial biserial portion of the test, widely flaring multiserial stage, the numerous compressed chambers in the terminal portion of the test, vermicular ornamentation (Pl. 14, figs. 5, 7, 8), and, as observed in apertural view, the slightly inflated biserial stage which becomes strongly compressed terminally.

Ventilabrella multicamerata s.l. (Pl. 14, figs. 9–10) differs from *V. multicamerata* s.s. in having a distinct initial, non-flaring biserial stage followed by a rapid increase in test width in the early multiserial stage, and in having chamber surfaces which lack the coarse vermicular ornamentation typical of *V. multicamerata* s.s. *V. multi-*

PLATE 14

		Page
1–2.	*Globigerinelloides prairiehillensis* s.s. Pessagno .... TX3BA-27BB5. Note the spherical to subspherical chambers which increase rapidly in size, the deep umbilici, and the low, broadly arched aperture; 210×.	39
3–4.	*Globigerinelloides prairiehillensis* s.l. Pessagno .... TX3BA-27C2. Individual differing from *G. prairiehillensis* s.s. in having a more highly arched primary aperture; 210×.	39
5–8.	*Ventilabrella multicamerata* s.s. de Klasz .... TX3BA-0C34. 5–6, Note the short initial biserial portion of the test and the widely-flaring multiserial stage which is laterally compressed; 105×. 7, Enlargement showing vermicular ornamentation typical of *V. multicamerata* s.s; 690×. 8, Enlargement showing fine longitudinal costae between chambers in the terminal portion of the test. Note the rather coarse and closely-spaced pores penetrating chamber surfaces; 340×.	37
9–10.	*Ventilabrella multicamerata* s.l. de Klasz .... TX4AC-19A22. Individual differing from *V. multicamerata* s.s. in having a longer and nonflaring initial biserial stage and chamber surfaces which lack vermicular ornamentation; 80×.	37

camerata s.l. is rare in samples from the Corsicana Formation in North Central Texas.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of the *A. mayaroensis* Subzone.

Occurrence.–*Ventilabrella multicamerata* de Klasz was originally described from the Upper Cretaceous, late Maestrichtian Gerhardsreuter Beds, near Traunstein, Upper Bavaria, southeastern Germany (de Klasz, 1953, p. 230). De Klasz (ibid.) also noted this species in the middle Maestrichtian Gerhardsreuter Beds near Seigsdorf; from the late Maestrichtian Bucheck Beds near Eisenarzt, Upper Bavaria, southeastern Germany; in the Maestrichtian near Gan, southwestern France; and in the late Maestrichtian Mendez Shale at its type locality near Mendez Station, Veracruz, Mexico.

Martin (1972, p. 88) has observed *Ventilabrella multicamerata* in the middle Maestrichtian (*G. gansseri* Subzone, *R. fructicosa* Zonule) Escondido Formation of Medina County, Texas, and Papagallos Shale of Mexico, as well as the late Maestrichtian (*A. mayaroensis* Subzone) Mendez Shale of Mexico.

Ventilabrella multicamerata de Klasz is rare to common in samples from the Corsicana Formation of North Central Texas (see text figs. 5–8). It has not been observed from the Corsicana Formation of Travis County, Texas (see Appendix, Locality TX25).

Family PLANOMALINIDAE Bolli, Loeblich, and Tappan

Genus **Globigerinelloides** Cushman and Ten Dam, 1948

Type species.–*Globigerinelloides algeriana* Cushman and Ten Dam, 1948.

Remarks.–Berggren (1962, p. 45) and Pessagno (1967, p. 274) have noted that *Biglobigerinella* Lalicker (1948) is an artificial genus representing the adult stage of the planispiral *Globigerinelloides* group. The presence of biserial chambers with paired apertures, common to only a few species of *Globigerinelloides*, is regarded as a specific rather than a generic characteristic. Thus, *Biglobigerinella* Lalicker is not used herein.

Globigerinelloides multispina (Lalicker)

Plate 13, figures 1–2, 3–6, 7, 8–9, 10–11

1948. *Biglobigerinella multispina* LALICKER, p. 624, pl. 92, figs. 1a–c, 2a–b, 3a–c.
1956. *Globigerinella biforaminata* HOFKER, p. 53, text-figs. 2, 5.
1957. *Biglobigerinella multispina* Lalicker. BOLLI, et al., p. 25, pl. 1, figs. 11, 12a–b.
1960. *Biglobigerinella biforaminata* (Hofker). OLSSON, p. 44, pl. 8, figs. 7–8.
1961. *Planomalina multispina* (Lalicker). BARR, pp. 563–564, pl. 69, figs. 5a–b.
1962. *Planomalina (Globigerinelloides) messinae* (Bronnimann). BERGGREN, pp. 44–49, pl. 8, figs. 4a–c, 5a–c, 6a–c, (?) 7a–c, 8a–c; text-fig. 6: 2a–b, (?) 5a–b, not 1a–b, 3a–e, 4a–c, 6a–c; text-fig. 7: 6a–c, 7a–c, 8a–b, not 1a–b, 2a–b, 3a–b, 4a–b, 5a–b.
1963. *Planomalina (Globigerinelloides) messinae biforaminata* (Hofker). VAN HINTE, p. 102, pl. 12, figs. 4a–b.
1964. *Globigerinelloides messinae* (Bronnimann). OLSSON, pp. 174, 176, pl. 7, figs. 6a–b, 7a–b, 8a–b.
1967. *Globigerinelloides multispina* (Lalicker). PESSAGNO, pp. 276–277, pl. 70, figs 1–2; pl. 82, figs. 10–11; pl. 91, figs. 1–2.

Description.–Test planispiral, biumbilicate, semi-involute; peripheral margin circular, lobate; five or six chambers in the final whorl; chambers in lateral view subcircular to ovate, strongly inflated, increasing moderately in size as added; early chambers in apertural view spherical, increasing rapidly in width as added, final chamber somewhat flattened and broadly ovate, and occasionally may be either partially or completely divided into paired chambers; umbilici rather wide, deep, exposing portions of chambers in the penultimate whorl; sutures radial, straight to slightly curved, strongly depressed; wall coarsely papillose, more strongly ornamented on early three or four chambers of final whorl; finely perforate; aperture bipartite; interiomarginal, a wide and highly arched opening at each side of the ultimate chamber, extending from near the crest of the initial chamber of the final whorl into the umbilicus; each aperture bordered by a thickened, well developed lip and apertural flap; relict apertures and apertural flaps often preserved in umbilical areas.

Remarks.–*Globigerinelloides multispina* (Lalicker) varies from being involute to slightly evolute, and, as observed in apertural view, from a test whose chambers expand rather slowly to those whose chambers expand rapidly in width as added. Variation also exists in the position of the apertures on the apertural face of the terminal chamber. Often the apertures, as seen in apertural view, are more umbilical and extend to the sides of the initial chamber in the last whorl (Pl. 13, figs. 3–6). The apertures of other individuals become more strongly equatorial, almost merging at the crest of the initial chamber of the final whorl (Pl. 13, fig. 2).

As noted by Pessagno (1967, p. 277), *G. multispina* appears to have been derived from *Globigerinelloides prairiehillensis* Pessagno by becoming slightly more involute and by biapertural development. It is probable that the form illustrated herein in Plate 13, figures 1–2, represents an individual in the early stages of biapertural development. In later stages of development, the apertures assume a more umbilical position (Pl. 13, figs. 3, 7), terminating in a form whose ultimate (rarely penultimate) chamber becomes divided, resulting in biserial chambers on either side of the plane of coiling (Pl. 13, figs. 9, 11).

Globigerinella biforaminata Hofker, the uniserial biapertural form, is regarded as a junior synonym of *Biglobigerinella multispina* Lalicker, the biserial, biapertural form of this species. Pessagno (1967, p. 277) has noted that both forms invariably occur together, and that both have essentially the same geologic range.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, base of *P. elegans* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globigerinelloides multispina* is from the early Maestrichtian Marlbrook Marl, eight feet above the base, at its type locality, about one and one-half miles north of Saratoga, Howard County, Arkansas.

Pessagno (1967, p. 277) reported *G. multispina* from the Mendez Shale of Mexico; the Upson Clay, Wolfe City Sand, "Upper Taylor Marl", Neylandville Marl, and Corsicana Marl of Texas; and the Ozan Formation, Annona Chalk, Marlbrook Marl, Saratoga Chalk, and Arkadelphia Marl of southwestern Arkansas. Olsson (1960, p. 44; 1964, p. 176) noted this species from the Mt. Laurel-Navesink Formation of Delaware, and the Marshalltown and Navesink Formations of New Jersey.

Globigerinelloides multispina has also been reported in the Upper Cretaceous from the Isle of Wight, England, (Barr, 1961, p. 564), the Maestrichtian of southern Scandinavia (Berggren, 1962, pp. 44–49), and from the Late Cretaceous of Austria (van Hinte, 1963, p. 102).

Globigerinelloides prairiehillensis Pessagno

Plate 14, figures 1–2, 3–4

1962. *Planomalina (Globigerinelloides) messinae* (Bronnimann). BERGGREN, pp. 44–49, text-fig. 7, (?) 1a–b, 2a–b, (?) 3a–b, 5a–b.
1967. *Globigerinelloides prairiehillensis* PESSAGNO, pp. 277–278, pl. 60, figs. 2–3; pl. 83, fig. 1; pl. 90, figs. 1–2, 4; pl. 97, figs. 3, 4.

Remarks.–The description given by Pessagno (1967, p. 277) is followed herein. *Globigerinelloides prairiehillensis* is distinguished by its spherical to subspherical chambers which increase rapidly in size as added; by its deep umbilici; and by its low and broadly arched aperture.

An examination of topotypic material indicates that there is considerable variation in this species both in degree of chamber inflation in apertural view as well as in the character of the aperture. Forms similar to the holotype, showing rapid increase in chamber width in apertural view and a low arched aperture are herein referred to *Globigerinelloides prairiehillensis* s.s. (Pl. 14, figs. 1–2). Closely related individuals, having a more highly arched aperture, are referred to *G. prairiehillensis* s.l. (Pl. 14, figs. 3–4). Although the difference between the two end forms is distinct, numerous specimens can not be placed with any certainty into either end member.

Globigerinelloides prairiehillensis Pessagno differs from *G. volutus* (White) in having much narrower and deeper umbilici; chambers in apertural view which are much more inflated and increase rapidly in width as added; and in having a low, arched aperture. *G. prairiehillensis* differs from *G. asperus* (Ehrenberg) in being larger, having a more rapid increase in chamber size, and in having a low and broadly arched aperture.

Range.–*G. bulloides* Assemblage Zone, upper part of *G. fornicata* Subzone, to *G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, upper part of *R. fruticosa* Zonule.

Occurrence.–The type locality of *Globigerinelloides prairiehillensis* is from the late Campanian, "Upper Taylor Marl" Member, Taylor Formation, near Prairie Hill, Limestone County, Texas (Pessagno, 1967, p. 277; 1969, p. 88). Pessagno (1967, p. 278) recorded it in the Austin Chalk, "Lower Taylor Marl", Wolfe City Sand, Pecan Gap Chalk, "Upper Taylor Marl", and the Neylandville Marl of Texas; Brownstown Marl, Ozan Formation, Annona Chalk, Marlbrook Marl, and Saratoga Chalk of Arkansas; lower and middle portions of the Mendez Shale in Mexico; and from the Parguera Limestone and Rio Yauco Formation in Puerto Rico.

Berggren (1962, pp. 48, 49) described *G. prairiehillensis* as *Planomalina (Globigerinelloides) messinae* (Bronnimann) from the latest Maestrichtian, Kjolby Gaard Marl of southern Scandinavia.

Forms which can be assigned with certainty to *G. prairiehillensis* s.s. are rare. However, *G. prairiehillensis* s.l. is abundant in the Corsicana Formation of North Central Texas (see text figs. 4–8).

Globigerinelloides (?) rosebudensis
Smith and Pessagno, n. sp.

Plate 15, figures 1–4, 5–8, 9–12

Description.–Test low trochospiral, biumblicate, involute to slightly evolute, laterally compressed, with a broad imperforate peripheral band, peripheral margin ovate, lobate; six or seven chambers in the final whorl; chambers in lateral view ovoid, weakly inflated, increasing gradually in size as added; chambers in apertural view initially spherical to subspherical, expanding only slightly in width as added, terminal two or three chambers becoming compressed and elongate-ellipsoidal in shape; umbilici wide, shallow; evolute side showing portions of chambers of previous whorls, opposite side more strongly involute; sutures radial, straight to slightly curved, depressed; chamber surfaces finely papillose to smooth, more coarsely ornamented on early chambers of last whorl; wall rather coarsely perforate except for broad imperforate peripheral band; aperture interiomarginal, spiro-umbilical, a broad asymmetrical arch extending onto the umbilical side of the test; primary aperture bordered by a thickened, well-developed lip extending into the umbilici; liplike relict apertural borders of terminal two or three chambers preserved in umbilical areas.

Remarks.–The placement of this species in *Globigerinelloides* Cushman and Ten Dam is questionable. It differs from *Globigerinelloides* in being low trochospiral rather than planispiral, and in having a spiro-umbilical rather than equitorial primary aperture. It is further distinguished by being one of the few known species of *Globigerinelloides* to possess an imperforate peripheral band.

Two distinct forms of *G.* (?) *rosebudensis*, n. sp., have been observed during this investigation. The somewhat larger specimens having laterally compressed ultimate chambers (elongate-ellipsoidal in shape) are herein referred to *G.* (?) *rosebudensis* s.s. (Pl. 15, figs. 1–4). Smaller specimens, herein referred to *G.* (?) *rosebudensis* s.l. (Pl. 15, figs. 5–8), are generally less compressed laterally and have ultimate chambers which are spherical to subspherical. At present, both forms are regarded as variants since they have the same stratigraphic range and invariably occur together.

Globigerinelloides (?) *rosebudensis*, n. sp., is named after the town of Rosebud, Falls County, Texas.

Dimensions.–Holotype measures 286μ in length, 217μ in width, and 87μ in maximum thickness. Paratypes vary from 166μ to 290μ in length; 140μ to 217μ in width; and 66μ to 86μ in thickness.

Type locality.–Hand auger sample about three feet below surface of roadside ditch along southern side of Farm Road 413, 3.4 miles north 78 degrees east of the intersection of U.S. Highway 77 with Texas Highway 53 in Rosebud, Falls County, Texas (see Appendix, Locality TX3).

Deposition of types.–The holotype (USNM 170538) and figured paratype (USNM 170539) of *G.* (?) *rosebudensis* n. sp., will be deposited in the collections of the U.S. National Museum, Washington, D.C. Unfigured paratypes (CS 4–6) will be deposited in the Pessagno Collection, Geosciences Division, The University of Texas at Dallas.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule (insofar known).

Occurrence.–Globigerinelloides (?) *rosebudensis*, n. sp., occurs throughout the Corsicana Formation (*R. fructicosa* Zonule) in North Central Texas (see text figs. 5–8). It has also been observed in the Arkadelphia Marl (*R. fructicosa* Zonule) of Arkansas (see Appendix, Pessagno sample AR8). It was not observed in the Corsicana Formation exposed along Onion Creek (*G. aegyptiaca* Zonule), Travis County, Texas.

Examination of both older and younger units in the western Gulf Coastal Plain indicates that *G.* (?) *rosebudensis* is restricted, insofar as known, to the middle Maestrichtian (*R. fructicosa* Zonule).

Globigerinelloides subcarinatus (Bronnimann)

Plate 16, figures 10–12

1952. *Globigerinella messinae subcarinata* BRONNIMANN, pp. 44–45, pl. 1, figs. 10–11; text-figs. 21a–m.
1955. *Globotruncana (Rugoglobigerina) beldingi subbeldingi* GANDOLFI, p. 32, pl. 1, figs. 7a–c; text-fig. 7: 3a–c.
1967. *Globigerinelloides subcarinatus* (Bronnimann). PESSAGNO, p. 278, pl. 62, figs. 12, 13.

Description.–Test planispiral, biumbilicate, involute, laterally compressed; peripheral margin ovate, strongly lobate, often with imperforate peripheral band; four or five chambers in the final whorl; chambers in lateral view subcircular to petaloid, increasing rapidly in size as added, the ultimate chamber often the same size or somewhat smaller than the penultimate chamber; final two chambers comprising about one-half the test; chambers in apertural view much compressed, elongate-ellipsoidal, expanding gradually in width as added; umbilici small, shallow; sutures radial, straight to slightly curved, strongly depressed; wall finely papillose, spinose along peripheral margin, ultimate chamber smooth or only slightly papillose; wall finely perforate; aperture equatorial, interiomarginal, a low semicircular arch extending laterally over the initial chamber of the final whorl, bordered by a thin lip.

Remarks.–Globigerinelloides subcarinatus (Bronnimann) differs from *G. volutus* (White) by (1) having a more strongly compressed test in apertural view, (2) four (rarely five) chambers in the final whorl, (3) petaloid chambers in lateral view, (4) elongate-ellipsoidal chambers in aper-

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PLATE 15

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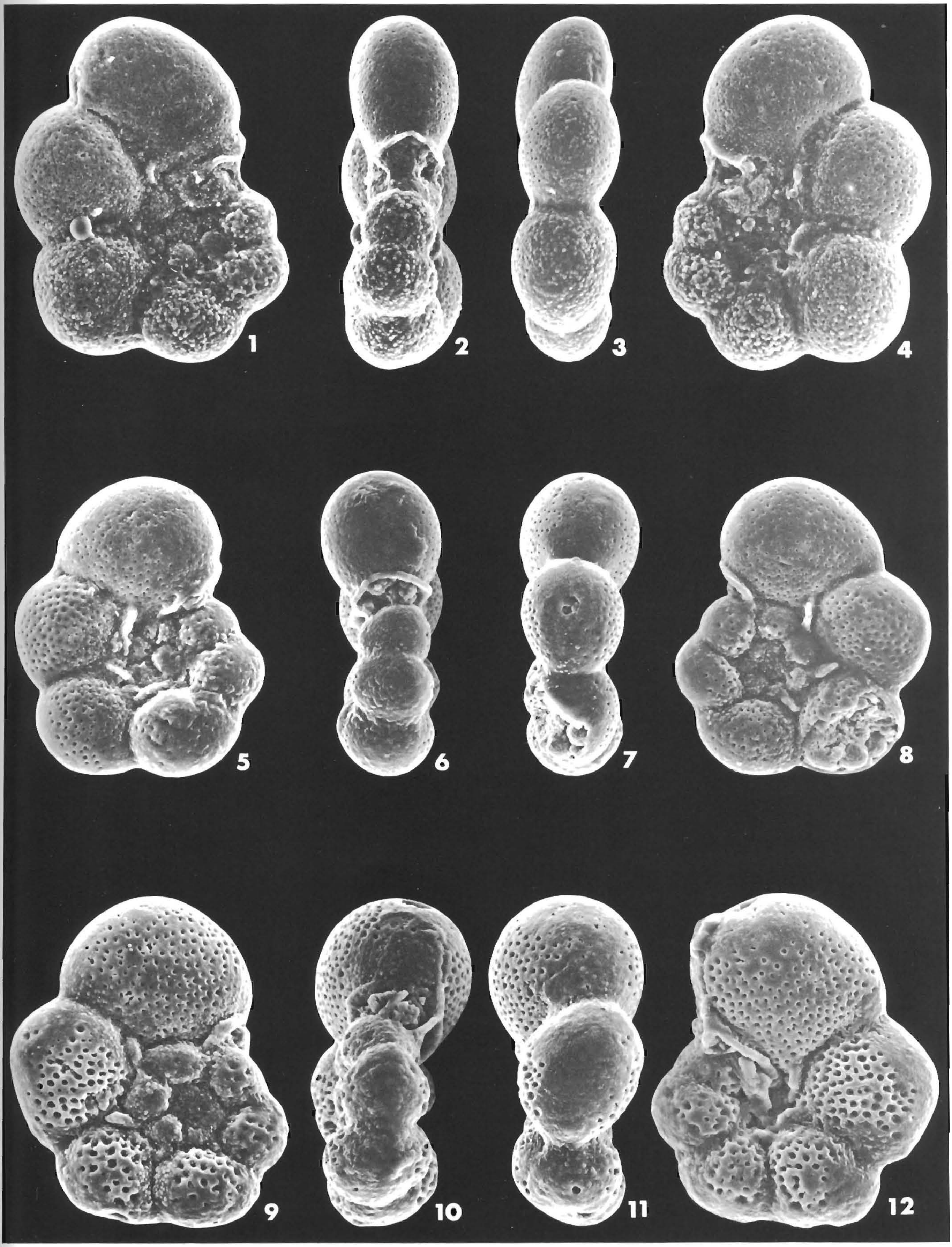
1–4. *Globigerinelloides* (?) *rosebudensis* s.s. Smith and Pessagno, n. sp. 39
TX3BA-28C3. Holotype (USNM 170538). Note the low trochospiral test; compressed and ovate chambers as observed in apertural and abapertural views; wide and shallow umbilici; and rather broad, imperforate peripheral band; 210×. Figure 1 shows the more evolute side of the test.

5–8. *Globigerinelloides* (?) *rosebudensis* s.l. Smith and Pessagno, n. sp. 39
TX3BA-0E56. Paratype (USNM 170539). Note the smaller size of the test and spherical to subterminal chambers. Figures 5 (umbilical side) and 8 (spiral side) show distinct and well-preserved relict apertural lips. Note the broad imperforate peripheral band; 310×.

9–12. *Globigerinelloides* (?) sp. aff. *G. rosebudensis* Smith and Pessagno, n. sp. 39
TX3BA-0E57. Individual with a strongly trochospiral test. Note the aperture extending only slightly onto the spiral side (Figure 9) and continuing into the umbilicus on the umbilical side of the test (Figure 12). Note the more coarsely perforate test and relict apertural lips; 340×.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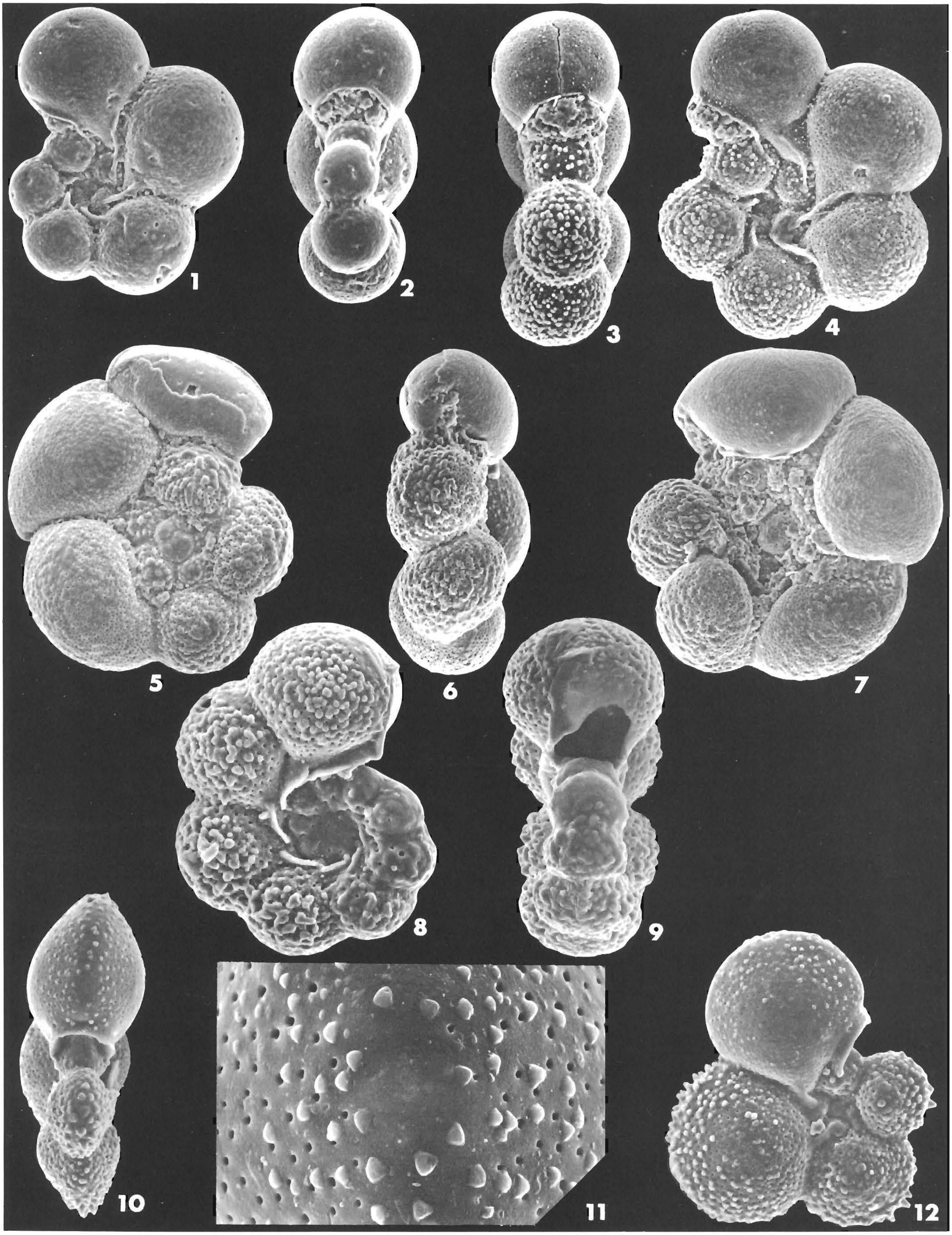
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tural view, (5) two final chambers which comprise about one-half the test, (6) much narrower umbilici, (7) having a spinose peripheral margin, and (8) a distinct imperforate peripheral band (Pl. 16, fig. 11).

Pessagno (1967, p. 278) noted that an examination of the holotype of *Globotruncana* (*Rugoglobigerina*) *beldingi subbeldingi* Gandolfi and comparison with the holotype and paratype of *G. subcarinatus* indicates that Gandolfi's species is a junior synonym of *G. subcarinatus* (Bronnimann).

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, upper part of *G. calcarata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globigerinelloides subcarinatus* is from the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) exposed in the Guayaguayare area in southeastern Trinidad (Bronnimann, 1952, pp. 6, 44–45). Gandolfi recorded it under the name of *G.* (*R.*) *beldingi subbeldingi* in the late Campanian and early Maestrichtian of northeastern Colombia, and Pessagno (1967, p. 278) noted it in the Mendez Shale of Mexico.

Globigerinelloides volutus (White)

Plate 16, figures 1–2, 3–4

1928a. *Globigerina voluta* WHITE, pp. 197–198, pl. 28, figs. 5a–b.
1952. *Globigerinella messinae messinae* BRONNIMANN, pp. 42–44, pl. 1, figs. 6–7; text-figs. 20a–q.
1967. *Globigerinelloides volutus* (White). PESSAGNO, pp. 278–279, pl. 62, figs. 9, 10–11; pl. 100, fig. 9.

Description.–Test planispiral, biumbilicate, involute to slightly evolute, laterally compressed; peripheral margin circular to ovate, strongly lobate; five or six chambers in the final whorl; chambers in lateral view subcircular to slightly ovoid, inflated, increasing gradually in size as added; chambers in apertural view spherical to ellipsoidal, expanding only slightly in width as added; umbilici wide, shallow, exposing portions of chambers in the previous whorl and the lip-like projections of relict apertural borders of chambers in the final whorl; sutures radial, straight, strongly depressed; wall finely papillose to smooth, more strongly ornamented on early chambers, finely perforate; aperture equatorial, interiomarginal, a broad, highly arched, semicircular opening extending over the peripheral margin of the initial chamber of the final whorl; bordered by a thin lip, with lateral lip-like projections extending into the umbilici.

Remarks.–Pessagno (1967, p. 278) noted that White's types of *Globigerina voluta* are missing from the Columbia University Paleontology Collection. Pessagno (ibid.) reexamined samples from the Mendez Shale at Mendez Station, the type locality of *G. voluta*, and noted that only two species of *Globigerinelloides* occur in the material; i.e., *G. messinae* (Bronnimann) and *G. subcarinatus* (Bronnimann). Pessagno (ibid.) concluded that although White's drawings of *G. volutus* were not accurate, the only individuals in the type material similar to White's drawings were specimens of *G. messinae* (Bronnimann). He thus concluded that *G. voluta* White was a senior synonym of *G. messinae* (Bronnimann).

Globigerinelloides volutus (White) differs from *G. prairiehillensis* Pessagno by having (1) a more laterally compressed test, (2) a more strongly lobate periphery, (3) chambers which increase gradually in size in lateral view and only slightly in width in apertural view, (4) broad and shallow umbilici, and (5) a more highly arched aperture.

Globigerinelloides volutus (White) differs from *G. subcarinatus* (Bronnimann) by having (1) a test which is much less laterally compressed, (2) five or six chambers in the final whorl, (3) chambers which are spherical to subspherical rather than ovoid and elongate, (4) much wider umbilici, and (5) by lacking an imperforate peripheral band.

Range.–*G. fornicata-stuartiformis* Assemblage Zone lower part of *G. elevata* Subzone, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globigerinelloides volutus* (White) is in the type locality of the Mendez Shale, about 2.6 kilometers east of Mendez Station along the

PLATE 16

		Page
1–2, 3–4.	*Globigerinelloides volutus* (White) .... 1–2, TX9XE-43AB8, 165×; 3–4, TX2BA-27B12, 185×. Note the lobate peripheral margin, gradual increase in chamber size, and wide, shallow umbilici exposing relict apertural lips.	41
5–7.	*Loeblichella hessi* (Pessagno) .... TX4AC-49B34. Note the low trochospiral test, subtrapezoidal terminal chambers, coarsely rugose initial chambers, and slit-like primary aperture. Sutural supplementary apertures on the spiral side of the test are filled with matrix; 145×.	42
8–9.	*Globigerinelloides* sp. a. .... TX20XA-0C31. Individual with a strongly evolute test, numerous small chambers in the final whorl, and rather highly arched primary aperture. Note the relict apertural flaps; 210×.	42
10–12.	*Globigerinelloides subcarinatus* (Bronnimann) . TX20XC-0C32. 10, 12, Note the strongly compressed test, rapid increase in chamber size, strongly lobate peripheral margin, and small umbilicus; 190×. 11, Enlargement showing the narrow, imperforate peripheral band, and finely perforate and papillose chamber well; 755×.	40

Tampico-Cuidad Valles Railroad (White, 1928a, p. 182, loc. 28; p. 197).

Pessagno (1967, p. 279) noted *G. volutus* in the type locality of the Mendez Shale of Mexico; "Upper Taylor Marl", Neylandville Marl, and Corsicana Marl of Texas; and in the Saratoga Chalk of southwestern Arkansas. Bronnimann (1952, p. 44) described this species as *G. messinae messinae* from the Guayaguayare Formation (late Maestrichtian, *A. mayaroensis* Subzone) of Trinidad and Bolli (1959, p. 261) recorded it in the Naparima Hill and Guayaguayare Formations of Trinidad. Its distribution and relative abundance in the Corsicana Formation of Texas are shown in text figs. 4–8.

Globigerinelloides sp. a

Plate 16, figures 8–9

Remarks.–Globigerinelloides sp. a differs from *Globigerinelloides prairiehillensis* Pessagno (1) by having a strongly evolute rather than involute test, (2) by having seven or eight chambers in the final whorl which increase very gradually in size as added, (3) by having chambers in apertural view which expand only slightly in width as added, (4) by having wider umbilici, and (5) by having a more highly arched primary aperture.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule (insofar known).

Occurrence.–Globigerinelloides sp. a is rare in samples from the Corsicana Formation in North Central Texas (see text figs. 5–8). It has been observed in the Arkadelphia Marl of Arkansas, middle Maestrichtian, *G. gansseri* Subzone (see Appendix, Pessagno sample AR18), and in the Papagallos Shale of Mexico, middle Maestrichtian, *R. fructicosa* Zonule (Pessagno sample MX174).

Family ROTALIPORIDAE Sigal
Subfamily LOEBLICHELLINAE Pessagno

Genus **Loeblichella** Pessagno, 1967

Type species.–Praeglobotruncana hessi s.s. Pessagno, 1962.

*Remarks.–*The description given by Pessagno (1967, p. 288) is followed herein.

Loeblichella hessi (Pessagno)

Plate 16, figures 5–7

1962. *Praeglobotruncana hessi hessi* PESSAGNO, pp. 358–360, pl. 5, figs. 8–9, 10–12 (holotype).
1967. *Loeblichella hessi* (Pessagno). PESSAGNO, 1967, p. 288, pl. 48, figs. 17–19; pl. 61, figs. 6–8, 9–11; pl. 100, figs. 1, 2.

*Remarks.–*The description given by Pessagno (1967, p. 288) is followed herein. *Loeblichella hessi* differs from *L. coarctata* (Bolli) by lacking an angled periphery.

Range.–G. fornicata-stuartiformis Assemblage Zone to *G. contusa-stuartiformis* Assemblage Zone.

*Occurrence.–*This species was originally defined by Pessagno (1962, p. 358) from the early Maestrichtian (*R. subcircumnodifer* Subzone) portion of the Rio Yauco Formation of Puerto Rico. Pessagno (1967, p. 288) noted *L. hessi* in the "Lower Taylor Marl", Pecan Gap Chalk, "Upper Taylor Marl", and Corsicana Formations of Texas. Although Pessagno (ibid.) recorded it from the Eagle Ford Group of Texas, it now appears the Eagle Ford specimens (e.g., Pessagno, 1967, pl. 48, figs. 17–19; pl. 100, figs. 1, 2) represent a separate species of *Loeblichella*. He (ibid., p. 288) also observed it in the Brownstown Marl of Arkansas, San Felipe Formation of Mexico, as well as from the late Campanian of Austria.

Family GLOBOTRUNCANIDAE Brotzen

Genus **Globotruncana** Cushman, 1927

Type species.–Pulvinulina arca Cushman, 1926.

*Remarks.–*The description of Loeblich and Tappan (1964, pp. C662–C663) as modified by Pessagno (1967, pp. 318–319) is followed herein.

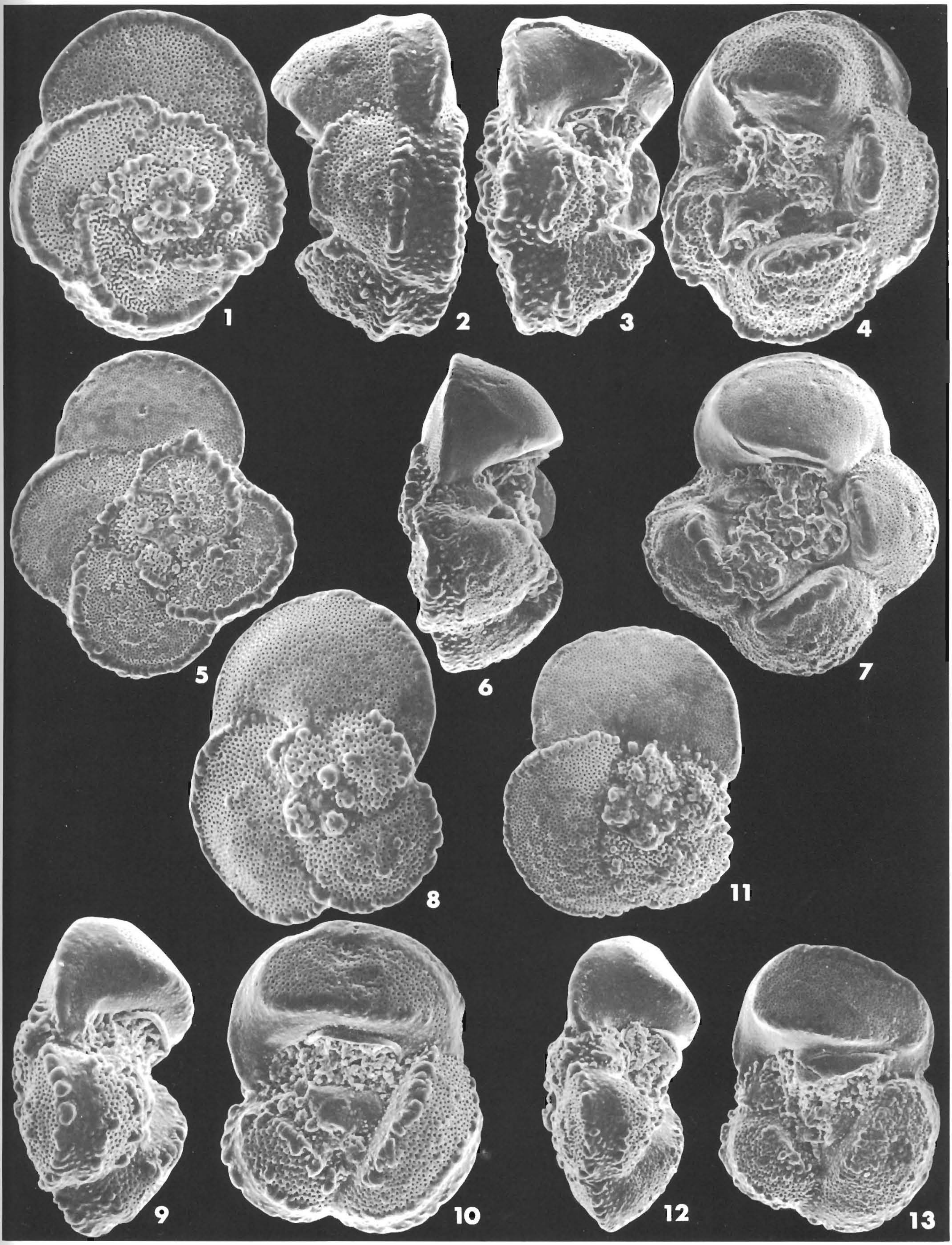
Globotruncana aegyptiaca Nakkady

Plate 17, figures 1–4, 5–7

1950. *Globotruncana aegyptiaca* NAKKADY, p. 690, pl. 90, figs. 20, 21, 22.
1951. *Globotruncana gagnebini* TILEV, pp. 50–56, text-figs. 14a–e, 15a–d, 16a–d, 17a–d; pl. 3, figs. 2a–c, 3a–d, 4a–c, 5a–d.
1954. *Globotruncana aegyptiaca* Nakkady. NAKKADY and OSMAN, pp. 75–76, pl. 20, figs. 20a–c.

PLATE 17

		Page
1–4.	*Globotruncana aegyptiaca* Nakkady .... TX4AE-0E1. Note the convex umbilical side of the test, crescentic to petaloid shaped spiral chambers, and the wide umbilicus and roughened umbilical collar. Note the somewhat atypical wide double keel; 140×.	42
5–7.	*Globotruncana aegyptiaca* Nakkady .... TX20XB-0E53. Note the narrow double keel, typical of individuals belonging to this species; 105×.	42
8–10, 11–13.	*Globotruncana duwi* Nakkady .... 8–10, TX4AB-0C59, 155×; 11–13, TX4AC-0C53, 120×. Note the three chambers in the final whorl which increase rapidly in size as added. The penultimate and ultimate chambers characteristically comprise three-fourths of the test.	46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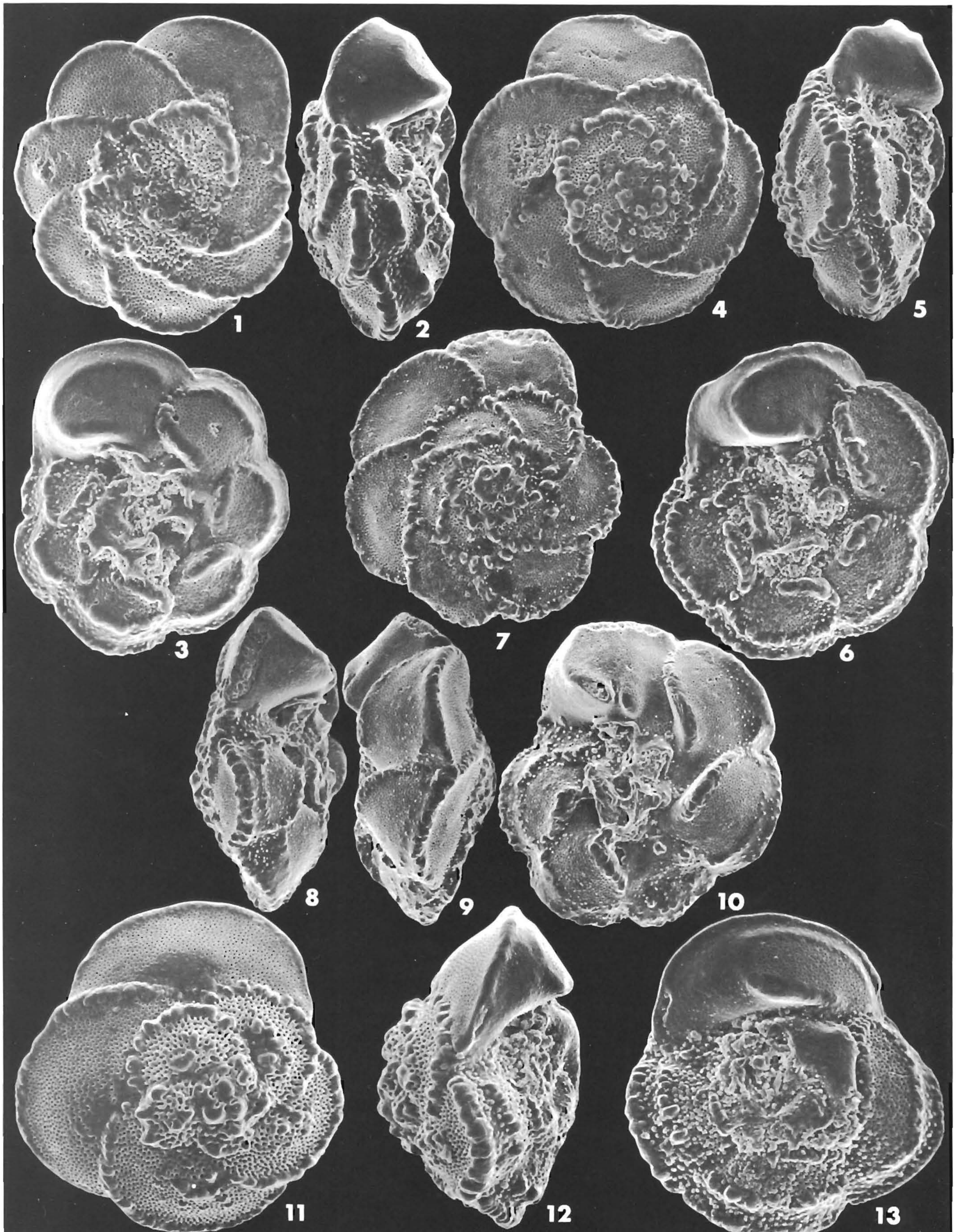

SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

1955. (?) *Globotruncana* aff. *cretacea* Cushman. GANDOLFI, p. 62, pl. 4, figs. 7a–c.
1957. *Globotruncana gagnebini* Tilev. BOLLI, p. 59, pl. 14, figs. 5a–c.
1962. *Globotruncana* (*Rugotruncana*) *gansseri dicarinata* PESSAGNO, p. 103, pl. 2, figs. 9–11; not pl. 3, figs. 1–3; not pl. 5, fig. 5.
1963. *Globotruncana* (*Globotruncana*) *aegyptiaca* Nakkady. VAN HINTE, p. 87, pl. 8, figs. 1a–c, (?) 2a–c.
1964. *Globotruncana gagnebini* Tilev. OLSSON, p. 165, pl. 4, figs. 4a–c.
1966. *Globotruncana gagnebini* Tilev. EL-NAGGAR, pp. 111–113, pl. 2, figs. 1a–d, 2a–d, 3a–d, 4a–d; pl. 3, figs. 1a–d, 3a–d, 6.
1966. *Globotruncana gansseri dicarinata* Pessagno. EL-NAGGAR, pp. 114–115, pl. 5, figs. 4a–d.
1967. *Globotruncana aegyptiaca* Nakkady. PESSAGNO, pp. 319–321, pl. 79, figs. 2–4; pl. 83, figs. 8–10; pl. 94, fig. 6; pl. 95, figs. 8–9.
1972. *Globotruncana gagnebini* Tilev. BARR, p. 21, pl. 8, figs. 5a–c.

Remarks.–The description given by Pessagno (1967, p. 319) is complete and will not be duplicated herein. *Globotruncana aegyptiaca* is distinguished by the planoconvex test; wide umbilicus bordered by a roughened umbilical collar; and the narrow double keel which may merge to form a single keel along the final one or two chambers.

Nakkady (1950, p. 690) described *G. aegyptiaca* var. *duwi* and *G. aegyptiaca* var. 1 as distinct variants of *G. aegyptiaca.* Although Berggren (1962, p. 59) stated that *G. aegyptiaca* var. *duwi* ". . . can probably be included in *G. aegyptiaca* s.s.", the present investigators regard the two forms as morphologically distinct species. Berggren (ibid.) also examined the holotype and paratype of *G. aegyptiaca* var. 1 and suggested that the variety belonged to *Globotruncana gansseri* Bolli.

Berggren (1962, p. 59) and Pessagno (1967, p. 320) regarded *Globotruncana gagnebini* Tilev as a junior synonym of *G. aegyptiaca* Nakkady. In addition, Pessagno has examined the hypotypes of *G. gagnebini* Tilev and *G. gansseri dicarinata* Pessagno of El-Naggar (1966, see synonomy) deposited in the British Museum (Nat. History), and found them to belong to *G. aegyptiaca* Nakkady.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, lower part of *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *G. aegyptiaca* Nakkady is from the Maestrichtian Esna Shales in the Abu Durba section, southwestern Sinai, Egypt. Nakkady (1950, p. 690) also noted it from the Maestrichtian of the Gebel Duwi section (Eastern Desert), Egypt.

Tilev (1951, p. 50) described this species as *G. gagnebini* from the upper Maestrichtian of Turkey. It has since been recorded from the middle and late Maestrichtian of Libya (Barr, 1972, p. 21); upper Maestrichtian of Austria (van Hinte, 1963, p. 87); upper Maestrichtian of Scandinavia (Berggren, 1962, p. 59); Maestrichtian of Colombia (Gandolfi, 1955, p. 62); upper Maestrichtian of Trinidad (Bolli, 1957, p. 59); and the middle Maestrichtian of New Jersey (Olsson, 1964, p. 165). Pessagno (1967, pp. 320–321) noted *G. aegyptiaca* in the late Maestrichtian, upper part of the Mendez Shale of Mexico, and the middle Maestrichtian Corsicana Formation of Texas and Arkadelphia Formation of Arkansas.

Globotruncana aegyptiaca is very abundant throughout the Corsicana Formation of Central and North Central Texas. It has also been observed in the Escondido Formation (middle Maestrichtian, *G. gansseri* Subzone) exposed along Seco Creek, Medina County, Texas, as well as from Maestrichtian samples from the Rio Grande Rise, JOIDES, Leg III (see Appendix).

Globotruncana arca (Cushman)

Plate 18, figures 1–3, 4–6

1926. *Pulvinulina arca* CUSHMAN, p. 23, pl. 3, figs. 1a–c.
1931. *Globotruncana arca* (Cushman). PLUMMER, pp. 195–198, pl. 13, figs. 8a–c; not figs. 7a–c, 9a–c, 11a–c.
1946. *Globotruncana arca* (Cushman). CUSHMAN, p. 150, pl. 62, figs. 4a–c; not figs. 5a–c.
1955. *Globotruncana arca arca* (Cushman). GANDOLFI, pp. 63–64, pl. 5, figs. 2a–c, 3a–c, 4a–c.
1956. *Globotruncana arca* (Cushman). BRONNIMANN and BROWN, pp. 539–540, pl. 23, figs. 10–12.
1957. *Globotruncana arca* (Cushman). BOLLI, et al., pp. 44–46, pl. 11, figs. 6, 7a–c, 8, 9, 10, 11a–c.
1960. *Globotruncana leupoldi* Bolli. OLSSON, p. 50, pl. 11, figs. 1–3.
1962. *Globotruncana arca* (Cushman). BERGGREN, pp. 49–51, pl. 9, figs. 1a–c, 2a–c.
1964. *Globotruncana arca* (Cushman). LOEBLICH and TAPPAN, pp. C662–C663, fig. 529: 1a–c, 2.
1964. *Globotruncana goudkoffi* MARTIN, p. 80, pl. 10, figs. 1a–c.

PLATE 18

		Page
1–3, 4–6.	*Globotruncana arca* (Cushman) . . . . 1–3, TX4AD-0C58, 120×; 4–6, TX4AC-2C50, 105×. Note the biconvex test, six or seven chambers which increase slightly in size as added, the truncate and flattened chambers umbilically, and the wide, umbilically reflected double keel.	43
7–10.	*Globotruncana stephensoni* Pessagno . . . . TX3BA-0E28. Note the sharply angled periphery and narrow double keel which merges along the final few chambers (Figure 9); 85×. Compare with *G. arca* (Figures 2, 5).	51
11–13.	*Globotruncana trinidadensis* Gandolfi . . . . TX4AC-10E51. Note the biconvex test, four or five crescentic to petaloid shaped and somewhat inflated chambers spirally, the truncate and flattened chambers umbilically, and the umbilically reflected rather wide double keel; 140×.	54

1964. *Globotruncana arca* (Cushman). OLSSON, pp. 162–163, pl. 4, figs. 1a–c, 2a–c, 3a–c.
1967. *Globotruncana arca* (Cushman). PESSAGNO, pp. 321–323, pl. 79, figs. 5, 6–8; pl. 90, figs. 6–8; pl. 96, figs. 7, 8, 17.
1971a. *Globotruncana arca* (Cushman). EL-NAGGAR, pl. 5, figs. g–i, j–l.
1972. *Globotruncana arca* (Cushman). BARR, p. 18, pl. 6, figs. 7a–c.

Remarks.–*Globotruncana arca* (Cushman) has been adequately described by Pessagno (1967, p. 321). *Globotruncana arca* is characterized (1) by having six to seven (rarely eight) petaloid and flattened chambers which expand slowly in size as added, (2) well developed double keel which tends to be inturned umbilically, and (3) wide umbilicus which is bordered by a roughened, heavily beaded, umbilical shoulder.

Cushman (1926, p. 23) originally described this species as *Pulvinulina arca*. Later (1927d, p. 91), when he erected the genus *Globotruncana* he designated *P. arca* as its type species. Pessagno (1967, pp. 321–322) noted that Cushman (1946, p. 150, pl. 62, figs. 4a–c, 5a–c) confused the recognition of *G. arca* by figuring both double and single-keeled forms. Pessagno (ibid.) referred the single-keeled form (Cushman, 1946, pl. 62, figs. 5a–c) to *G. elevata* (Brotzen).

Globotruncana arca (Cushman) is closely related to *G. stephensoni* Pessagno. It differs from the former species by (1) possessing a wide, well developed double keel, and (2) a broadly truncate periphery.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone, lower part of *D. multicostata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–Cushman (1926, p. 23) originally described *Pulvinulina arca* and stated that its type locality was near Huiches, Hacienda El Limon, San Luis Potosi, Mexico. Lacking additional detail regarding Cushman's locality, Pessagno (1967, p. 323) suggested that the type locality for *G. arca* be defined as the road cut immediately east of the bridge over the Rio Huiches along the highway from Tampico to Ciudad Valles, about 2.2 kilometers east of Tamuin. This site is within the area mentioned by Cushman (1926, p. 23), and may possibly be the locality from which his samples were collected. Pessagno (ibid.) found that samples from the Mendez Shale at this locality contained a planktonic assemblage assignable to the late Maestrichtian, *A. mayaroensis* Subzone.

Recorded occurrences of *Globotruncana arca* indicate that it has a world-wide distribution in Campanian and Maestrichtian strata in both the Boreal and Tethyan faunal provinces. Douglas and Sliter (1966, p. 107) noted *G. arca* from the Campanian and Maestrichtian of California, and Olsson (1964, p. 163) recorded it from the Maestrichtian, Navesink and Redbank Formations of New Jersey. In Mexico, Pessagno (1967, p. 322) noted it in the Campanian and Maestrichtian portions of the Mendez Shale, and the early Campanian portion of the San Felipe Formation. Pessagno (ibid., p. 323) observed *G. arca* in the late Campanian "Upper Taylor Marl", and the early Maestrichtian Upson Clay, of Texas, while Bolli, et al. (1957, p. 46) recorded it from the Corsicana Formation in Williamson County, Texas. In Arkansas, Pessagno (ibid.) noted it in the Campanian Ozan Formation, and early Maestrichtian Marlbrook Marl.

During the present investigation, *Globotruncana arca* has been found to be an important component in the planktonic foraminiferal assemblage of the Corsicana Formation of Texas (see text figs. 4–8). It has also been observed in the Escondido Formation (*G. gansseri* Subzone) exposed along Seco Creek, Medina County, Texas, as well as from Maestrichtian samples from the Rio Grande Rise, JOIDES, Leg III (see Appendix).

Globotruncana conica White

Plate 19, figures 7–9

1928b. *Globotruncana conica* WHITE, p. 285, pl. 38, figs. 7a–c.
1950. Not *Globotruncana arca* var. *esnehensis* NAKKADY, p. 690, pl. 90, figs. 23–26.
1951. *Globotruncana conica* White. BOLLI, p. 196, pl. 34, figs. 13–15.
1954. *Globotruncana esnehensis* Nakkady. NAKKADY and OSMAN, pp. 79–80, pl. 19, figs. 3a–c.
1955. *Globotruncana stuarti conica* (White). GANDOLFI, pp. 65–66, pl. 5, figs. 8a–c.
1961. *Globotruncana esnehensis* Nakkady. SAID and KERDANY, p. 331, pl. 2, figs. 12a–c.
1962. Not *Globotruncana conica* White. PESSAGNO, p. 362, pl. 4, figs. 13–14; text-fig. 4.
1966. *Globotruncana conica* White. EL-NAGGAR, pp. 87–90, pl. 12, figs. 2a–d.

PLATE 19

		Page
1–3, 4–6.	*Globotruncana elevata* (Brotzen) .... 1–3, TX2AD-0E19, 85×; 4–6, TX4AC-6A13, 85×. Note the umbilicoconvex test (1–3, T'X/TX = 1.71; 4–6, T'X/TX = 1.56), and planiform single-keeled peripheral margin.	47
7–9.	*Globotruncana conica* White .... TX9AG-9AA8. Note the strongly spiroconvex test (T'X/TX = 0.40), straight to slightly curved sutures both spirally and umbilically, and the prominent single keel; 120×.	44
10–12.	*Globotruncana stuartiformis* Dalbiez .... TX2AA-51. Note the biconvex test (T'X/TX = 1.14), subtriangularly-shaped chambers spirally, and prominent sigmoidal single keel; 120×. Compare with *G. elevata* (Figures 1–3, 4–6).	52

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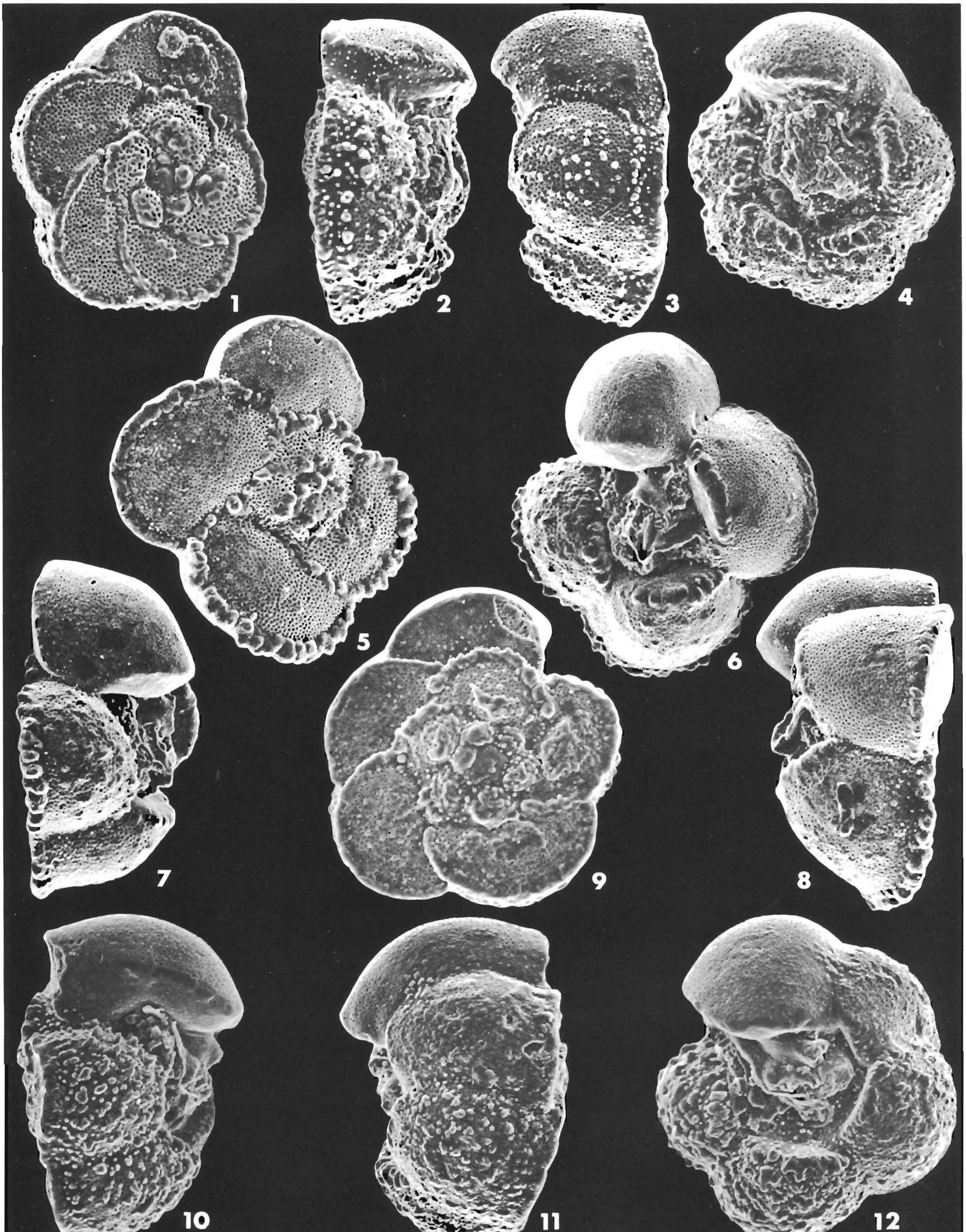

SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

1966. (?)*Globotruncana orientalis* EL-NAGGAR, pp. 125–127, pl. 12, figs. 4a–d.
1966. *Globotruncana sharawnaensis* EL-NAGGAR, pp. 130–131, pl. 12, figs. 3a–d.
1967. *Globotruncana conica* White. PESSAGNO, pp. 328–330, pl. 65, figs. 8–10; pl. 85, figs. 1–2, 3–5; pl. 93, figs. 12, 13; text-figs. 36, 37.
1969. Not *Globotruncana conica* White. DUPEUBLE, p. 157, pl. 2, figs. 6a–d.
1972. Not *Globotruncana conica* White. BARR, p. 19, pl. 6, figs. 2a–c.

Remarks.–The description of *Globotruncana conica* given by Pessagno (1967, pp. 328–329) is followed herein. Pessagno (ibid.) noted that *G. conica* White and *G. stuarti* (de Lapparent) are closely related. *Globotruncana conica* can be separated from *G. stuarti* only by the more highly spiroconvex nature of its test.

The mean T′X/TX value (Pessagno, 1967, p. 251, text-fig. B), a measure of the convexity of the umbilical versus the spiral side of the test (where T′X/TX values less than 1.00 represent spiroconvex tests, 1.00 biconvex, and greater than 1.00 umbilicoconvex tests), has been shown to be a valuable indicator in differentiating *G. conica* from *G. stuarti.* Pessagno (ibid., p. 329; p. 333, text-fig. 37) differentiates the two species, at least in part, by their T′X/TX values. Specimens having a T′X/TX value less than 0.45 are referred to *G. conica* White; values greater than 0.45 and less than 0.58 are transitional; and specimens with values greater than 0.58 are referred to *G. stuarti* (de Lapparent). Pessagno (1967, pp. 328–329) noted that the mean T′X/TX value of 12 measured specimens of *G. conica* was 0.281.

Nakkady (1950, p. 690) distinguished *G. arca* var. *esnehensis* from *G. conica* White by having fewer chambers and more strongly curved sutures on the spiral side of the test. An examination of the holotype (P 41780) and eleven paratypes (P 41781) in the British Museum (Nat. History) indicate the presence of a narrow double keel along the initial chambers of the final whorl which merges into a single keel.

Pessagno examined the holotype and paratypes of *G. orientalis* El-Naggar (1966, pp. 125–127) and *G. sharawnaensis* El-Naggar (ibid., pp. 130–131). Although *G. orientalis* is described as having two closely-spaced keels which merge in the final part of the last whorl, the holotype (slide P. 45549, B.M.N.H.) and paratypes were observed to be single keeled throughout. It is herein questionably assigned to *G. conica.*

Globotruncana sharawnaensis El-Naggar was originally described as being single keeled along the early chambers of the last whorl, but having two closely-spaced keels on the last chamber of the ultimate whorl. The holotype (slide P. 45553, B.M.N.H.) was examined and found to be single-keeled throughout, with a T′X/TX value of about 0.29 (strongly spiroconvex). It is herein regarded as a junior synonym of *G. conica* White.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *G. conica* is in an exposure of the Mendez Shale (late Maestrichtian, *A. mayaroensis* Subzone) about 2.2 kilometers east of Tamuin (= Guerrero), San Luis Potosi, Mexico. *G. conica* has been reported from the middle and late Maestrichtian of Egypt (Nakkady and Osman, 1954, p. 80; Said and Kerdany 1961, p. 331; El-Naggar, 1966, p. 90); and the late Maestrichtian portion of the Colon Shale of Colombia (Gandolfi, 1955, p. 66). Pessagno (1967, p. 330) noted it from the Gauyaguayare Formation (late Maestrichtian) of Trinidad; middle and late Maestrichtian portion of the Mendez Shale of Mexico; and the Kemp Clay of Falls County, Texas. The occurrence of *G. conica* in Corsicana localities of North Central Texas is indicated in text figs. 5–8. This species was not observed from the Corsicana Formation of Travis County, Texas (see Appendix, Locality TX25).

Globotruncana contusa (Cushman)

Plate 21, figures 1–3, 4–5

1926. *Pulvinulina arca* var. *contusa* CUSHMAN, p. 23.
1928b. *Globotruncana conica* var. *plicata* WHITE, pp. 285–286, pl. 38, figs. 8a–c.
1941. *Globotruncana linnei caliciformis* VOGLER, p. 288, pl. 24, fig. 23.

PLATE 20

		Page
1–4.	*Globotruncana gansseri* Bolli .... TX2AA-55. Note the planoconvex, strongly umbilicoconvex test; angular conical and strongly protruding chambers as observed in apertural and abapertural views; the curved, raised sutures spirally, and straight, depressed sutures umbilically; and the broad, deep umbilicus. Note the wide double keel throughout the peripheral margin; 140×.	48
5–8.	*Globotruncana gansseri* Bolli .... TX2AA-57. Note the more lobate peripheral outline and prominent, somewhat beaded single keel. Note the angular conical chambers in apertural and abapertural views, and the roughened umbilical shoulder; 105×.	48
9–12.	*Globotruncana gansseri* Bolli .... TX3BA-0E27. Individual with a narrow double keel which merges to form a single keel along the ultimate few chambers. Note the strongly protruding chambers umbilically, and the wide, deep umbilicus; 140×.	48

1946. *Globotruncana arca* var. *contusa* (Cushman). CUSHMAN, pp. 150–151, pl. 62, figs. 6a–b.
1951. *Globotruncana contusa* (Cushman). BOLLI, p. 196, pl. 34, figs. 7–9.
1955. *Globotruncana contusa* (Cushman). TROELSEN, pp. 80–81, text-figs. 2: a–c; not text-figs. 2: d–f, g.
1955. *Globotruncana contusa contusa* (Cushman). GANDOLFI, pp. 53–54, pl. 4, figs. 3a–c.
1962. *Globotruncana contusa galeoidis* HERM, pp. 74–75, pl. 1, figs. 3 (three views), 4b (two views).
1963. Not *Globotruncana contusa* (Cushman). BRONNIMANN and RIGASSI, pl. 16, figs. 2a–c (no pagination).
1964. *Globotruncana contusa* (Cushman). OLSSON, pp. 163–164, pl. 3, figs. 6a–c; not pl. 2, figs. 5a–c; not pl. 3, figs. 9a–c.
1966. *Globotruncana contusa contusa* (Cushman). EL-NAGGAR, pp. 90–93, pl. 7, figs. 2a–c, 3a–c; pl. 11, figs. 1a–b.
1966. *Globotruncana contusa witwickae* EL-NAGGAR, pp. 95–97, pl. 7, figs. 1a–c.
1967. *Globotruncana contusa* (Cushman). PESSAGNO, pp. 330–333, pl. 77, figs. 4–6, 7–9; pl. 78, figs. 6–8, 9–11; pl. 92, figs. 10–12; pl. 96, figs. 14, 15, 16; not pl. 75, figs. 18–20; not pl. 77, figs. 1–3; not pl. 96, figs. 11, 13.
1969. Not *Globotruncana contusa* (Cushman). DUPEUBLE, pp. 154–155, pl. 1, figs. 2a–c.
1972. *Globotruncana contusa* (Cushman). BARR, p. 19, pl. 7, figs. 7a–c.

Remarks.–The description of *Globotruncana contusa* (Cushman) given by Pessagno (1967, p. 331) is followed herein. *Globotruncana contusa* is characterized (1) by the trochospiral, strongly spiroconvex, umbilicoconcave test, (2) somewhat polygonal and distinctly undulating peripheral outline, and (3) strongly plicated spiral surface.

Globotruncana contusa was initially described by Cushman (1926, p. 23) as a variety of *Pulvinulina* (= *Globotruncana*) *arca* Cushman. Troelsen (1955, pp. 80–81) described two distinct forms of this species from the Kjolby Gaard Marl (Maestrichtian) of Denmark. Troelsen (ibid.) noted that the plicate form agreed very well with Cushman's holotype and paratypes deposited in the U.S. National Museum. A second form from the Kjolby Gaard Marl was noted to be nonplicate, but was included by Troelsen in *G. contusa* (Cushman) since it was observed to grade into the typical plicate form.

Gandolfi (1955, p. 53) noted similar transitional stages between *G. contusa* and a nonplicate form in his study of the Globotruncanidae of Colombia. He described the nonplicate form as *G. contusa patelliformis*, correctly noting that *G. contusa* becomes more frequent, at the expense of *G. patelliformis*, higher in the Maestrichtian section.

Pessagno (1967, pp. 331–332) referred to these forms as *Globotruncana contusa* s.s. (plicate form) and *G. contusa* s.l. (smaller, nonplicate form). In addition, Pessagno (ibid.) found that *G. contusa* s.l. (= *G. patelliformis* Gandolfi) is more abundant in the *G. gansseri* Subzone, whereas *G. contusa* s.s. is the dominant form in the *A. mayaroensis* Subzone.

Pessagno has examined the holotype and unfigured paratypes of *G. contusa witwickae* El-Naggar (1966, pp. 95–97) deposited in the British Museum (Nat. History). The holotype, and one unfigured paratype, are herein included in *G. contusa* since they differ only in being somewhat lower spired. The remaining unfigured paratypes (two) belong to *G. patelliformis* Gandolfi.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globotruncana contusa* is from the Mendez Shale (Maestrichtian) at Coco Station, kilometer post K 574.00 along the railroad from Tampico to Cuidad Valles, Mexico (see Pessagno, 1967, pp. 332–333).

Globotruncana contusa has since been recorded from the late Maestrichtian Kjolby Gaard Marl, northwestern Denmark (Troelsen, 1955, pp. 80–81); middle and late Maestrichtian of the Esna-Idfu Region, Nile Valley, Egypt (El-Naggar, 1966, pp. 90–93, 95–97) and Libya (Barr, 1972, p. 19); Colon Shale (Maestrichtian) of Colombia (Gandolfi, 1955, pp. 53–54); Guayaguayare Formation (late Maestrichtian) of Trinidad (Bolli, 1951, p. 196); late Maestrichtian of Mexico (Olvera, 1959, pp. 39–40, 43–44); and the Navesink and Redbank Formations (Maestrichtian) of New Jersey (Olsson, 1964, pp. 163–164).

The present investigation has shown that *Globotruncana contusa* (Cushman) makes its initial appearance in the *R. fructicosa* Zonule (upper part of the *G. gansseri* Subzone) and continues through the *A. mayaroensis* Subzone. It has not been observed in the Corsicana Formation (*G. aegyptiaca* Zonule, lower part of *G. gansseri* Subzone) as exposed along Onion Creek, Travis County, Texas (see Appendix, Locality TX25), nor has it been observed in stratigraphically older units in either Texas or Arkansas. *Globotruncana contusa* is particularly common in the type locality of the Corsicana Formation (Locality TX2), and occurs frequently throughout the Corsicana Formation as exposed in North Central Texas (see text figs. 5, 6). Pessagno (1967, p. 332) notes its abundant occurrence throughout the Mendez Shale (*A. mayaroensis* Subzone) of Mexico.

Globotruncana duwi Nakkady

Plate 17, figures 8–10, 11–13

1950. *Globotruncana aegyptiaca* var. *duwi* NAKKADY, p. 690, pl. 90, figs. 17, 18, 19.
1954. *Globotruncana aegyptiaca* var. *duwi* Nakkady. NAKKADY and OSMAN, pp. 76–77, pl. 20, figs. 21a, 21b–c.
1955. (?) *Globotruncana tricarinata colombiana*? GANDOLFI, pp. 20–22, text-fig. 5 (2a–c); not pl. 1, figs. 3a–c, 4a–c; not text-fig. 5 (1a–c).
1956. (?)*Rugotruncana skewesae* BRONNIMANN and BROWN, pp. 550–551, pl. 23, figs. 4–6.
1964. *Globotruncana aegyptiaca* var. *duwi* Nakkady. SAID and SABRY, p. 387, pl. 3, figs. 2a–c.
1966. *Globotruncana aegyptiaca duwi* Nakkady. EL-NAGGAR, pp. 80–81, pl. 3, figs. 5a–c.

1967. *Globotruncana duwi* Nakkady. PESSAGNO, pp. 333–334, pl. 83, figs. 5–6, 7; pl. 95, figs. 12–14; not pl. 83, figs. 2–4.

1972. *Globotruncana duwi* Nakkady. BARR, p. 20, pl. 4, figs. 6a–c.

Remarks.–Pessagno (1967, p. 333) has adequately described this species. *Globotruncana duwi* Nakkady is characterized by the planoconvex test, and the three or four crescent shaped chambers in the final whorl which increase very rapidly in size, the ultimate chamber comprising about one-half the test. The penultimate chamber is almost equal in size to the ultimate chamber, and combined, the two chambers constitute three-fourths of the test (Pl. 17, figs. 8, 11).

Although *G. duwi* is morphologically similar to *G. aegyptiaca* Nakkady, *G. duwi* differs by (1) lacking a single-keeled early stage of development (Pessagno, 1967, p. 333); (2) having fewer chambers which increase much more rapidly in size; and (3) an ultimate chamber which is quite inflated umbilically.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, lower part of *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–*Globotruncana duwi* Nakkady was originally described from the Maestrichtian chalk exposed in the Gebel Duwi Section (Eastern Desert), Egypt. It has since been noted from the Maestrichtian of the southern and western Sinai, Egypt (Nakkady and Osman, 1954, p. 76), the Maestrichtian of the Esna-Idfu Region along the Nile Valley, Egypt (Said and Sabry, 1964, p. 387; El-Naggar, 1966, pp. 80–81). Gandolfi (1955, p. 21) illustrated a form referred to *G. tricarinata colombiana*? (text-fig. 5: 2a–c) from the Colon Shale (Maestrichtian) of Colombia which is tentatively included here in *G. duwi*.

Pessagno (1967, pp. 335–336) noted *G. duwi* in the late Maestrichtian portion of the Mendez Shale and in the middle Maestrichtian portion of the Papagallos Shale of Mexico; in the middle Maestrichtian Corsicana Marl of Texas and Arkadelphia Marl of Arkansas; and in the late Maestrichtian Guayaguayare Formation of Trinidad. It has also been observed in the Escondido Formation (middle Maestrichtian, *G. gansseri* Subzone) exposed along Seco Creek, Medina County, Texas, as well as from Maestrichtian samples from the Rio Grande Rise, JOIDES, Leg III (see Appendix).

Globotruncana elevata (Brotzen)

Plate 19, figures 1–3, 4–6

1934. *Rotalia elevata* BROTZEN, p. 66, pl. 3, fig. C.

1946. *Globotruncana arca* (Cushman). CUSHMAN, p. 150, pl. 62, figs. 5a–c; not figs. 4a–c.

1955. *Globotruncana (Globotruncana) elevata elevata* (Brotzen). DALBIEZ, p. 169, text-figs. 9a–c.

1955. *Globotruncana rosetta insignis* GANDOLFI, pp. 67–68, pl. 6, figs. 2a–c.

1957. *Globotruncana andori* de Klasz. BOLLI, p. 59, pl. 14, figs. 6a–c.

1960. *Globotruncana (Globotruncana) stuarti elevata* (Brotzen). PESSAGNO, p. 101, pl. 5, figs. 1, 8.

1960. *Globotruncana (Globotruncana) subspinosa* PESSAGNO, pp. 101–102, pl. 1, figs. 1–3, 4–6, 7–9; pl. 5, fig. 5.

1962. *Globotruncana (Globotruncana) stuarti elevata* (Brotzen). PESSAGNO, p. 362, pl. 1, fig. 10; pl. 2, figs. 10–11.

1963. *Globotruncana (Globotruncana) elevata elevata* (Brotzen). VAN HINTE, p. 70, pl. 5, figs. 4a–c.

1963. *Globotruncana (Globotruncana) elevata stuartiformis* Dalbiez. VAN HINTE, p. 68, pl. 1, figs. 3a–c.

1964. *Globotruncana stuarti elevata* (Brotzen). OLSSON, p. 169, pl. 5, figs. 7a–c.

1964. *Globotruncana stuarti stuartiformis* Dalbiez. OLSSON, p. 170, pl. 5, figs. 6a–c, 8a–c.

1967. *Globotruncana elevata* (Brotzen). PESSAGNO, pp. 336–338, pl. 78, figs. 12–14; pl. 80, figs. 1–2, 3–6; pl. 81, figs. 9, 10–11, 12–14; pl. 93, figs. 1, 2, 3, 4, 5, 8; text-figs. 43, 44: 1–17.

1970. *Globotruncana elevata* (Brotzen). KUHRY, pp. 292–295, pl. 1, figs. 1–3; text-figs. 1 (three views), 4a–b, 4e–f, 4g–h; not pl. 1, figs. 4–6, 7–9; not text-figs. 4c–d.

1972. *Globotruncana elevata* (Brotzen). BARR, p. 20, pl. 6, figs. 5a–c.

1972. *Globotruncana stuarti* (de Lapparent). BARR, pp. 24–25, pl. 6, figs. 1a–c, 3a–c (?).

Remarks.–The description given by Pessagno (1967, p. 336) is followed herein. Pessagno (ibid.) noted the close similarity between *Globotruncana elevata* (Brotzen) and *G. stuartiformis* Dalbiez, and showed that the most significant feature in the separation of the two species is the more strongly umbilicoconvex nature of *G. elevata*. The mean T′X/TX value (see Pessagno, 1967, p. 251, text-fig. B) of 35 measured specimens of *G. elevata* was 2.31. Significantly, the mean T′X/TX value of 26 specimens of *G. stuartiformis* was 0.92. Pessagno (ibid., p. 337) distinguished between the two species in part by their T′X/TX values, where *G. elevata* has values greater than 1.40, and *G. stuartiformis* has values less than 1.25. Intermediate values were considered transitional between the two species. Note that the T′X/TX value for the lower limit of *G. elevata* is herein raised from 1.25 (see Pessagno, 1967, p. 337) to a value of 1.40 (see remarks under *G. stuartiformis* herein).

Kuhry (1970, p. 293) presented a discussion of his examination of *Globotruncana elevata* (Brotzen). Kuhry (ibid.) noted that Brotzen (1934, p. 66) did not designate a holotype, and also noted that the specimen figured by Brotzen (1934, pl. 3, fig. C) has a narrow double keel and belongs to *G. carinata* Dalbiez (= *M. concavata* (Brotzen) of Pessagno, 1967, pp. 304–305). Kuhry (ibid., p. 293, pl. 1, figs. 1–3), therefore, selected and figured a lectotype for *Globotruncana elevata* (Brotzen).

The present authors disagree with Kuhry's (1970, p. 299) inclusion of *Globotruncana stuartiformis* Dalbiez as a junior synonym of *G. elevata* (see remarks under *G. stuartiformis* herein). The lectotype of *G. elevata* selected by Kuhry has a T′X/TX value of about 7.00, and is typical of Brotzen's description of this species. Kuhry's figured topotypes, however, are herein included in *G. stuartiformis* Dalbiez. One of the topotypes figured by Kuhry (1970, pl. 1, figs. 4–6) is clearly biconvex (T'X/TX = 0.917) and belongs to *G. stuartiformis*. The other figured topotype (ibid., pl. 1, figs. 7–9) has a T'X/TX value of about 1.22 and is included herein in *G. stuartiformis*, although the specimen is somewhat umbiliconvex and is becoming transitional toward *G. elevata*.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, lower part of *P. elegans* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *G. elevata* is in an exposure of calcilutites (Santonian-Campanian) near Wadi Madi on the southeastern slope of Mount Carmel, Israel. It has since been recorded from the late Campanian and Maestrichtian of Europe, Asia, Russia, North Africa, Australia, northern South America, the East and West Indies, as well as throughout North America (see Pessagno, 1967, pp. 337–338). This is a common species in the Corsicana Formation of Texas (see text figs. 4–8).

Globotruncana gansseri Bolli

Plate 20, figures 1–4, 5–8, 9–12

1951. *Globotruncana gansseri* BOLLI, pp. 196–197, pl. 35, figs. 1–3.
1955. *Globotruncana gansseri gansseri* Bolli. GANDOLFI, pp. 69–70, pl. 6, figs. 5a–c, 6a–c, 8a–c.
1955. *Globotruncana gansseri subgansseri* GANDOLFI, p. 70, pl. 6, figs. 7a–c.
1955. *Globotruncana rosetta pettersi* GANDOLFI, p. 68, pl. 6, figs. 3a–c.
1955. *Globotruncana wiedenmayeri magdalenaensis* GANDOLFI, p. 72, pl. 7, figs. 3a–c.
1955. *Globotruncana wiedenmayeri wiedenmayeri* GANDOLFI, p. 71, pl. 7, figs. 4a–c.
1956. *Rugotruncana gansseri* (Bolli). BRONNIMANN and BROWN, pp. 549–550, pl. 13, figs. 7–9; text-fig. 23.
1960. *Globotruncana monmouthensis* OLSSON, pp. 50–51, pl. 10, figs. 22–24.
1960. *Globotruncana (Rugotruncana) gansseri* BOLLI. Pessagno, p. 102, pl. 4, fig. 11.
1964. *Globotruncana gansseri* Bolli. OLSSON, pp. 165–166, pl. 3, figs. 2a–c, 3a–c, 4a–c, 5a–c.
1964. *Globotruncana gansseri dicarinata* Pessagno. OLSSON, p. 166, pl. 3, figs. 1a–c.
1966. *Globotruncana fundiconulosa* Subbotina. EL-NAGGAR, pp. 110–111.
1966. *Globotruncana youssefi* EL-NAGGAR, pp. 144–145, pl. 6, figs. 4a–d.
1967. *Globotruncana gansseri* Bolli. PESSAGNO, pp. 341–343, pl. 75, fig. 1; pl. 92, figs. 13–15, 16–18; pl. 95, figs. 1, 2, 3, 4.
1971a. *Globotruncana gansseri* Bolli. EL-NAGGAR, pl. 5, figs. d–f.
1972. *Globotruncana gansseri* Bolli. BARR, p. 21, pl. 5, figs. 3a–c, 4a–c.

Remarks.–The description given by Pessagno (1967, p. 341) is complete and will not be duplicated herein. Diagnostic characters of *G. gansseri* are (1) the plano-convex, strongly umbilicoconvex test, (2) the four or five umbilical chambers which, in apertural and abapertural views, are strongly inflated, angular conical and hemispherical in shape, and (3) the curved, raised, and beaded spiral sutures and straight to slightly curved, depressed umbilical sutures.

Globotruncana gansseri shows wide variation in the convexity of the umbilical side of the test, shape of spiral chambers, and nature of the keel. Rare individuals from the Corsicana Formation are entirely single-keeled (Pl. 20, figs. 5–8), although the majority show a narrow double keel which merges to form a single keel along the ultimate one or two chambers. Pessagno (1967, p. 341) noted that in thin-section the early globigeriniform stage of *G. gansseri* possesses a weakly developed double keel.

Pessagno has examined the specimen of *Globotruncana fundiconulosa* Subbotina (of El-Naggar, 1966, pp. 110–111), and the holotype and paratypes of *Globotruncana youssefi* El-Naggar (1966, pp. 144–145) deposited in the British Museum (Nat. History), and found them to be within the range of variation of *G. gansseri*.

Globotruncana arabica El-Naggar (1966, pp. 81–83), although superficially resembling *G. gansseri*, is herein regarded as a separate and distinct species. Pessagno examined the holotype and paratypes of *G. arabica* in the British Museum, and observed that it differed from *G. gansseri* in lacking the strongly beaded sutures spirally and in having a weakly developed single keel along the spiral margin of the test. An examination of the hypotypes of *G. gansseri subgansseri* Gandolfi (of El-Naggar, 1966, pp. 119–120) and *G. lugeoni* Tilev (of El-Naggar, 1966, pp. 122–123) in the British Museum indicate them to be

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PLATE 21

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1–3, 4–5.	*Globotruncana contusa* (Cushman) .... 1–3, TX4AC-4C52, 70×; 4–5, TX2BA-0C49, 105×. Note the strongly spiroconvex, umbilico-concave test; polygonal and distinctly undulating peripheral outline; and strongly plicate chambers spirally. Narrow double keel poorly preserved.	45
6–8.	*Globotruncana patelliformis* Gandolfi .... TX4AC-4BA12. Note the spiroconvex test; smooth and circular peripheral outline; and spirally elongate, crescent-shaped, nonplicate chambers spirally; 95×.	50
9–11.	*Globotruncana plummerae* Gandolfi .... TX2AA-45. Note the biconvex test; four or five chambers which increase rapidly in size as added; and the deep, usually non-beaded sutures both spirally and umbilically; 140×.	51


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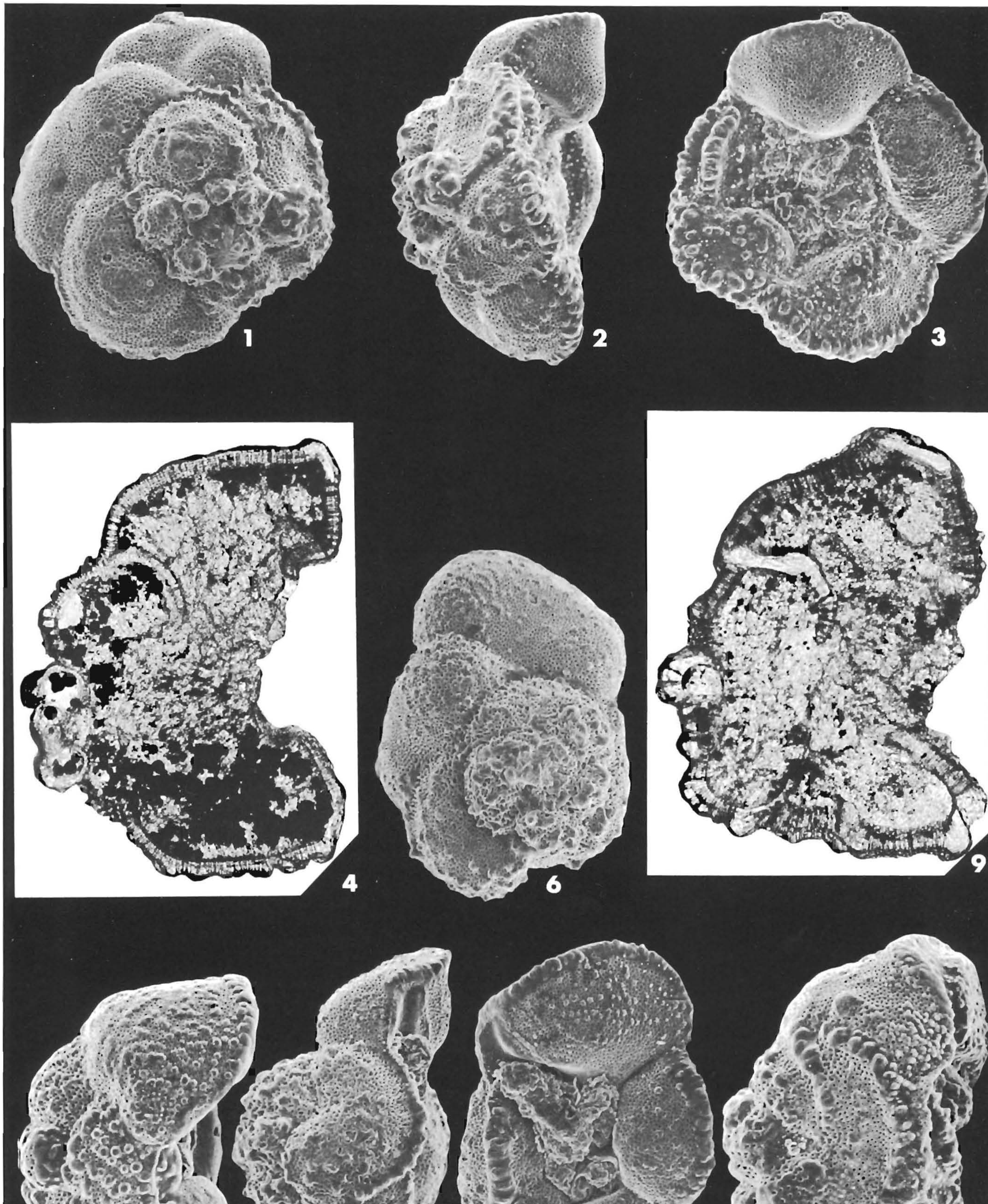

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variants of *G. arabica* El-Naggar. It seems worth noting that forms similar to *G. arabica* have not been observed during the course of this investigation. To the investigators' knowledge, this species has not been recorded outside its type area in the Esna-Idfu Region, Egypt.

A number of species described by Gandolfi (1955, see synonymy) are considered to be junior synonyms of *G. gansseri* Bolli.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *R. subcircumnodifer* Subzone, upper part of *R. subpennyi* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, lowermost part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globotruncana gansseri* is in the Maestrichtian Guayaguayare Formation (Lantern Marl), exposed in the Brighton area near Pitch Lake, southwestern Trinidad. It has since been recorded from the Maestrichtian Esna Shale of Egypt (Said and Sabry, 1964, p. 387; El-Naggar, 1966, see remarks herein); Maestrichtian of the Krappfeld Region, Austria (van Hinte, 1963, p. 72); middle and upper Maestrichtian of Libya (Barr, 1972, p. 21); Maestrichtian from Galicia Bank, west of Spain (Funnell, et al., 1969, pp. 31–32); from mixed Upper Cretaceous to Recent faunas of mid-Pacific flat-topped seamounts (Hamilton, 1953, p. 232); Colon Shale of Colombia (Gandolfi, 1955, see synonymy); middle Maestrichtian portions of the Parguera Limestone and Rio Yauco Mudstone of southwestern Puerto Rico (Pessagno, 1960, p. 102); Maestrichtian Via Blanca Formation of Cuba (Bronnimann and Rigassi, 1963, pp. 261, 280); Maestrichtian Mt. Laurel, Navesink, and Redbank Formations of New Jersey (Olsson, 1960, pp. 50–51; 1964, pp. 165–166); middle Maestrichtian Corsicana and Kemp Formations of Texas, and Prairie Bluff Chalk of Alabama (Bronnimann and Brown, 1956, pp. 549–550). Pessagno (1967, p. 342) noted *G. gansseri* from the upper part of the Mendez Shale (lower part of *A. mayaroensis* Subzone) of Mexico; Corsicana and Kemp Formations of Texas; and in the Arkadelphia Marl of southwestern Arkansas. The occurrence of this species in the Corsicana Formation is shown in text figs. 4–8.

Globotruncana navarroensis Smith and Pessagno, n. sp.

Plate 22, figures 1–3, 4–5, 6–8, 9–10

1971a. *Globotruncana* sp. EL-NAGGAR, pl. 6, figs. i, j, k–l.

Description.–Test trochospiral, strongly spiroconvex (mean T'X/TX value = 0.079 for 13 measured specimens), umbilical side flattened, often somewhat concave; initial whorls of spiral portion of test characteristically offset toward the peripheral margin due to the extremely rapid increase in size of the last three chambers; periphery subcircular to elongate ellipsoidal, slightly lobate, initial portion truncated by umbilically reflected, beaded double keel which merges rapidly into a single keel in the early portion of the final whorl; chambers on spiral side initially small, globular, increasing gradually in size as added; final whorl consisting of four or five large, crescentic, slightly inflated chambers increasing rapidly in size as added; the ultimate chamber occasionally having a medial and radially orientated shallow depression; chambers umbilically subrectangular to trapezoidal, flattened to weakly inflated, increasing gradually in size as added; spiral sutures strongly curved, broadly depressed; umbilical sutures straight, radial, sharply and deeply depressed; spiral surface smooth or occasionally possessing irregularly placed coarse papillae, usually more abundant on the early chambers spirally; chambers umbilically smooth to finely papillate; wall finely perforate; umbilicus subrectangular, variable in width but usually rather narrow, deep; primary aperture interiomarginal, umbilical; tegilla with intralaminal and infralaminal accessory apertures poorly preserved in material examined.

Remarks.–*Globotruncana navarroensis* exhibits variation in shape of the periphery, convexity of the spiral surface as observed in axial view, surface ornamentation, and width

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PLATE 22

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1–3.	*Globotruncana navarroensis* Smith and Pessagno, n. sp. TX2AA-0C45. Holotype (USNM 170540). Note the spiroconvex test; somewhat inflated and vaulted chambers spirally and umbilically; rapid increase in size of the ultimate three chambers; and narrow double keel restricted to the initial chamber of the final whorl; 85×.	49
4–5.	*Globotruncana navarroensis* Smith and Pessagno, n. sp. TX2AA-0E6. 4, Vertical section of paratype (USNM 170542). Note the strongly spiroconvex test; globigeriniform initial chambers; large terminal chambers with vertical axes almost perpendicular to a horizontal plane passing through the test; and radial hyaline, imperforate narrow double keel. Note the asymmetric initial spire; 170×. 5, Apertural view of individual shown in Figure 4; 120×.	49
6–8.	*Globotruncana navarroensis* Smith and Pessagno, n. sp. TX2AA-0C47. Paratype (USNM 170541) showing the rapid increase in size of the ultimate three chambers resulting in the initial spire being offset toward the periphery. Note the curved, depressed sutures spirally, and radial, straight, depressed sutures umbilically, and single keel throughout; 85×.	49
9–10.	*Globotruncana navarroensis* Smith and Pessagno, n. sp. TX2AA-0E5. 9, Vertical section of paratype (USNM 170543) showing the steeply angled periphery of the test near the offset initial spire. Note the umbilically reflected narrow double keel; 170×. 10, Apertural view of individual shown in Figure 9; 140×.	49

of the umbilicus. Diagnostic characters of this species are (1) the strongly spiroconvex test, (2) the three ultimate chambers which increase rapidly in width, resulting in the initial spire being asymmetric and offset toward the peripheral margin, and (3) the strongly curved, depressed spiral sutures and radial, depressed umbilical sutures.

Globotruncana navarroensis was derived from *G. plummerae* Gandolfi through an increase in convexity spirally and the restriction of the double keel to the initial portion of the final whorl. It differs from *G. plummerae* (1) by being strongly spiroconvex rather than biconvex, (2) in the asymmetric initial spire offset toward the peripheral margin, and (3) by the possession of a double keel (when present) restricted to the initial portion of the final whorl.

Globotruncana navarroensis differs from *G. patelliformis* Gandolfi (1) by generally having a more lobate equatorial periphery, (2) by having an asymmetrically placed initial spire, and (3) by having chambers in the final whorl which spirally are crescentic to somewhat petaloid and wide, rather than crescentic and narrow.

Globotruncana navarroensis, n. sp., is named after Navarro County, Texas.

Dimensions.–Holotype measures 664μ in length, 624μ in width, and 408μ in maximum thickness. Topotypes vary from 412μ to 672μ in length; 385μ to 496μ in width; and 305μ to 408μ in maximum thickness.

Type locality.–Alternate type locality of Corsicana Formation, exposed in southern clay pit of the Corsicana Brick Company, two miles south of the courthouse and east of the Southern Pacific Railway and Farm Road 709 (15th. Street), in southern portion of Corsicana, Navarro County, Texas. Type sample TX2AA, from dark gray, conchoidal fracturing, calcareous mudstone taken from the base of quarry (as of May, 1970). University of Texas (Bureau of Economic Geology) locality 174-T-4. Pessagno samples TX 281–287 (Pessagno, 1967, pp. 379–380; 1969, pp. 97–98).

Deposition of types.–The holotype (USNM 170540) and figured paratypes (USNM 170541–170543) of *G. navarroensis* n. sp., will be deposited in the collections of the U.S. National Museum, Washington, D.C. Unfigured Paratypes (CS 7–9) will be deposited in the Pessagno Collection, Geosciences Division, The University of Texas at Dallas.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *R. fructicosa* Zonule.

Occurrence.–*Globotruncana navarroensis* n. sp., has been observed only from the Corsicana Formation of Texas. The specimen figured by El-Naggar (1971a, pl. 6, fig. i) as *Globotruncana* sp. from the Maestrichtian Mendez Shale of Tampico, Mexico, is included herein, although no specimens of *G. navarroensis*, n. sp., were observed from the Mendez during the course of this investigation.

Examination of both biostratigraphically older and younger stratigraphic units in the western Gulf Coastal Plain indicates that *G. navarroensis* is restricted, insofar known, to the middle Maestrichtian (*G. gansseri* Subzone).

Globotruncana patelliformis Gandolfi

Plate 21, figures 6–8

1955. *Globotruncana contusa* (Cushman). TROELSEN, pp. 80–81, text-figs. 2: d–f, g; not text-figs. 2: a–c.
1955. *Globotruncana contusa patelliformis* GANDOLFI, pp. 54–55, pl. 4, figs. 2a–c.
1960. *Globotruncana contusa* (Cushman). OLSSON, p. 50, pl. 10, figs. 25–26.
1963. *Globotruncana contusa* (Cushman). BRONNIMANN and RIGASSI, pl. 16, figs. 2a–c (no pagination).
1963. *Globotruncana (Globotruncana) plicata caliciformis* Vogler. VAN HINTE, p. 64, pl. 3, figs. 2a–c.
1964. *Globotruncana contusa* (Cushman). OLSSON, pp. 163–164, pl. 2, figs. 5a–c; pl. 3, figs. 9a–c; not pl. 3, figs. 6a–c.
1966. *Globotruncana adamsi* EL-NAGGAR, pp. 75–76, pl. 8, figs. 2a–d.
1966. *Globotruncana contusa patelliformis* Gandolfi. EL-NAGGAR, pp. 93–95, pl. 8, figs. 1a–c.
1967. *Globotruncana contusa* (Cushman). PESSAGNO, pp. 330–333, pl. 75, figs. 18–20; pl. 77, figs. 1–3; pl. 96, figs. 11, 13; not pl. 77, figs. 4–6, 7–9; not pl. 78, figs. 6–8, 9–11; not pl. 92, figs. 10–12; not pl. 96, figs. 14, 15, 16.
1969. *Globotruncana contusa* (Cushman). DUPEUBLE, pp. 154–155, pl. 1, figs. 2a–c.

Remarks.–Troelsen (1955, p. 80) noted two forms of *Globotruncana contusa* from the Kjolby Gaard Marl (Maestrichtian) of Denmark. Troelsen (ibid.) stated that one form differs from the typical *G. contusa* by showing no trace of spiral plications, but included it in *G. contusa* since it was observed to grade into the typical plicate form. Gandolfi (1955, pp. 54–55) noted similar variation in his investigation of the Colon Shale (Maestrichtian) of Colombia. Gandolfi (ibid.) named the smaller, generally higher spired, and non-plicate form *G. contusa patelliformis*, retaining the name *G. contusa contusa* for the larger plicate form.

Globotruncana patelliformis Gandolfi differs from *G. contusa* (Cushman) (1) by generally being somewhat smaller, (2) in having a more circular peripheral outline, rather than being polygonal and undulating, (3) by being less convex spirally, and (4) lacking pronounced plications spirally.

Globotruncana patelliformis is closely related and gave rise to *G. contusa* in the late portion of the middle Maestrichtian (*G. gansseri* Subzone, *R. fructicosa* Zonule). Gandolfi (1955, p. 53) correctly noted that *G. patelliformis* becomes less frequent, while *G. contusa* becomes more abundant in the latest Maestrichtian (i.e., *A. mayaroensis* Subzone).

The holotype of *G. adamsi* El-Naggar (1966, pp. 75–76) was examined at the British Museum (Nat. History), and found to belong to *G. patelliformis* Gandolfi. Of the three unfigured paratypes (slide P. 45510, B.M.N.H.), one belongs to *G. fornicata* Plummer, and the remaining two specimens appear to be transitional forms between *G. fornicata* and *G. patelliformis* Gandolfi.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone insofar known.

Occurrence.–The type locality of *Globotruncana patelliformis* is an exposure of the Colon Formation (Maestrichtian) in the Rancheria Valley along the Fonseca-Rio Hacha road, about 400 kilometers north of Fonseca, northeastern Colombia. It has since been reported from the middle and late Maestrichtian of the Esna-Idfu Region, Nile Valley, Egypt (El-Naggar, 1966, pp. 76, 95); Maestrichtian of Austria (van Hinte, 1963, p. 64); late Maestrichtian of France (Dupeuble, 1969, pp. 154–155); and the late Maestrichtian of northwestern Denmark (Troelsen, 1955, pp. 80–81). Bronnimann and Rigassi (1963) figured *G. patelliformis* as *G. contusa* from the Upper Maestrichtian Penalver Formation of Cuba.

Pessagno (1967, pp. 332–333) referred this species to *G. contusa* s.l., and figured several specimens from the Corsicana Formation at its type locality in Navarro County, Texas. The individuals figured by Olsson (1960, pl. 10, figs. 25–26; 1964, pl. 2, figs. 5a–c) as *G. contusa* (Cushman) from the Redbank and Navesink Formations (Maestrichtian) of New Jersey belong to *G. patelliformis* Gandolfi.

Globotruncana plummerae Gandolfi

Plate 21, figures 9–11

1955. *Globotruncana fornicata plummerae* GANDOLFI, p. 42, pl. 2, figs. 3a–c, 4a–c.
1963. (?) *Globotruncana fornicata* Plummer. BRONNIMANN and RIGASSI, pl. 17, figs. 3a–c (no pagination).
1963. *Globotruncana* (*Globotruncana*) *fornicata plummerae* Gandolfi. VAN HINTE, p. 63, pl. 3, figs. 1a–c.
1966. *Globotruncana fornicata cesarensis* Gandolfi. EL-NAGGAR, pp. 103–105, pl. 13, figs. (?) 3a–c, 4a–c; pl. 14, figs. 6a–c.
1966. *Globotruncana fornicata globulocamerata* EL-NAGGAR, pp. 108–109, pl. 14, figs. 1a–c, 2a–c; not pl. 13, figs. 1a–c.
1967. *Globotruncana plummerae* Gandolfi. PESSAGNO, pp. 351–352, pl. 66, figs. 3–4, 5, 6–8.

Remarks.–The description given by Pessagno (1967, p. 351) is followed herein. *Globotruncana plummerae* Gandolfi is distinguished by (1) its biconvex test, (2) its inflated, spirally elongate, and crescentic-shaped spiral chambers, (3) the four or five chambers in the final whorl which increase very rapidly in size, and (4) by its strongly curved, depressed, and usually non-beaded sutures. Gandolfi (1955, p. 42) noted the close relation between *G. plummerae* and *G. fornicata* Plummer, but differentiated the former by its inflated, non-crenulate spiral chambers.

Pessagno has examined the types of *Globotruncana fornicata globulocamerata* El-Naggar (1966, pp. 108–109) deposited in the British Museum (Nat. History). The holotype (El-Naggar, pl. 14, figs. 2a–c) properly belongs to *G. plummerae* Gandolfi; the figured paratype (ibid., pl. 13, figs. 1a–c) is a specimen transitional between *G. fornicata* Plummer and *G. plummerae*; and of the remaining two unfigured paratypes (slide P. 45533, B.M.N.H.), one is transitional between *G. fornicata* and *G. plummerae*, the taxonomic assignment of the second specimen remains questionable.

Pessagno (1967, p. 351) suggested that *G. plummerae* evolved from *G. fornicata* through the arching of the spiral chambers and by the development of depressed, generally non-beaded sutures. A possible phylogenetic link with *G. bulloides* Vogler was also suggested.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *G. elevata* Subzone, upper part of *P. elegans* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, upper part of *R. fructicosa* Zonule.

Occurrence.–*Globotruncana fornicata plummerae* was originally described from an exposure of the Colon Formation (Maestrichtian) in the Rancheria Valley, along the Fonseca-Rio Hacha road, about 400 kilometers north of Fonseca, northeastern Colombia.

Bronnimann and Rigassi (1963, pl. 17, figs. 3a–c) figured an individual questionably assigned to this species from the Campanian of Cuba. El-Naggar (1966, pp. 103–105) described *G. plummerae* as *G. fornicata cesarensis* Gandolfi (in part), giving its range (questionable, since two distinct forms were included) as early Maestrichtian, occurring only rarely in the basal portion of the overlying *G. gansseri* Zone. In addition, van Hinte (1963, p. 63; 1965, p. 23) recorded it from the Campanian and Maestrichtian of Austria as well as the type Campanian of France.

Pessagno (1967, p. 352) noted *Globotruncana plummerae* in the late Campanian and early Maestrichtian portions of the Mendez and Papagallos Shales of Mexico; the upper part of the Wolfe City Sand, Pecan Gap Chalk, "Upper Taylor Marl", and Neylandville Marl of Texas; and in the Annona Chalk, Marlbrook Mark, and Saratoga Chalk of Arkansas.

To the authors' knowledge, the present report represents its first noted occurrence in the Corsicana Formation of Texas, as well as its youngest occurrence stratigraphically in the western Gulf Coastal Plain.

Globotruncana stephensoni Pessagno

Plate 18, figures 7–10

1931. *Globotruncana arca* (Cushman). PLUMMER, pp. 195–198, pl. 13, figs. 7a–c; not pl. 13, figs. 8a–c, 9a–c, 11a–c.
1962. *Globotruncana conica* White. PESSAGNO, p. 362, pl. 4, figs. 13–14; text-fig. 4.

1963. *Globotruncana (Globotruncana) rosetta rosetta* (Carsey). VAN HINTE, pp. 89–91, pl. 9, figs. 1a–c, 2a–c; pl. 10, figs. 1a–c; not pl. 9, figs. 3a–c.
1966. (?)*Globotruncana esnehensis* Nakkady. EL-NAGGAR, pp. 98–100, pl. 12, figs. 1a–d.
1967. *Globotruncana stephensoni* PESSAGNO, pp. 354–356, pl. 69, figs. 1–3, 4–6, 7–9; pl. 96, figs. 5, 6.
1972. *Globotruncana stephensoni* Pessagno. BARR, p. 24, p. 6, figs. 6a–c.

Remarks.–The description of *Globotruncana stephensoni* given by Pessagno (1967, p. 354) is followed herein. Pessagno (ibid.) noted the near homeomorphism of *G. stephensoni* for both *G. stuarti* (de Lapparent) and *G. conica* White. Data presented by Pessagno (1967) shows there is overlap in T′X/TX values for the three species; thus, this criterion can not be applied with certainty in differentiating these species. *Globotruncana stephensoni* may be distinguished, however, by possessing a narrow double keel which merges into a single keel along the final few chambers of the ultimate whorl. Individuals of *G. stephensoni* which are single keeled throughout, although rare in occurrence, can only be separated from *G. stuarti* and *G. conica* in thin section.

Van Hinte (1963, pp. 89–91) described and figured (in part) this species as *G. rosetta* (Carsey). Although *G. rosetta* is truncated by a narrow double keel which often merges into a single keel, it differs from *G. stephensoni* (1) by being planoconvex (umbilicoconvex rather than spiroconvex), (2) in having fewer chambers in the final whorl which increase more rapidly in size as added, and (3) in having chambers spirally which are crescent shaped rather than trapezoidal to subtrapezoidal.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone, lower part of *D. multicostata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, upper part of *R. fructicosa* Zonule.

Occurrence.–The type locality of *G. stephensoni* is from the "Upper Taylor Marl" (late Campanian) exposed in a ditch along Texas Highway 73, about 2.4 miles east of the intersection of Texas Highway 73 with Farm Road 737 in the town of Prairie Hill, Limestone County, Texas.

Plummer (1931, pl. 13, figs. 7a–c) figured this species as *G. arca* (Cushman) from the "Upper Taylor Marl" along Onion Creek, Travis County, Texas. *Globotruncana stephensoni* was figured (in part) as *G. rosetta* by van Hinte (1963, see synonymy) from the Mannsberg and Pemberger Folges (Campanian and Maestrichtian) of the Krappfeld Region, Austria. Barr (1972, p. 24) recorded *G. stephensoni* from the Campanian of Northern and Northeastern Libya, while Pessagno (1962, pl. 4, figs. 13–14) figured it as *G. conica* White from the Campanian of Puerto Rico. Pessagno (1967, pp. 355–356 recorded *G. stephensoni* from the early Campanian portion of the San Felipe Formation, and early Campanian to early Maestrichtian portion of the Mendez Shale of Mexico; late Campanian Pecan Gap Chalk and "Upper Taylor Marl", and early Maestrichtian Upson Clay of Texas; and the late Campanian Ozan Formation and Annona Chalk, and the early Maestrichtian Saratoga Chalk of Arkansas.

The presence of *Globotruncana stephensoni* in the Mendez Shale about 15 kilometers southwest of Aldama, Mexico (lower part of *A. mayaroensis* Subzone) extends its range at least into the early portion of the late Maestrichtian.

Globotruncana stuartiformis Dalbiez

Plate 19, figures 10–12

1955. *Globotruncana (Globotruncana) elevata stuartiformis* DALBIEZ, p. 169, text-figs. 10a–c.
1955. *Globotruncana stuarti stuarti* (de Lapparent). GANDOLFI, pp. 64–65, pl. 5, figs. 6a–c.
1955. *Globotruncana stuarti parva* GANDOLFI, p. 65, pl. 5, figs. 7a–c.
1962. *Globotruncana (Globotruncana) stuarti stuartiformis* Dalbiez. PESSAGNO, p. 362, pl. 2, figs. 4–6.
1962. *Globotruncana (Globotruncana) stuarti subspinosa* Pessagno. PESSAGNO, p. 362, pl. 2, figs. 7–9.
1963. *Globotruncana (Globotruncana) elevata subspinosa* Pessagno. VAN HINTE, p. 71, pl. 3, figs. 3a–c; not pl. 4, figs. 1a–c.
1963. Not *Globotruncana (Globotruncana) elevata stuartiformis* Dalbiez. VAN HINTE, p. 68, pl. 1, figs. 3a–c.
1964. *Globotruncana stuarti stuarti* (de Lapparent). OLSSON, pp. 169–170, pl. 5, figs. 9a–c.
1964. Not *Globotruncana stuarti stuartiformis* Dalbiez. OLSSON, p. 170, pl. 5, figs. 6a–c, 8a–c.
1966. *Globotruncana stuarti stuartiformis* Dalbiez. EL-NAGGAR, pp. 136–139, pl. 9, figs. 3a–d.
1966. *Globotruncana stuarti parva* Gandolfi. EL-NAGGAR, pp. 131–133, pl. 9, figs. 2a–d.
1966. *Globotruncana stuarti subspinosa* Pessagno. EL-NAGGAR, pp. 139–140, pl. 10, figs. 2a–c, 3a–c.
1967. *Globotruncana stuartiformis* Dalbiez. PESSAGNO, pp. 357–359, pl. 80, figs. 3–6 (*G. stuartiformis* trans. to *G. elevata*); pl. 92, figs. 1–3; pl. 93, figs. 6, 7; text-figs. 43, 44: 17.
1969. *Globotruncana stuarti stuartiformis* Dalbiez. FUNNELL, et al., pp. 34–35, pl. 4, figs. 10–12; text-figs. 18a–c.
1969. *Globotruncana stuarti* (de Lapparent). FUNNELL et al., pp. 33–34, pl. 4, figs. 7–9; text-figs. 17a–c.
1970. *Globotruncana elevata* (Brotzen). KUHRI, pp. 293–294, pl. 1, figs. 4–6, 7–9; text-figs. 4c–d (=*G. stuartiformis* Dalbiez).
1972. *Globotruncana stuartiformis* Dalbiez. BARR, p. 25, pl. 6, figs. 4a–c.

Remarks.–The description given by Pessagno (1967, pp. 357–358) is followed herein.

The illustration of the holotype of *Globotruncana stuartiformis* (Dalbiez, 1955, text-figs. 10a–c) has a T′X/TX value of about 1.14. The T′X/TX value of the holotype, as incorporated in the limits set by Pessagno (1967, p. 358; text-fig. 43), falls within the transitional *G. stuartiformis*-*G. elevata* range. If T′X/TX values are to be used as a useful aid in distinguishing between the two species, as proposed by Pessagno and applied herein, the upper limit for *G. stuartiformis* must be raised from the present value of 1.07. Until further measurements can be made and significant statistical limits placed on the variability of this species, an upper limit (T'X/TX value of *G. stuartiformis*) of 1.25 is arbitrarily used herein. Specimens with T'X/TX between 1.25 and 1.40 are herein termed transitional, and those with values greater than 1.40 are referred to *G. elevata* (Brotzen).

Pessagno (1967, p. 358) notes that *Globotruncana stuartiformis* is the basic species which gave rise to both *G. elevata* (Brotzen) and *G. stuarti* (de Lapparent). *Globotruncana stuartiformis* is distinguished from *G. elevata* by (1) being more nearly biconvex (T'X/TX values less than 1.25) rather than umbilicoconvex (T'X/TX values greater than 1.40), and (2) by having subtriangular (rarely crescent shaped) rather than petaloid to crescent shaped chambers spirally.

Pessagno (ibid., p. 337, text-fig. 44) noted the great amount of variation in chamber shape of *G. elevata*, illustrating forms with petaloid, subrectangular to trapezoidal, crescentic, and several individuals with a variable number of triangularly shaped spiral chambers. Having examined numerous specimens of *G. elevata*, Pessagno concluded that the shape of the spiral chambers alone was not a good criterion for distinguishing *G. stuartiformis* and *G. elevata*. Observations during the present investigation confirm Pessagno's conclusion, and herein, the T'X/TX values are used as the most important criterion in distinguishing these two species.

Although *G. stuarti* (de Lapparent) is also closely related to *G. stuartiformis*, *G. stuarti* is characterized externally by possessing trapezoidally shaped spiral chambers. Pessagno (1967, p. 356) noted that in thin-section, *G. stuarti* differs from *G. stuartiformis* (1) by possessing wide, radial hyaline imperforate peripheral bands in early whorls beneath the keel umbilically, and (2) by possessing a smaller umbilical diameter relative to its test diameter. T'X/TX values of both species are similar and thus cannot be used as a reliable criterion in distinguishing between these two species.

The specimen figured as *Globotruncana elevata stuartiformis* (van Hinte, 1955, pl. 1, figs. 3a–c), although showing crescentic to triangularly shaped spiral chambers, is very strongly umbilicoconvex (T'X/TX value about 1.62) and is included herein in *G. elevata* (Brotzen). The specimens figured by Olsson (1964, pl. 5, figs. 6a–c, 8a–c) as *G. stuarti stuartiformis* are strongly umbilicoconvex, have high T'X/TX values (1.60 and 1.50 respectively), and thus are included herein in *G. elevata*. The individual figured by Funnell, et al. (1969, p. 33, pl. 4, figs. 7–9; text-figs. 17a–c) as *G. stuarti* (de Lapparent) has subtriangularly shaped spiral chambers and properly belongs to *G. stuartiformis*.

Kuhri (1970, pp. 296–299) presents a discussion of *G. elevata* and *G. stuartiformis*, concluding that *G. stuartiformis* should be considered a junior synonym of *G. elevata* (Brotzen). Kuhri (ibid., p. 299) states . . ."It is clear that the taxon *G. stuartiformis* has caused considerable confusion, and furthermore has no stratigraphic value in worldwide correlation." That confusion exists regarding the phylogenetically related single-keeled *G. stuarti* lineage group is unquestioned. The present authors, however, regard *G. stuartiformis* as a valid, morphologically distinct, and stratigraphically important taxon.

The problems in correlation of the Gulf Coast section with the standard type European Campanian Stage have been presented by Pessagno (1969, pp. 25–26). Although *G. stuartiformis* has not been reported from the type Campanian section of France, van Hinte (1965, pp. 20–24) has reported the presence of *G. arca* (Cushman), *G. linneiana* (d'Orbigny), and *P. elegans* (Rzehak). As noted by Pessagno (ibid., p. 26), van Hinte's findings indicate that the type Campanian can be no older than the *G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone.

In the discussion of the range of *G. stuartiformis*, Pessagno (1967, p. 359) states . . ."This is one of the most important zone fossils in the Upper Cretaceous." Repeated occurrences of this taxon in the earliest Campanian of the western Gulf Coast and Caribbean (e.g., Puerto Rico) has proven it to be an important guide in distinguishing late Santonian from early Campanian strata. In addition, the initial appearance of *G. elevata* in the early portion of the late Campanian provides an important datum in separating early and late Campanian strata in the western Gulf Coastal Plain and Caribbean regions.

The initial appearance of *G. stuartiformis* in the Gulf Coast and its association with other species whose initial appearances are diagnostic of the early Campanian fauna is sufficient to establish the value of *G. stuartiformis* for local and worldwide correlation.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, basal part of *A. blowi* Subzone, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globotruncana stuartiformis* is in an exposure of the Aleg (?) Formation (Campanian) from Le Kef-Mellegue, northwestern Tunisia. This species has since been recorded under a variety of names (see synonymy) from the Esna-Idfu Region (Maestrichtian) of Egypt (El-Naggar, 1966, pp. 131–133, 136–139); Campanian and Maestrichtian of Libya (Barr, 1972, p. 25); early Campanian of Wadi Madi, Israel (Kuhri, 1970, pl. 1, figs. 4–6, 7–9); Pemberger Folge (late Campanian to middle Maestrichtian) of Austria (van Hinte, 1963, p. 71); Galicia Bank (late Maestrichtian), west of Spain (Funnell, et al., 1969, pp. 33–35); late Campanian and early Maestrichtian of Panama (Pessagno, 1967, p. 359); Colon Shale (Maestrichtian) of Colombia (Gandolfi, 1955, pp. 64–65); Naparima Hill and Guayaguayare Formations (Campanian and Maestrichtian) of Trinidad (Pessagno, 1967, p. 359); Campanian and early Maestrichtian of Puerto Rico (Pessagno, 1960, p. 101; 1962, p. 362); and the Shrewsbury Member, Redbank Formation (middle Maestrichtian) of New Jersey (Olsson, 1964, p. 170).

Pessagno (1967, p. 359) recorded *G. stuartiformis* from the early Campanian portion of the San Felipe Formation of Mexico; early Campanian to late Maestrichtian portion of the Mendez Shale of Mexico; and throughout the early Campanian to late Maestrichtian of Texas and Arkansas.

Globotruncana trinidadensis Gandolfi

Plate 18, figures 11–13

1918. Not *Rosalina linnei* d'Orbigny "mutation caliciforme" DE LAPPARENT, p. 8, tf. 2, fig. j; pl. 1, fig. 2 (nomen nudum).
1951. *Globotruncana caliciformis* (de Lapparent). BOLLI, pp. 194, 196, pl. 34, figs. 4–6.
1953. *Globotruncana caliciformis* (de Lapparent). HAMILTON, p. 232, pl. 29, figs. 6–8.
1955. *Globotruncana caliciformis trinidadensis* GANDOLFI, p. 47, pl. 3, figs. 2a–c.
1955. *Globotruncana caliciformis caliciformis* (de Lapparent). GANDOLFI, pp. 46–47, pl. 3, figs. 1a–c.
1955. *Globotruncana caliciformis sarmientoi* GANDOLFI, pp. 47–48, pl. 3, figs. 3a–c.
1966. *Globotruncana leupoldi* Bolli. EL-NAGGAR, pp. 121–122, pl. 1, figs. 4a–c.
1967. *Globotruncana trinidadensis* Gandolfi. PESSAGNO, pp. 359–362, pl. 84, figs. 4–6, 7–9, 10–12; pl. 90, figs. 9–10, 11–13; pl. 96, figs. 1, 2; text-fig. 57: a–c.

Remarks.–The description given by Gandolfi (1955, p. 47) and emendation by Pessagno (1967, p. 360) is followed herein. *Globotruncana trinidadensis* is distinguished by having four or five crescent to petaloid shaped chambers in the final whorl; straight, radial and slightly depressed umbilical sutures; and an umbilically reflected rather wide double keel which often merges to form a single keel along the final few chambers.

Pessagno (1967, p. 360) noted that *Globotruncana linnei caliciformis* Vogler (1941, p. 228) is a junior synonym of *G. contusa* (Cushman). Pessagno (ibid.) examined the holotypes of both *G. caliciformis trinidadensis* Gandolfi and *G. caliciformis sarmientoi* Gandolfi and concluded the two represented slightly different variants of the same taxonomic unit. Pessagno (ibid.) used the name *G. trinidadensis*, "As the holotype of *G. trinidadensis* is more typical of this taxonomic unit. . .".

Globotruncana trinidadensis is similar to *G. arca* (Cushman), but differs from the latter species by (1) having fewer chambers in the final whorl, (2) usually crescent shaped rather than petaloid shaped spiral chambers, and (3) depressed rather than raised and beaded umbilical sutures. Both species are closely related and numerous intermediate forms have been observed during the course of this investigation. It is probable that *G. arca* gave rise to *G. trinidadensis* during middle Maestrichtian time.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, lower part of *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *G. trinidadensis* is in an exposure of the Colon Formation (Maestrichtian) in the Rancheria Valley, along the Fonseca-Rio Hacha Road, about 400 kilometers north of Fonseca, northeastern Colombia. This species was figured as *G. calciformis* by Bolli (1951, p. 196) from the Maestrichtian Guayaguayare Formation (Lantern Marl) of Trinidad, and by Hamilton (1953, p. 232) from mixed Upper Cretaceous to Recent faunas from mid-Pacific guyots. El-Naggar (1966, pp. 121–122) noted this species as *G. leupoldi* Bolli from the Maestrichtian Sharawna Shale of the Esna-Idfu Region, Nile Valley, Egypt. Pessagno (1967, p. 362) recorded it from the middle and late Maestrichtian portions of the Mendez Shale of Mexico; middle Maestrichtian Corsicana and Kemp Formations of Texas; and the middle Maestrichtian Arkadelphia Marl of Arkansas. During this investigation, *G. trinidadensis* has been recorded in numerous samples from the Corsicana Formation of Texas (see text figs. 4–8).

Genus **Rugoglobigerina** Bronnimann, 1952

Type species.–*Globigerina rugosa* Plummer, 1926.

Remarks.–The emended definition of Pessagno (1967, p. 364) is followed herein.

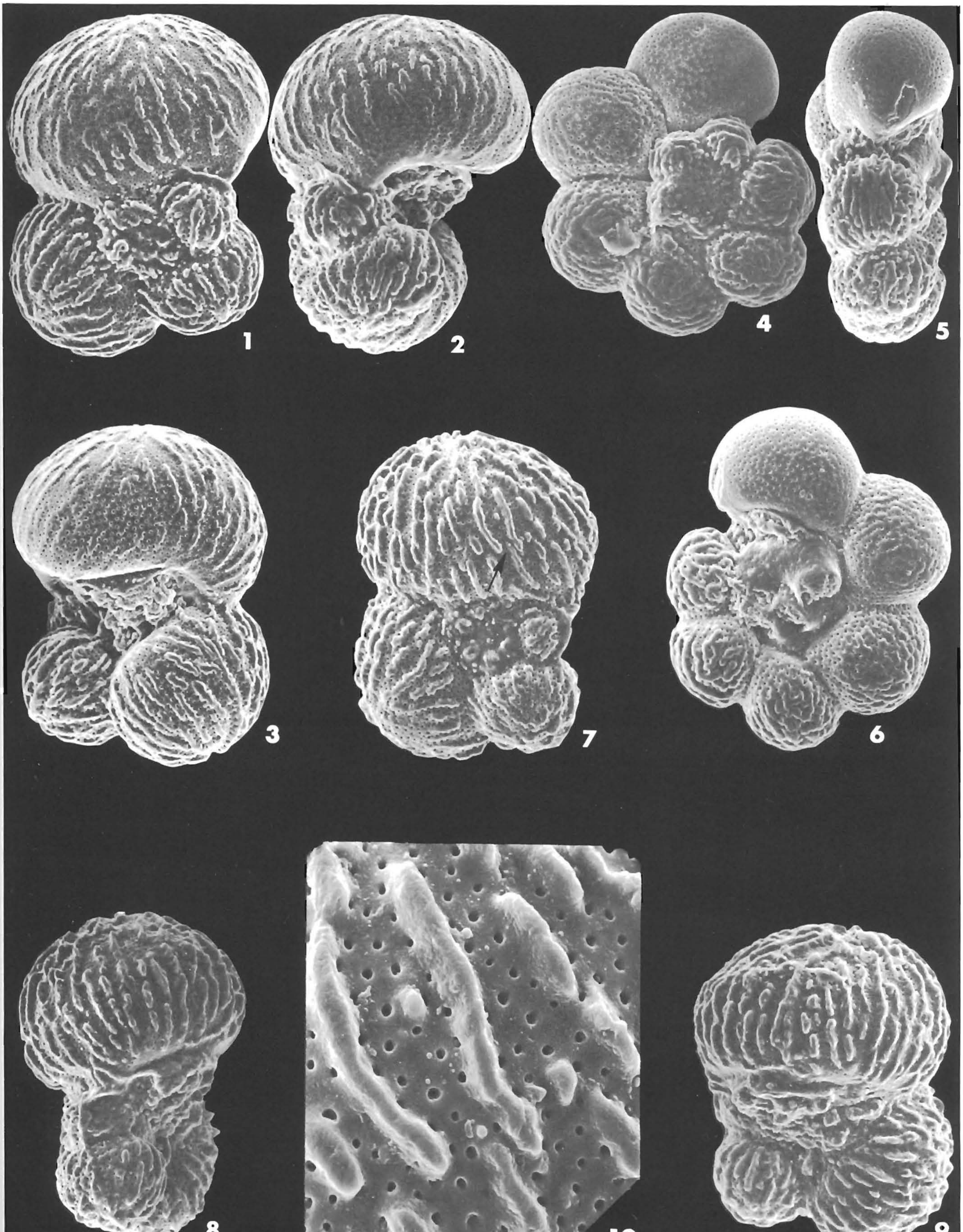
Rugoglobigerina hexacamerata Bronnimann

Plate 23, figures 4–6

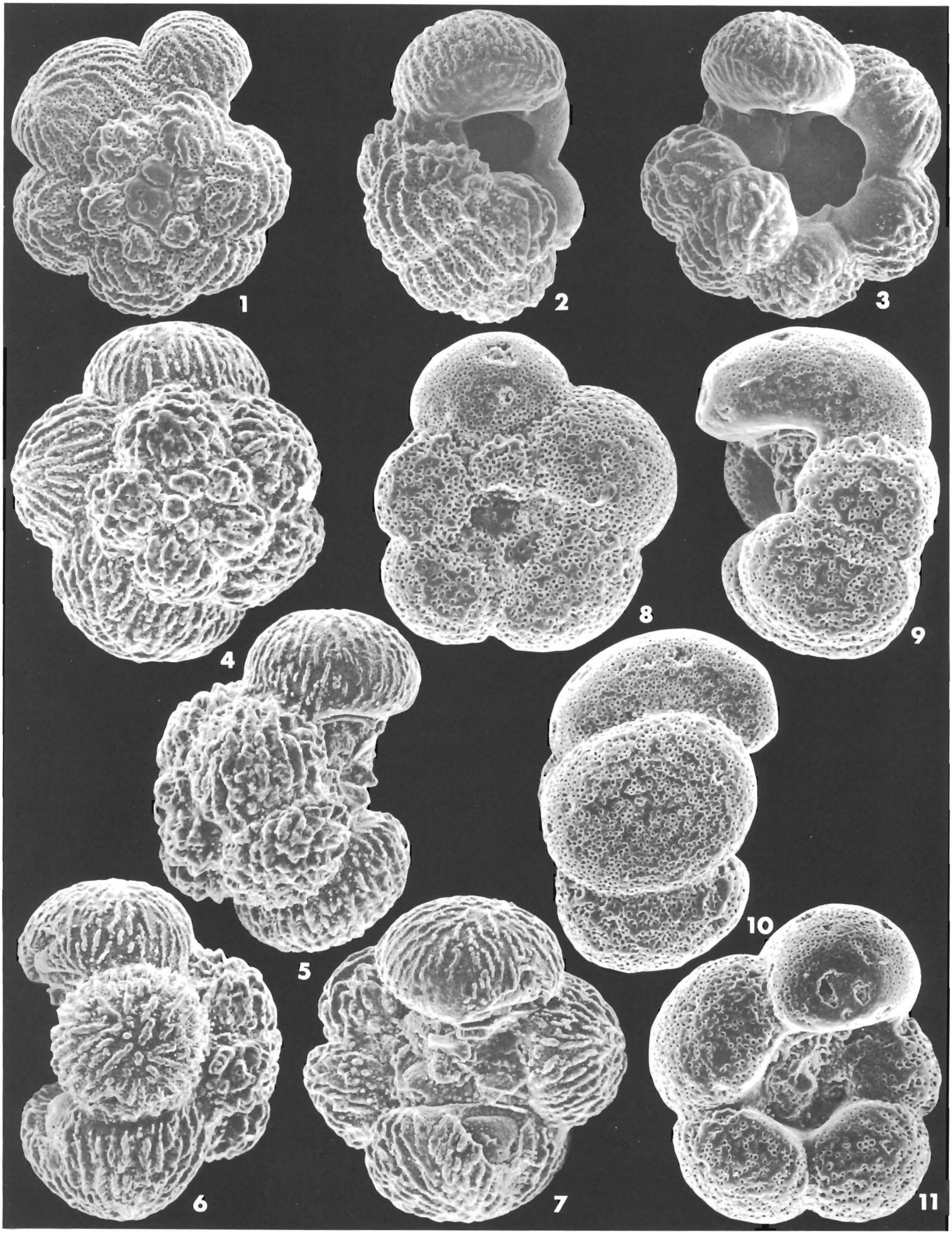
1952. *Ruguglobigerina reicheli hexacamerata* BRONNIMANN, pp. 23–25, pl. 2, figs. 10–12; text-figs. 8a–c, d–f, g–i, k–m.

PLATE 23

		Page
1–3.	*Rugoglobigerina macrocephala* Bronnimann ...... TX20XA-0E38. Note the low, trochospiral test; rapid increase in chamber size, the ultimate two chambers comprising three-fourths the test; and axially elongate ultimate chamber as seen in apertural view; 140×.	55
4–6.	*Rugoglobigerina hexacamerata* Bronnimann ...... TX4AC-40B27. Note the compressed test as observed in apertural view; six chambers in the final whorl increasing slowly in size; and the broad umbilicus; 165×.	54
7–10.	*Rugoglobigerina macrocephala* Bronnimann ...... TX20XA-41B40. 7–9, 165×. 10, Enlargement of a portion of the ultimate chamber showing the massive and discontinuous, meridionally arranged costae or rugosities. Note the irregularly placed pores in intercostal areas; 690×.	55



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS



SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

1955. *Globotruncana* (*Rugoglobigerina*) *hexacamerata hexacamerata* (Bronnimann). GANDOLFI, pp. 33–34, pl. 1, figs. 12a–c.
1955. *Globotruncana* (*Rugoglobigerina*) *hexacamerata subhexacamerata* GANDOLFI, p. 34, pl. 1, figs. 11a–c.
1967. *Rugoglobigerina hexacamerata* Bronnimann. PESSAGNO, pp. 364–365, pl. 74, (?) fig. 4; pl. 91, figs. 5–7.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *hexacamerata* Bronnimann. EL-NAGGAR, pp. 485–486, pl. 9, figs. 1, 2(?), 3, 6(?), 7, 8(?), 9, 10, 11, 12(?); not fig. 5; pl. 10, figs. 1a–d, 2a–d(?).
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *pennyi* Bronnimann. EL-NAGGAR, pp. 488–489, pl. 11, figs. 1(?), 3(?).
1972. *Rugoglobigerina hexacamerata* Bronnimann. BARR, p. 28–30, pl. 9, figs. 6a–c.

Remarks.–Rugoglobigerina hexacamerata Bronnimann is characterized by (1) having a very low trochospiral test, (2) having six (rarely seven) globular to rounded chambers in the final whorl which increase slowly in size as added, (3) possessing meridionally arranged rugosities, and (4) having a broad, deep umbilicus.

Rugoglobigerina hexacamerata differs from *R. pennyi* Bronnimann in being less trochospiral and spiroconvex (a somewhat flattened and planar spiral side is typical of *R. hexacamerata*), and in being much thinner as observed in apertural view (Pl. 23, fig. 5).

Pessagno (1967, p. 365) examined the holotype of *Globotruncana subhexacamerata* Gandolfi, and noted it differed from *R. hexacamerata* Bronnimann by possessing a weakly developed double keel along the early few chambers of the final whorl. He (ibid., p. 364) further noted that many species included in *Rugoglobigerina* possess imperforate peripheral bands, or weakly developed double keels, which do not truncate the peripheral margin of the test. Thus, *G. subhexacamerata* is included herein in *R. hexacamerata* Bronnimann.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *R. hexacamerata* Bronnimann is from the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) from the subsurface of southeastern Trinidad. Gandolfi (1955, pp. 33–34) noted it in the Colon Shale (Maestrichtian) of northeastern Colombia. It has also been described and figured from the late Maestrichtian of Libya (Barr, 1972, pp. 28–30). El-Naggar (1971b) recorded this species as both *R.* (*R.*) *hexacamerata* (in part) and *R.* (*R.*) *pennyi* Bronnimann (in part) from middle and late Maestrichtian strata in the Nile Valley, Egypt.

Pessagno (1967, p. 365) recorded this species from the late Maestrichtian (*A. mayaroensis* Subzone) portion of the Mendez Shale, and the middle Maestrichtian (*G. gansseri* Subzone) portion of the Papagallos Shale of Mexico; the Corsicana Marl and Kemp Clay (middle Maestrichtian) of Texas; and the Arkadelphia Marl (middle Maestrichtian) of Arkansas. Its occurrence in the Corsicana Formation of Texas is shown in text figs. 4–8.

Rugoglobigerina macrocephala Bronnimann

Plate 23, figures 1–3, 7–10

1952. *Rugoglobigerina macrocephala macrocephala* BRONNIMANN, pp. 25–27, pl. 2, figs. 1–3; text-figs. 9a–s.
1952. *Rugoglobigerina macrocephala ornata* BRONNIMANN, pp. 27–28, pl. 2, figs. 4–6; text-figs. 10a–i.
1955. *Globotruncana* (*Rugoglobigerina*) *macrocephala macrocephala* (Bronnimann). GANDOLFI, pp. 45–46, pl. 2, figs. 12a–c.
1955. *Globotruncana* (*Rugoglobigerina*) *macrocephala submacrocephala* GANDOLFI, p. 46, pl. 2, figs. 11a–c.
1962. Not *Rugoglobigerina macrocephala* Bronnimann. BERGGREN, pp. 76–78, pl. 12, figs. 4a–c, 5a–c, 6a–c; text-fig. 9: 1a–c, 2a–c, 3a–c, 4a–b, 5; text-fig. 10: 1, 2, 3, 4, 5.
1963. (?) *Rugoglobigerina macrocephala macrocephala* Bronnimann. BRONNIMANN and RIGASSI, pl. 18, figs. 2a–c (no pagination).
1964. Not *Rugoglobigerina macrocephala* Bronnimann. OLSSON, p. 172, pl. 6, figs. 9a–c.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *macrocephala* Bronnimann. EL-NAGGAR, pp. 486–487, pl. 6, figs. 1(?), 3, 5(?), 7(?), 9(?), 11, 16; not figs. 2, 4, 6, 8, 10, 12, 13, 14, 15; pl. 14, fig. 4.

Remarks.–Rugoglobigerina macrocephala is characterized by (1) having a low trochospiral test, (2) four (rarely five) chambers in the final whorl which increase rapidly in size, (3) having a large final chamber usually comprising about one-half the total size of the test; and (4) possessing a narrow, deep umbilicus.

The specimens figured by Berggren (1962, see synonymy) as *R. macrocephala* differ by being more trocho-

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PLATE 24

		Page
1–3.	*Rugoglobigerina pennyi* Bronnimann .... TX20XA-44BB42. Note the low trochospiral, spiroconvex test; the large diameter of the penultimate whorl as compared to the test diameter; and the six to seven, small globular chambers in the final whorl which increase slowly in size; 145×.	57
4–7.	*Rugoglobigerina milamensis* Smith and Pessagno, n. sp. .... TX9AD-0E35. Holotype (USNM 170544) showing the strongly spiroconvex test; initial whorls which are offset in a plane higher than that of the ultimate whorl; and somewhat axially elongate and inturned chambers umbilically; 140×.	56
8–11.	*Rugoglobigerina rotundata* Bronnimann .... TX9AH-0E34. Note the strong axially elongate chambers as observed in apertural and abapertural views; the narrow, deep umbilicus; and poorly-defined meridionally arranged rugosities; 120×.	58

spiral, in having a much less rapid increase in chamber size, and in having an ultimate chamber which is only slightly larger than the initial chamber of the final whorl, and thus atypical of the species as described by Bronnimann (1952). Furthermore, Berggren's figured specimens (1962, text-fig. 10: 1–5) do not show meridionally arranged rugosities. Hence, they do not belong to *Rugoglobigerina* as emended by Pessagno (1967, p. 364).

It seems probable that *R. rugosa* (Plummer) gave rise to *R. macrocephala* in the middle Maestrichtian (*G. gansseri* Subzone). Numerous transitional individuals (Pl. 25, figs. 8–10) have been observed from the Corsicana Formation of both the North Central and Central Texas areas.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, lower part of *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone (insofar known).

Occurrence.–The type locality of *R. macrocephala* Bronnimann is situated in the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) of southeastern Trinidad. It has since been noted by Gandolfi (see synonymy) from the Colon Shale (Maestrichtian) of northeastern Colombia, and by El-Naggar (1971b, pp. 486–487) from the type section of the Sharawna Shale, Esna-Idfu Region, Egypt.

Rugoglobigerina macrocephala is common in the Corsicana Formation (*G. gansseri* Subzone, *R. fructicosa* Zonule) throughout Texas (see text figs. 5–8). It has also been observed in the Corsicana Formation (*G. gansseri* Subzone, *G. aegyptiaca* Zonule) as exposed along Onion Creek (see text fig. 4), Travis County, Texas; the Arkadelphia Marl (*G. gansseri* Subzone) near McNab, Hempstead County, Arkansas; the Papagallos Shale (*G. gansseri* Subzone) of Mexico (see Appendix, Pessagno locality MX174); and the late Maestrichtian (*A. mayaroensis* Subzone) portion of the Mendez Shale of Mexico (Pessagno locality MX78).

Rugoglobigerina macrocephala has not been observed in the late Campanian or early Maestrichtian of Texas or Arkansas, nor was it observed in the early Maestrichtian portion of the Rio Yauco Formation of Puerto Rico. It should, thus, prove to be an important guide to the middle and late Maestrichtian.

Rugoglobigerina milamensis Smith and Pessagno, n. sp.

Plate 24, figures 4–7

1962. *Rugoglobigerina rugosa* (Plummer). BERGGREN, pp. 71–75, pl. 11, figs. 3a–c, 5a–b; not figs. 1a–b, 2, 4a–c; not text-fig. 8.

1963. *Globotruncana* (*Rugoglobigerina*) *rugosa* (Plummer). VAN HINTE, p. 92, pl. 11, figs. 2a–c; 3a–c; not figs. 1a–c.

1964. *Rugoglobigerina rugosa* (Plummer). OLSSON, p. 173, pl. 7, figs. 3a–c, 4a–c; not figs. 2a–c, 5a–c.

1966. *Rugoglobigerina rotundada* Bronnimann. DOUGLAS and SLITER, p. 116, pl. 1, figs. 5a–c; not figs. 2a–c, 6a–c.

Description.–Test trochospiral, strongly spiroconvex, early whorls offset in a higher plane than ultimate whorl; peripheral margin subcircular, lobate; five or six chambers in the final whorl spherical to subspherical, in apertural and abapertural views slightly elongate axially, ultimate chamber slightly offset umbilically; initial chambers on spiral side increasing rapidly in size as added, chambers of final whorl increasing only slightly in size; sutures radial, curved, strongly depressed; chambers of ultimate whorl heavily rugose, rugosities or costellae closely spaced, aligned in a meridional pattern, ultimate chamber generally more finely rugose; wall finely perforate; umbilicus large, subrectangular, deep; primary aperture interiomarginal, umbilical; spiral system of tegilla with intralaminal and infralaminal accessory apertures poorly preserved in specimens examined.

Remarks.–*Rugoglobigerina milamensis*, n. sp., has been previously figured (see synonymy) as *R. rugosa* (Plummer). It differs from the latter species in being much more strongly trochospiral, and in having a slight rather than rapid increase in chamber size. *Rugoglobigerina milamensis* differs from *R. rotundata* Bronnimann in being more trochospiral, in having chambers which, in apertural view, are not strongly elongate axially, in having coarse and well-developed meridional rugosities, and in having a large rather than small umbilicus. It differs from *R. tradinghousensis* Pessagno (= ? *R. pilula* Belford) in having strongly developed meridional rugosities or costellae on all chambers of the ultimate whorl, and in having a much larger umbilicus.

Rugoglobigerina milamensis, n. sp., is named after Milam County, Texas.

Dimensions.–Holotype measures 435μ in length, 415μ in width, and 340μ in maximum thickness.

Type Locality.–Exposure in bluff along southern bank of Walkers Creek, 5.6 miles north 21 degrees east of Cameron, Milam County, Texas (see Appendix, locality TX9). Type sample TX9AD, dark gray, conchoidal fracturing, calcareous mudstone, about 8.5 feet above base of exposure.

Deposition of types.–The holotype of *R. milamensis* n. sp. (USNM 170544), and unfigured paratypes (USNM 170545–170546, will be deposited in the collections of the U.S. National Museum, Washington, D.C. Unfigured paratypes (CS 10–12) will be deposited in the Pessagno Collection, Geosciences Division, The University of Texas at Dallas.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, lower part of *G. aegyptiaca* Zonule, to upper part of *A. mayaroensis* Subzone (insofar known).

Occurrence.–*Rugoglobigerina milamensis*, n. sp., has been figured previously as *R. rugosa* from the Maestrichtian of Denmark (Berggren, 1962); Pemberger Folge (Maestrichtian) of Austria (van Hinte, 1963); and the Redbank and Mt. Laurel Formations (Maestrichtian) of New Jersey (Olsson, 1964). Douglas and Sliter (1966) figured this form as *R. rotundata* Bronnimann from the Marsh Creek Formation of Contra Costa County, California.

During the present investigation, this species was observed in the Corsicana Formation (middle Maestrichtian, *G. aegyptiaca* Zonule) along Onion Creek, Travis County, Texas; Corsicana Formation (middle Maestrichtian, *R. fructicosa* Zonule) of North Central Texas; Papagallos Shale (middle Maestrichtian, *R. fructicosa* Zonule) of Mexico (see Appendix, Pessagno sample MX174); Mendez Shale (late Maestrichtian, *A. mayaroensis* Subzone) of Mexico (Pessagno sample MX78); and the Guayaguayare Formation (late Maestrichtian, *A. mayaroensis* Subzone) of Trinidad.

Rugoglobigerina pennyi Bronnimann

Plate 24, figures 1–3

1952. *Rugoglobigerina rugosa pennyi* BRONNIMANN, p. 34, pl. 4, figs. 1–3; text-figs. 14a–c, d–f, g–i.
1955. *Globotruncana* (*Rugoglobigerina*) *pennyi pennyi* (Bronnimann). GANDOLFI, p. 73, pl. 7, figs. 8a–c.
1962. Not *Rugoglobigerina pennyi* Bronnimann. BERGGREN, p. 75, pl. 12, figs. 1a–c, 2a–c, 3a–c.
1966. *Rugoglobigerina rotundata* Bronnimann. DOUGLAS and SLITER, p. 116, pl. 1, figs. 2a–c, 6a–c; not figs. 5a–c.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *pennyi* Bronnimann. EL-NAGGAR, pp. 488–489, pl. 8, fig. 1(?); not fig. 2; pl. 9, figs. 4(?), 13(?), 15(?), 16(?); not fig. 14; pl. 17, fig. 12(?); not pl. 6, fig. 19; not pl. 11, figs. 1–10.

Remarks.–*Rugoglobigerina pennyi* Bronnimann is characterized by (1) having a low trochospiral, spiroconvex test, (2) six (rarely seven) small globular chambers in the final whorl which increase slowly in size or show no increase in size as added, (3) having meridionally arranged rugosities, and (4) a large, deep umbilicus.

Rugoglobigerina pennyi has previously been confused with *R. rugosa* (Plummer). It differs from *R. rugosa* (1) by having a more trochospiral test as observed in apertural view, (2) by having a much larger penultimate whorl (maximum diameter usually more than one-half the total diameter of the ultimate whorl), (3) by having a larger number of chambers in the final whorl, and (4) by having smaller chambers which increase little in size as added.

The specimen figured as *Rugoglobigerina rotundata* Bronnimann by Douglas and Sliter (1966, pl. 1, figs. 6a–c) belongs to *R. pennyi*. *Rugoglobigerina pennyi* is distinguished from *R. rotundata* by having globular to ovate rather than axially elongate chambers as seen in apertural view, and by having a much smaller umbilicus. The specimen figured by Douglas and Sliter (ibid., figs. 5a–c) appears to be strongly trochospiral and spiroconvex, and is included herein in *Rugoglobigerina milamensis* n. sp.

The forms figured by Berggren as *R. pennyi* (see synonymy) do not show meridionally arranged rugosities and thus should be included in *Archaeoglobigerina* Pessagno.

Rugoglobigerina pennyi differs from *R. hexacamerata* Bronnimann by having a more strongly trochospiral and much thicker test as observed in apertural view.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *R. subcircumnodifer* Subzone, *R. subpennyi* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–This species was originally defined by Bronnimann (1952, p. 34) from the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) of southeastern Trinidad. As already noted, Douglas and Sliter (1966) figured it as *R. rotundata* from the Marsh Creek Formation of Contra Costa County, California.

During the present investigation *R. pennyi* was observed in the early Maestrichtian (*R. subcircumnodifer* Subzone) portion of the Rio Yauco Formation of Puerto Rico (see Appendix, Pessagno locality PR 789.32); Arkadelphia Marl (middle Maestrichtian, *G. gansseri* Subzone) near McNab, Hempstead County, Arkansas; Corsicana Formation (middle Maestrichtian, *G. aegyptiaca* Zonule) exposed along Onion Creek, Travis County, Texas; Papagallos Shale (middle Maestrichtian, *R. fructicosa* Zonule) of Mexico (Pessagno locality MX174); and the Mendez Shale (late Maestrichtian, *A. mayaroensis* Subzone) of Mexico (Pessagno locality MX78).

Rugoglobigerina pennyi has not been observed in the Campanian of Texas or Arkansas, and thus should prove to be a valuable guide to the Maestrichtian.

Rugoglobigerina reicheli Bronnimann

Plate 26, figures 1–3, 4–6

1952. *Rugoglobigerina reicheli reicheli* BRONNIMANN, pp. 18–19, pl. 3, figs. 10–12; text-figs. 4: a–c, d–f, g–i, k–m; text-figs. 5: a–c, d–f, g–i.
1967. *Rugoglobigerina reicheli* Bonnimann. PESSAGNO, p. 365, pl. 65, figs. 5–6, 7; pl. 91, fig. 3.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *reicheli* Bronnimann. EL-NAGGAR, pp. 490–491, pl. 8, figs. 7(?), 8(?); not figs. 3, 6, 9; not pl. 6, fig. 18.

Remarks.–*Rugoglobigerina reicheli* Bronnimann is distinguished from *R. rugosa* (Plummer) by (1) the clavate to somewhat conical, and coarsely spinose nature of the initial chambers of the final whorl, and (2) having a much thinner test as observed in apertural view. It differs from *R. hexacamerata* Bronnimann (1) by having fewer chambers in the final whorl (four or five rather than six or seven) which increase rather rapidly in size as added, and (2) in the clavate and strongly spinose peripheral margin.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *R. reicheli* occurs in the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) of southeastern Trinidad.

Pessagno (1967, p. 365) noted it in the middle Maestrichtian (*G. gansseri* Subzone) portion of the Papagallos Shale of Mexico; Kemp Clay of Falls County, Texas; and Arkadelphia Marl of Arkansas. To the authors' knowledge, *R. reicheli* has not been reported from Europe, Asia, or Africa, although El-Naggar (1971b, see synonymy) presented a single view of two individuals from the middle and late Maestrichtian strata of the Esna-Idfu Region, Egypt, which are questionably assigned to *R. reicheli* Bronnimann.

Rugoglobigerina rotundata Bronnimann

Plate 24, figures 8–11

1952. *Rugoglobigerina rugosa rotundata* BRONNIMANN, pp. 34–36, pl. 4, figs. 7–9; text-figs. 15: a–c, d–f; 16: a–c.
1955. *Globotruncana (Rugoglobigerina) rotundata rotundata* (Bronnimann). GANDOLFI, p. 70, pl. 7, figs. 2a–c.
1956. *Kuglerina rotundata* (Bronnimann). BRONNIMANN and BROWN, p. 557.
1966. Not *Rugoglobigerina rotundata* Bronnimann. DOUGLAS and SLITER, p. 116, pl. 1, figs. 5a–c, 6a–c.
1967. *Rugoglobigerina rotundata* Bronnimann. PESSAGNO, pp. 365–366, pl. 65, figs. 1–3, 4; pl. 68, figs. 1–3.
1969. *Rugoglobigerina rugosa* (Plummer). DUPEUBLE, p. 157, pl. 4, figs. 11a–d.
1969. *Rugoglobigerina rotundata* Bronnimann. FUNNELL, et al., p. 37, pl. 5, figs. 7–9; text-fig. 21: a–c.
1971b. *Rugoglobigerina (Rugoglobigerina) rotundata* Bronnimann. EL-NAGGAR, pp. 491–492, pl. 10, figs. 3a–b, 3c(?), 3d(?).
1972. *Rugoglobigerina rotundata* Bronnimann. BARR, p. 30, pl. 10, figs. 3a–c.

Remarks.–Rugoglobigerina rotundata Bronnimann is distinguished from other species of *Rugoglobigerina* by its large, low trochospiral test; by having five (rarely six) chambers in the final whorl which are strongly elongate axially; and by its centrally placed, narrow and deep umbilicus. Bronnimann (1952, p. 36) noted that the ornamentation of *R. rotundata* is not so clearly developed in a meridional pattern as that observed on other species of *Rugoglobigerina*.

The specimen figured by Douglas and Sliter (1966, pl. 1, figs. 2a–c, 6a–c) as *R. rotundata* differs by lacking the axially elongate chambers and narrow umbilicus characteristic of this species and is included under *R. pennyi* Bronnimann. The form figured as *R. rotundata* (ibid., figs. 5a–c) appears to be rather strongly spiroconvex and to have spherical to globular shaped chambers, and is included herein under *Rugoglobigerina milamensis* n. sp.

Range.–G. contusa-stuartiformis Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *R. rotundata* is from the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) of southeastern Trinidad. It has since been recorded from the Colon Shale (Maestrichtian) of northeastern Colombia (Gandolfi, 1955, p. 70); from a sample of chalk (late Maestrichtian, *A. mayaroensis* Subzone) dredged from Galicia Bank (Funnell, et al., 1969, p. 37); middle and late Maestrichtian Sharawna Shale, Esna-Idfu Region, Nile Valley, Egypt (El-Naggar, 1971b, pp. 491–492); late Maestrichtian portion of the Atrun Limestone in northeastern Libya (Barr, 1972, p. 30); and from the late Maestrichtian of France (Dupeuble, 1969, p. 157).

Pessagno (1967, p. 366) recorded *R. rotundata* from the middle Maestrichtian (*R. fructicosa* Zonule) portion of the Papagallos Shale (see Appendix, Pessagno locality MX174), and late Maestrichtian (*A. mayaroensis* Subzone) portion of the Mendez Shale of Mexico (Pessagno locality MX78), as well as from the Kemp Clay of Falls County, Texas (Locality TX20).

Rugoglobigerina rotundata has not been observed in the Corsicana Formation below the *R. fructicosa* Zonule. It appears to be an excellent marker for the late middle Maestrichtian and late Maestrichtian (see text fig. 3).

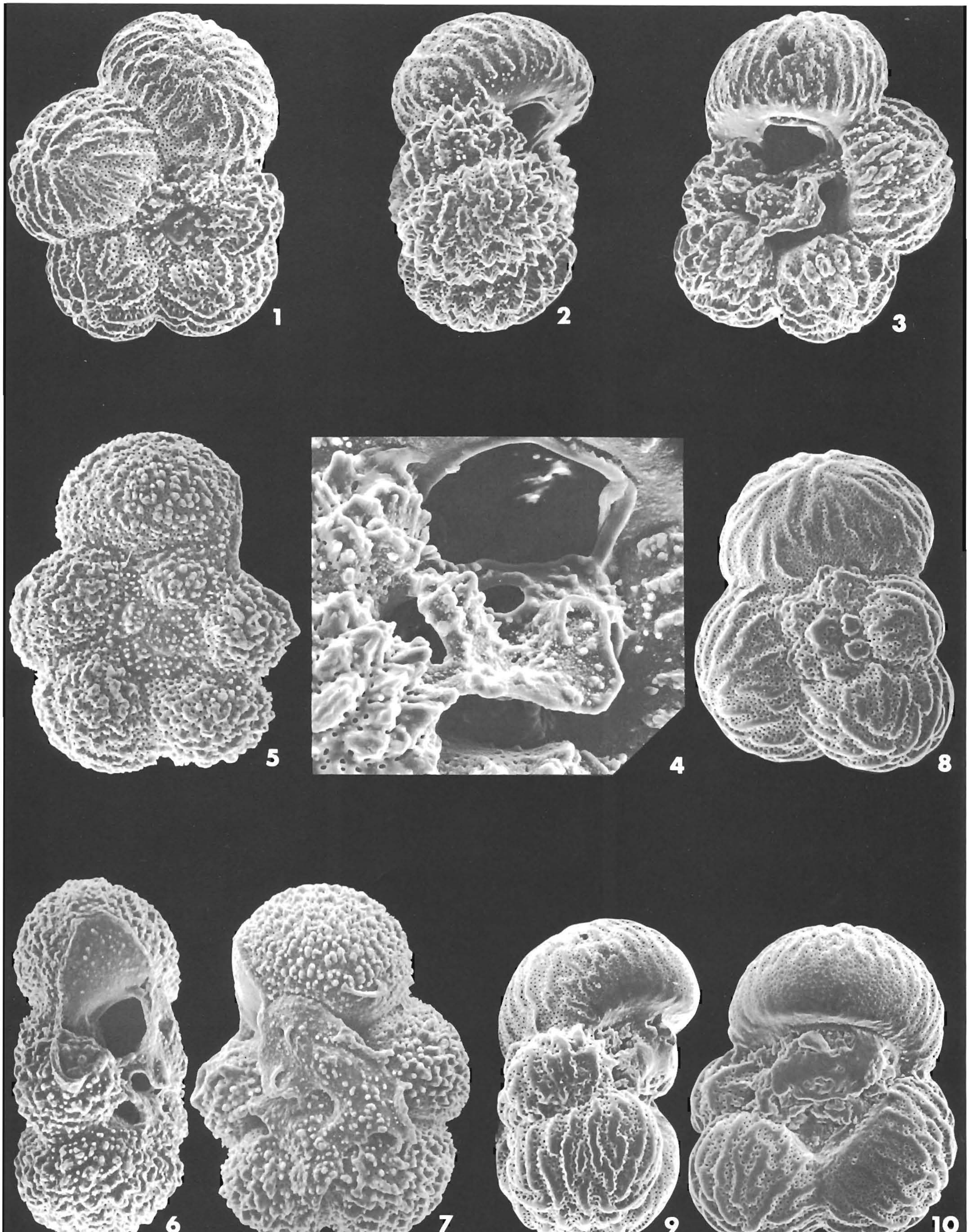
Rugoglobigerina rugosa (Plummer)

Plate 25, figures 1–4

1926. *Globigerina rugosa* PLUMMER, pp. 38–39, pl. 2, figs. 10a, b, c, d.
1952. *Rugoglobigerina rugosa rugosa* (Plummer). BRONNIMANN, pp. 28–33, text-figs. 11a–i, 12a–i, 13a–i.
1955. *Globotruncana (Rugoglobigerina) rugosa rugosa* (Plummer). GANDOLFI, p. 72, pl. 7, figs. 6a–c.
1955. *Globotruncana (Rugoglobigerina) rugosa subrugosa* GANDOLFI, p. 72, pl. 7, figs. 5a–c.

PLATE 25

		Page
1–4.	*Rugoglobigerina rugosa* (Plummer) .... TX20XA-0E36. 1–3, Note the low trochospiral test and five chambers in the final whorl which increase rapidly in size as added; 120×. 4, Enlargement of umbilical area showing tegilla with infralaminal and intralaminal accessory apertures; 275×.	58
5–7.	*Rugoglobigerina rugosa* (Plummer) transitional to *Rugoglobigerina hexacamerata* Bronnimann ...... TX3BA-41AB36. Note the five chambers which increase gradually in size, and compressed test as observed in apertural view; 165×. Compare with *R. hexacamerata* Bronnimann (Pl. 23, figs. 4–6).	59
8–10.	*Rugoglobigerina rugosa* (Plummer) transitional to *Rugoglobigerina macrocephala* Bronnimann ...... TX9AE-41B44. Note the four chambers which increase rapidly in size as added. The ultimate and penultimate chambers comprise about three-fourths the test; 210×. Compare with *R. macrocephala* Bronnimann (Pl. 23, figs. 1–3, 7–10).	58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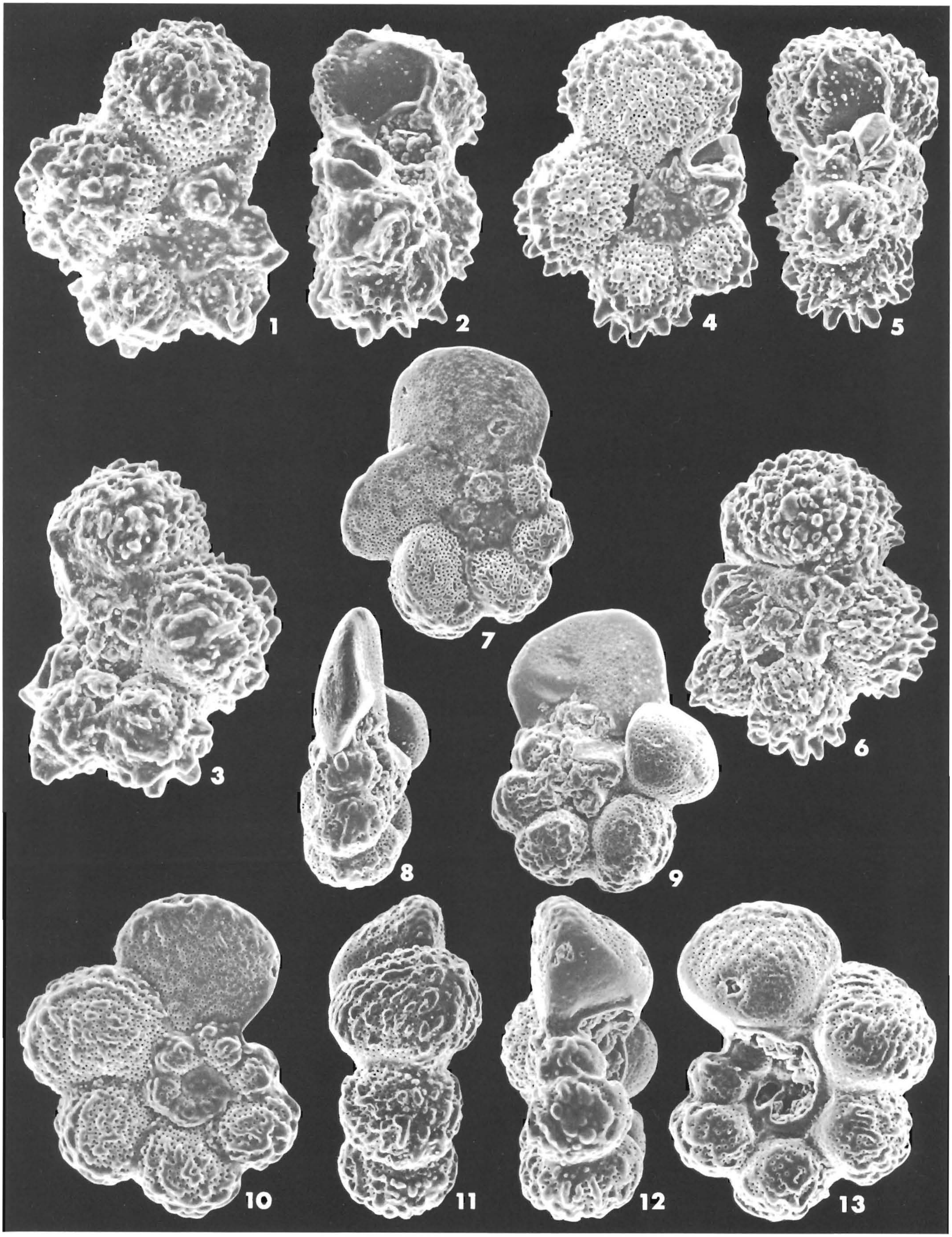


SMITH & PESSAGNO: CORSICANA FORAMINIFERA FROM TEXAS

5. *Globotruncana (Rugoglobigerina) ornata ornata* Bronnimann). GANDOLFI, pp. 49–50, pl. 3, figs. 7a–c.
5. *Globotruncana (Rugoglobigerina) ornata subornata* GANDOLFI, p. 50, pl. 3, figs. 6a–c.
7. *Rugoglobigerina rugosa* (Plummer). BOLLI, et al., pp. 43–44, pl. 11, figs. 2a–c.
0. *Rugoglobigerina rugosa rugosa* (Plummer). OLSSON, p. 50, pl. 10, figs. 16–18.
3. *Globotruncana (Rugoglobigerina) rugosa* (Plummer). VAN HINTE, p. 92, pl. 11, figs. 1a–c; not figs. 2a–c, 3a–c.
54. *Rugoglobigerina macrocephala* Bronnimann. OLSSON, p. 172, pl. 6, figs. 9a–c.
64. *Rugoglobigerina rugosa* (Plummer). LOEBLICH and TAPPAN, p. C663, fig. 530: 3a–c.
67. *Rugoglobigerina rugosa* (Plummer). PESSAGNO, pp. 366–367, pl. 75, figs. 2–3; pl. 101, figs. 8–9.
69. Not *Rugoglobigerina rugosa* (Plummer). DUPEUBLE, p. 157, pl. 4, figs. 11a–d.
71a. Not *Rugoglobigerina (Rugoglobigerina) rugosa* (Plummer). EL-NAGGAR, pl. 5, figs. a–c.
71b. *Rugoglobigerina (Rugoglobigerina) badryi* EL-NAGGAR, pp. 482–483, pl. 14, figs. 2, 5, 9, 10; pl. 16, figs. 1, 3, 4(?), 5(?), 7, 11(?).
971b. *Rugoglobigerina (R.) browni* EL-NAGGAR, pp. 484–485, pl. 17, figs. 2, 3, 5, 6, 8.
971b. *Rugoglobigerina (Rugoglobigerina) hexacamerata* Bronnimann. EL-NAGGAR, pp. 485–486, pl. 9, fig. 5.
971b. *Rugoglobigerina (Rugoglobigerina) macrocephala* Bronnimann. EL-NAGGAR, pp. 486–487, pl. 6, figs. 2, 4, 12, 13, 15.
971b. *Rugoglobigerina (Rugoglobigerina) reicheli* Bronnimann. EL-NAGGAR, pp. 490–491, pl. 6, fig. 18(?); pl. 8, figs. 3(?), 6, 9(?).
971b. *Rugoglobigerina (Rugoglobigerina) rugosa* (Plummer). EL-NAGGAR, pp. 492–494, pl. 1, figs. 1, 2(?), 3, 4, 5, 6(?), 8(?), 9, 10(?); not figs. 7, 11; pl. 2, figs. 3, 4(?), 5(?), 6(?); not figs. 1, 2, 7, 8, 10, 11; pl. 3, figs. 1, 2(?), 3, 4, 5, 6(?), 7(?), 8(?), 9, 10(?), 13, 14(?), 15(?), 16; not figs. 11, 12; pl. 4, figs. 1(?), 2, 3, 4(?), 5(?), 7, 8, 9, 10, 12(?), 13, 14; not figs. 6, 11, 15; pl. 6, figs. 17; pl. 8, figs. 4, 5(?).
972. *Rugoglobigerina rugosa* (Plummer). BARR, p. 30, pl. 9, figs. 7; pl. 10, figs. 4a–c.

Remarks.–*Rugoglobigerina rugosa* (Plummer) is characterized by (1) its low trochospiral test, (2) four to five globular to hemispherical chambers in the final whorl which increase rapidly in size as added, and (3) its large, deep umbilicus.

Examination of numerous specimens, including abundant topotypes, of *R. rugosa* shows that the test varies in the number of chambers in the final whorl, the rapidity of their increase in size as added, and the degree of development of meridionally arranged rugosities.

The four-chambered forms of *R. rugosa* differ from the five-chambered forms in having a less rapid increase in chamber size, by having a more trochospiral test, and in having a larger ultimate chamber. Bronnimann (1952, p. 32) has previously noted the affinity of the four-chambered forms of *R. rugosa* to *R. macrocephala* Bronnimann. It is probable that *R. rugosa* gave rise to *R. macrocephala* in the middle Maestrichtian (*G. gansseri* Subzone). Transitional forms have been observed in the Corsicana Formation and are figured herein (Pl. 25, figs. 8–10). The individuals figured by El-Naggar as *R. (R.) rugosa* (1971b, pl. 2, figs. 1, 2, 7, 10) and *R. (R.) macrocephala* (ibid., pl. 6, figs. 6, 14) show similar transitional characteristics.

Rugoglobigerina (R.) browni El-Naggar (1971b, pp. 484–485) is included in part in *R. rugosa*. Although El-Naggar presented only a single view of the holotype (ibid., pl. 17, fig. 1), that individual, as well as several of the paratypes (ibid., figs. 4, 7, 9, 10), shows intermediate characteristics between *R. rugosa* s.s. and *R. macrocephala* Bronnimann. Of the remaining five paratypes illustrated by El-Naggar (ibid., pl. 17, figs. 2, 3, 5, 6, 8), all are assignable to *R. rugosa* (Plummer).

Berggren (1962) illustrated several forms described as *R. rugosa* which do not conform to the lectotype selected by Bronnimann (1952, p. 32) or figures of the syntypes illustrated by Plummer (1926, pl. 2, figs. 10b, c, d; lectotype, fig. 10a). The forms figured by Berggren (1962, pl. 11, figs. 1a–b, 2; text-fig. 8) differ from *R. rugosa* in being more strongly trochospiral, in having a much larger initial chamber in the final whorl, and by showing very little or no increase in chamber size in the last whorl. This form is distinct and perhaps should be placed in a separate species. The form figured by Berggren (ibid., pl. 11, figs. 4a–c) does not appear to have meridionally arranged rugosities and perhaps should be included in *Archaeoglobigerina* Pessagno. The six-chambered, strongly trochospiral forms figured by Berggren (ibid., pl. 11, figs. 3a–c, 5a–b) are included herein *Rugoglobigerina milamensis*, n. sp.

Rugoglobigerina rugosa differs from *R. hexacamerata* Bronnimann in being larger, having a thicker test as seen

PLATE 26

		Page
1–3, 4–6.	*Rugoglobigerina reicheli* Bronnimann ...... 1–3, TX20XA-0E44, 170×; 4–6, TX20XA-0E43, 140×. Note the somewhat clavate early chambers, and massive, blunt spines along the peripheral margin of the initial chambers of the ultimate whorl.	57
7–9, 10–13.	*Rugoglobigerina scotti* (Bronnimann) ...... 7–9, TX9XF-25B21, 125×; 10–13, TX9XE-0E32, 140×. Note the low trochospiral, somewhat compressed test, and the ultimate (occasionally penultimate) chamber which is strongly compressed and flattened. Note the thin imperforate peripheral band along the spiral margin of the test as observed in apertural and abapertural views.	60

in apertural view, and by having larger chambers which increase more rapidly in size as added. Rare individuals from the Corsicana Formation consist of five (rarely six) chambers in the final whorl, and show a gradual increase in size of chambers as added. Such specimens appear to be transitional between *R. rugosa* and *R. hexacamerata* (Pl. 25, figs. 5–7). Many of the individuals figured by El-Naggar as *R.* (*R.*) *badryi* (1971b, pl. 14, figs. 1, 6, 13; pl. 16, figs. 2, 6, 8, 9a–c, 10, 12, 13) and *R.* (*R.*) *rugosa* (pl. 1, figs. 7, 11; pl. 3, figs. 11, 12) show similar transitional characteristics. Although the holotype of *R.* (*R.*) *badryi* El-Naggar (ibid., pl. 16, fig. 8) is considered a transitional form, other figured paratypes (see synonymy) are assignable to *R. rugosa* (Plummer).

Rugoglobigerina pennyi Bronnimann differs from *R. rugosa* in having a more highly trochospiral, spiroconvex test consisting of usually six chambers in the final whorl which increase slowly or show no increase in size.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *A. blowi* Subzone, lower part of *P. glabrata* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *R. rugosa* (Plummer) is in an exposure of the uppermost Corsicana Formation (middle Maestrichtian, *R. fructicosa* Zonule) along the southern bank of Walkers Creek, Milan County, Texas (Loc. TX9). It has since been recorded from the Campanian and Maestrichtian Pemberger Folge of Austria (van Hinte, 1963, p. 92); Maestrichtian Esna Shale of Egypt (Said and Sabry, 1964, p. 386; El-Naggar, 1971b, see synonymy); late Campanian and Maestrichtian strata of Libya (Barr, 1972, p. 30); Upper Cretaceous of South India (Rasheed and Govindan, 1968, p. 84); mixed Upper Cretaceous to Recent faunas from mid-Pacific flat-topped seamounts (Hamilton, 1953, p. 227); Maestrichtian Colon Shale of Colombia (Gandolfi, 1955, see synonymy); late Maestrichtian Guayaguayare Beds of Trinidad (Bronnimann, 1952, pp. 28–30); Campanian and Maestrichtian of Puerto Rico (Pessagno, 1960, p. 99; 1962, p. 360); Maestrichtian of Cuba (Bronnimann and Rigassi, 1963, no pagination); Maestrichtian Redbank Formation of New Jersey (Olsson, 1960, p. 50); and Upper Cretaceous Monmouth Group of New York (Perlmutter and Todd, 1965, p. I 18). Pessagno (1967, pp. 366–367) noted *R. rugosa* throughout the Campanian and Maestrichtian of Texas, Arkansas, and Mexico.

Rugoglobigerina scotti (Bronnimann)

Plate 26, figures 7–9, 10–13

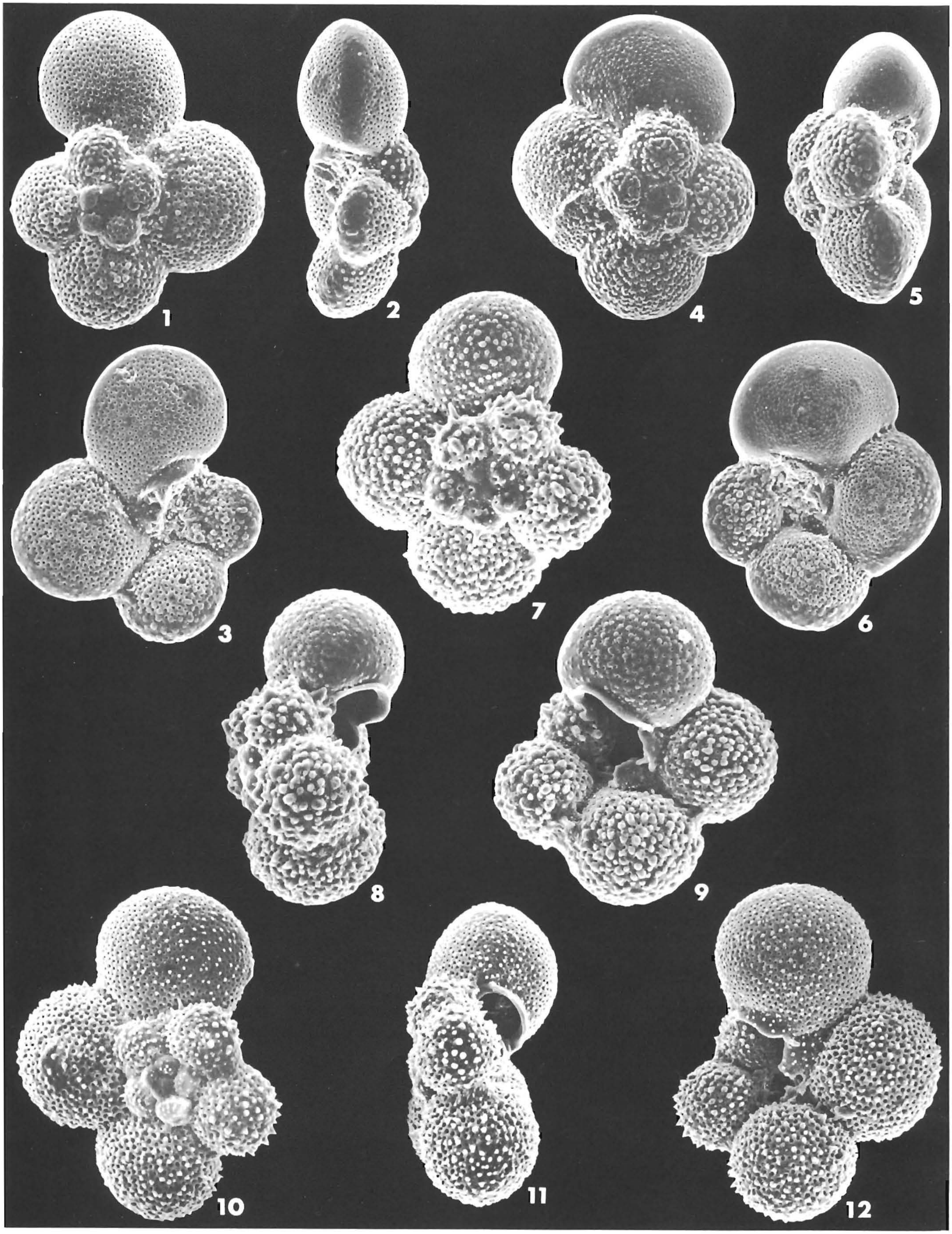
1952. *Trinitella scotti* BRONNIMANN, p. 57, pl. 4, figs. 4–6; text-figs. 30: a–c, d–f, g–i, k–m.
1956. *Trinitella scotti* Bronnimann. BRONNIMANN and BROWN, p. 555, pl. 23, figs. 13–15; pl. 24, fig. 3.
1957. *Rugoglobigerina scotti* (Bronnimann). BOLLI, et al., p. 44, pl. 11, figs. 3a–c, 4a–c.
1963. *Trinitella scotti* Bronniman. BRONNIMANN and RIGASSI, pl. 16, figs. 3a–c.
1964. *Trinitella scotti* Bronnimann. LOEBLICH and TAPPAN, p. C663, fig. 530: 2a–c.
1964. *Trinitella scotti* Bronnimann. OLSSON, pp. 173–174, pl. 6, figs. 10a–c.
1967. *Rugoglobigerina scotti* (Bronnimann). PESSAGNO, p. 367, pl. 74, figs. 9–11, 12–14; pl. 76, figs. 4–6.
1969. (?)*Rugoglobigerina scotti* (Bronnimann). FUNNELL, et al., pp. 37–38, pl. 5, figs. 10–12; text-fig. 21: a–c.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *bronnimanni* EL-NAGGAR, pp. 483–484, pl. 12, figs. 1, 2(?), 3(?), 4, 5, 6, 7, 8(?), 9; pl. 13, figs. 1, 2a–e; pl. 14, fig. 15(?); not figs. 14, 16.
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *pennyi* Bronnimann. EL-NAGGAR, pp. 488–489, pl. 11, figs. 2, 5, 6(?), 7, 8, 9(?), 10(?).
1971b. *Rugoglobigerina* (*Rugoglobigerina*) *scotti* (Bronnimann). EL-NAGGAR, pp. 494–495, pl. 13, figs. 3a–c.

Remarks.–*Rugoglobigerina scotti* is characterized by having (1) a planiform spiral side, and (2) an ultimate (occasionally penultimate) chamber which is distinctly compressed and flattened, and truncate by an imperforate peripheral band along the spiral margin of the test.

Bronnimann (1952, p. 56) described *Trinitella* (type species: *T. scotti* Bronnimann) for forms with chambers ". . . flattened at the spiral side and peripherally keeled in the end stage." Bolli, et al. (1957, p. 44) and Pessagno (1967, p. 367) considered *Trinitella* a junior synonym of *Rugoglobigerina* since both genera were similar in surface

PLATE 27

		Page
1–3.	*Globotruncanella petaloidea* (Gandolfi) . . . . TX4AC-38BB15. Note the low trochospiral, compressed test; lobate peripheral margin; petaloid-shaped chambers spirally and umbilically; imperforate peripheral band; and the low extraumbilical-umbilical aperture; 165×.	61
4–6.	*Globotruncanella petaloidea* (Gandolfi) . . . . TX4AA-38AB14. Note the more spirally convex test; more inflated chambers as observed in apertural view; and less lobate peripheral margin; 145×.	61
7–9.	*Globotruncanella monmouthensis* (Olsson) . . . . . . TX20XA-0B56. Note the low trochospiral test, spherical chambers, and arched aperture as observed in apertural view; 190×. Compare with Figures 1–3, 4–6 of *G. petaloidea* (Gandolfi).	61
10–12.	*Globotruncanella* sp. a . . . . TX2AD-38B20. Note intermediate characteristics in degree in compression of the test and nature of the aperture as seen in apertural view between *G. petaloidea* (Gandolfi) and *G. monmouthensis* (Olsson); 185×.	62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ornamentation and apertural character, and only slightly different in terminal chamber shape. Although Bronnimann (ibid.) and Bronnimann and Brown (1956, pp. 554–555) refer to *Trinitella* as being ". . . peripherally keeled . . ." or having a ". . . keeled, imperforate peripheral band.", many species of *Rugoglobigerina* occasionally possess imperforate peripheral bands or weakly developed keels which have little or no affect on the peripheral margin of the test (see Pessagno, 1967, pp. 364, 369).

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *R. subcircumnodifer* Subzone, *R. subpennyi* Zonule, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Rugoglobigerina scotti* occurs in the upper part of the Guayaguayare Beds (late Maestrichtian, *A. mayaroensis* Subzone) of southeastern Trinidad. It has since been recorded from the Penalver Formation (late Maestrichtian) of Cuba, and from a sample of chalk (late Maestrichtian, *A. mayaroensis* Subzone) dredged from Galicia Bank, a seamount west of Spain (Funnell, et al., 1969). El-Naggar (1971b) reported *R. scotti* under a variety of names (see synonymy) from middle and late Maestrichtian strata of the Esna-Idfu Region, Nile Valley, Egypt.

In Mexico, *R. scotti* has been reported from the middle Maestrichtian (*G. gansseri* Subzone) portion of the Papagallos Shale, and late Maestrichtian (*A. mayaroensis* Subzone) portion of the Mendez Shale (Pessagno, 1967, p. 367).

In Texas, it has been noted in the middle Maestrichtian (*G. gansseri* Subzone) Corsicana Marl and Kemp Clay of Central and North Central Texas (Bronnimann and Brown, 1956, p. 555; Pessagno, 1967, p. 367). Bronnimann and Brown (ibid.) also noted its occurrence in the Arkadelphia Marl of Arkansas and Prairie Bluff Chalk of Alabama. Olsson (1964, p. 174) reported *R. scotti* from the Maestrichtian Redbank Formation of New Jersey.

Rugoglobigerina scotti is common to abundant throughout the Corsicana Formation of Texas (see text figs. 4–8).

Family ABATHOMPHALIDAE Pessagno

Genus **Globotruncanella** Reiss, 1957

Type species.–*Globotruncana citae* Bolli, 1951 (= *Globotruncana havanensis* Voorwijk, 1937).

Remarks.–The emended definition given by Pessagno (1967, p. 373) is followed herein.

Globotruncanella monmouthensis (Olsson)

Plate 27, figures 7–9

1960. *Globorotalia monmouthensis* OLSSON, p. 47, pl. 9, figs. 22–24.
1962. *Praeglobotruncana* (*Hedbergella*) *monmouthensis* (Olsson). BERGGREN, pp. 37–41, pl. 8, figs. 1a–c, 2a–c, 3a–c; text-fig. 5: 1a–5c.
1964. *Hedbergella monmouthensis* (Olsson). OLSSON, p. 161, pl. 1, figs. 3a–c.
1967. *Globotruncanella monmouthensis* (Olsson). PESSAGNO, p. 374, pl. 61, figs. 1–3.

Remarks.–*Globotruncanella monmouthensis* is characterized by the low trochospiral test and inflated, spherical to subspherical chambers which increase rather rapidly in size as added. It is distinguished from *G. petaloidea* (Gandolfi) in having inflated, rather than compressed and ovate, chambers as observed in apertural view, and in having a more highly arched primary aperture.

This species has been assigned previously to several different genera (see synonymy). It is herein included in *Globotruncanella* based on Pessagno's (1967, p. 374) observation of tegilla with infralaminal accessory apertures in well-preserved individuals.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *R. fructicosa* Zonule, to upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *G. monmouthensis* (Olsson) is from the Sandy Hook Member of the Redbank Formation (middle Maestrichtian, *G. gansseri* Subzone) at the base of Atlantic Highlands Bluff about one mile west of Highlands, New Jersey. It has since been recorded by Berggren (1962, pp. 40–41) from the Kjolby Gaard Marl (late Maestrichtian, *A. mayaroensis* Subzone) of Denmark. El-Naggar (1966, pp. 151–152) noted this species as *Hedbergella monmouthensis* from the middle and late Maestrichtian portions of the Sharawna Shale in the Esna-Idfu Region of Egypt.

Pessagno (1967, p. 374) reported *G. monmouthensis* from the Corsicana Marl of Navarro County and Kemp Clay of Falls County, Texas, as well as from the Arkadelphia Marl of Arkansas.

Globotruncanella petaloidea (Gandolfi)

Plate 27, figures 1–3, 4–6

1955. *Globotruncana* (*Rugoglobigerina*) *petaloidea petaloidea* GANDOLFI, p. 52, pl. 3, figs. 13a–c.
1960. *Rugoglobigerina jerseyensis* OLSSON, p. 49, pl. 10, figs. 19–21.
1962. *Praeglobotruncana* (*Hedbergella*) *petaloidea* (Gandolfi). BERGGREN, pp. 41–43, pl. 7, figs. 4a–c.
1964. *Praeglobotruncana petaloidea* (Gandolfi). OLSSON, p. 162, pl. 1, figs. 6a–c, 7a–c; pl. 2, figs. 1a–c.
1966. *Globotruncana petaloidea* (Gandolfi). DOUGLAS and SLITER, pp. 113–114, pl. 1, figs. 11a–c.
1967. *Globotruncanella petaloidea* (Gandolfi), PESSAGNO, pp. 374–375, pl. 82, figs. 6–8, 9.

Remarks.–*Globotruncanella petaloidea* is characterized by (1) the compressed, low trochospiral, spiroconvex test, (2) petaloid shaped spiral and umbilical chambers, and (3) the low arched extraumbilical-umbilical aperture. It exhibits variation in the spiral convexity of the test, degree of lobation of the peripheral margin, and chamber inflation (Pl. 27, figs. 4–6). *Globotruncanella petaloidea* may be confused with *G. havanensis* (Voorwijk) from which it differs by having much more inflated and broadly ovate chambers as observed in apertural and abapertural views.

Berggren (1962, p. 41) redescribed this species as being entirely perforate and lacking both a keel and an imperforate peripheral band along the peripheral margin of the test. Contrary to Berggren's observation, Olsson (1964, p. 162) and Douglas and Sliter (1966, p. 113) noted that *G. petaloidea* has an imperforate peripheral band on all chambers. Although all specimens examined with the Scanning Electron Microscope from the Corsicana Formation have a poreless peripheral band (Pl. 27, figs. 2, 5), its presence or absence is not regarded as a diagnostic character of the genus *Globotruncanella* (see emended definition of Pessagno, 1967, p. 373). Pessagno (1967) has noted other species of *Globotruncanella*, as well as species of *Archaeoglobigerina* and *Rugoglobigerina*, both with and without imperforate peripheral bands.

Range.–*G. fornicata-stuartiformis* Assemblage Zone, *R. subcircumnodifer* Subzone, to *G. contusa-stuartiformis* Assemblage Zone, upper part of *A. mayaroensis* Subzone.

Occurrence.–The type locality of *Globotruncanella petaloidea* is from the Colon Shale (late Maestrichtian, *A. mayaroensis* Subzone) from the subsurface (Papayal Well No. 1, 70–75 feet) in the Rancheria Valley, northeastern Colombia. It has since been recorded from the Kjolby Gaard Marl (late Maestrichtian, *A. mayaroensis* Subzone) of Scandinavia (Berggren, 1962, p. 43); Marshalltown, Mt. Laurel, Navesink, and Redbank Formations (late Campanian through middle Maestrichtian) of New Jersey (Olsson, 1960, p. 49; 1964, p. 162); and the Rosario Formation (Maestrichtian) of San Diego County, California (Douglas and Sliter, 1966, p. 113). Pessagno (1967, pp. 374–375) noted *Globotruncanella petaloidea* in the upper part of the Mendez Shale (late Maestrichtian) of Mexico; San Miguel Formation (early Maestrichtian), and the Corsicana Marl and Kemp Clay (middle Maestrichtian) of Texas. Its distribution and abundance in the Corsicana Formation of Texas is shown in text figs. 4–8.

Globotruncanella sp. a

Plate 27, figures 10–12

Remarks.–This form shares characteristics of both *Globotruncanella monmouthensis* (Olsson) and *G. petaloidea* (Gandolfi). In spiral and umbilical views, the chambers are elongate and ovoid as in *G. petaloidea.* However, it differs from the latter species in having (1) much more inflated chambers as observed in apertural view (the initial chambers of the last whorl are almost spherical), (2) a wide umbilicus, and (3) a more highly arched primary aperture. It differs from *G. monmouthensis* in having (1) a slightly compressed test as observed in apertural view, (2) more strongly petaloid and ovate shaped chambers as observed in spiral and umbilical views, and (3) compressed and ovate shaped chambers in apertural view.

Range.–*G. contusa-stuartiformis* Assemblage Zone, *G. gansseri* Subzone, *R. fructicosa* Zonule (insofar known).

Occurrence.–Several individuals referred to this form have been encountered throughout the Corsicana Formation of North Central Texas (see text figs. 5, 6, 8).

APPENDIX

LOCATION AND DESCRIPTION OF MICROFOSSIL SAMPLES MENTIONED IN TEXT

Kaufman County, Texas

Locality TX10.–Exposure in small bluff along the southeastern bank of a branch of Little Cottonwood Creek (text fig. 10), 3.4 miles north 32 degrees west of Kemp, about thirty feet west of old Highway 175 (now abandoned) Kaufman County, Texas.

This exposure consists of 3.5 feet of dark gray, thinly-bedded, quartzose silty and fine sandy, ferruginous stained, slightly calcareous mudstone. Washed residue consists of quartzose silt and fine sand with a well-preserved benthonic calcareous and arenaceous fauna with *Guembelitria cretacea* Cushman and *Heterohelix navarroensis* Loeblich.

Locality TX11.–Exposure in land fill excavation at garbage dump just west of the old (abandoned) U. S. Highway 175 (text fig. 10), 1.2 miles north 33 degrees west of the intersection of U. S. Highway 175 and Farm Road 1391 in Kemp, Kaufman County, Texas.

Exposed at this locality are about fifteen feet of light chalky gray, massive, earthy fracturing, quartzose silty and fine sandy, ferruginous, noncalcareous mudstone. Washed residue consists entirely of quartzose silt and very fine sand. No foraminiferal fauna was observed.

Locality TX12.–Exposure in bluff along southern bank an unnamed tributary of Big Cottonwood Creek (text fig. 10), 4.2 miles south 79 degrees west of the intersection of U. S. Highway 175 and Farm Road 1391 in Kemp, Kaufman County, Texas. To reach this site proceed west from the intersection of Texas Highway 274 and Farm Road 148 about 3.4 miles along Farm Road 148 to an unnumbered gravel road, turn north along gravel road 1.3 miles to bridge over creek. Exposure is about 75 yards east of bridge.

This exposure consists of about four feet of light gray, massive, conchoidal fracturing, ferruginous stained, slightly calcareous mudstone. Washed residue consists almost entirely of fine sand-size grains of limonite with common phosphatic fish-scale and bone debris. This site contains a very abundant late Cretaceous arenaceous fauna with rare calcareous benthonic foraminifera. *Guembelitria cretacea* Cushman, *Heterohelix striata* (Ehrenberg), *Planoglobulina carseyae* (Plummer), and *Rugoglobigerina rugosa* (Plummer) were the only planktonic foraminifera observed.

Locality TX13.–Exposure in roadside ditch along southern side of unnumbered county road (asphalt), 0.2 miles east of the bridge over Little Cottonwood Creek (text fig. 10), 1.5 miles north 66 degrees west of the intersection of U. S. Highway 175 and Farm Road 1391 in Kemp, Kaufman County, Texas.

This site consists of about two feet of dark grayish-brown, massive, highly ferruginous, quartzose silty and fine sandy, nonfossiliferous mudstone.

Locality TX14.–Exposure in recently excavated large earthern stock-tank along the northern side of Farm Road 1391 (text fig. 11), 2.4 miles east of the intersection of Farm Road 1391 and U. S. Highway 175 in Kemp, Kaufman County, Texas.

This exposure consists of about fourteen feet of dark gray to orange-brown, poorly bedded, ferruginous, quartzose silty and fine sandy, nonfossiliferous mudstone.

Locality TX15.–Exposures in small gulleys along western escarpment of Cedar Creek Valley (text fig. 11), 3.6 miles north 62 degrees east from the center of Kemp, Kaufman County, Texas. To reach this site proceed northeast on Farm Road 1895 about 1.5 miles from its intersection with U. S. Highway 175 in Kemp; turn east along unnumbered asphalt road about 1.6 miles to intersection of gravel road from north; proceed north along gravel road about 0.5 miles, then turn east at intersection with dirt road and continue about 0.6 miles to escarpment and exposures along southern side of road.

Exposures consist of about six feet of light gray, weathering orange-brown, massively bedded, ferruginous, slightly muscovitic, calcareous, quartzose silty and fine sandy, nonfossiliferous mudstone.

Locality TX16.–Exposures beneath indurated sandstone ledge in pasture north of a farm house about fifty yards south of Farm Road 1391 (text fig. 11), 2.3 miles east along Farm Road 1391 from its intersection with U. S. Highway 175 in in Kemp, Kaufman County, Texas.

Unweathered exposure consists of about two feet of dark grayish-tan, massive, conchoidal fracturing, ferruginous, highly calcareous, nonfossiliferous mudstone.

Navarro County, Texas

Locality TX2.–Alternate type locality of Corsicana Formation. Exposure in clay pit of Corsicana Brick Company, 2.0 miles south of Courthouse, just east of Farm Road 709 and Southern Pacific Railway in southern portion of Corsicana, Navarro County, Texas (text figs. 12, 13).

Unit A. Dark gray, weathering light gray, thickly bedded, conchoidal fracturing, slightly muscovitic and quartzose silty, highly calcareous mudstone. Lower portion of unit with irregularly placed, discontinuous thin seams of selinite. Contains an abundant, diverse, and well preserved planktonic foraminiferal fauna.

Unit B. Dark gray calcareous mudstone similar to Unit A, but somewhat more calcareous and indurated, forming a slight topographic bench bordering the southeastern excavation.

Unit C. Similar to Unit A.

Unit D. Dark grayish-green, weathering dark brownish-orange, nonbedded, blocky fracturing, silty and fine quartzose sandy, slightly calcareous, highly glauconitic mudstone. Contains small phosphatic pebbles and reworked fish-teeth and shell debris. This unit yields a sparse, ferruginous stained and rather poorly preserved planktonic fauna.

Unit E. Light gray to tan, thickly bedded, conchoidal fracturing, slightly glauconitic and calcareous, silty to fine quartzose sandy mudstone. Lower portion of unit with discontinuous seams of selinite and limonite. Upper portion of unit less calcareous and becoming silty and fine sandy, containing a dwarfed, principally calcareous benthonic and arenaceous foraminiferal fauna.

Locality TX6.–Exposure in small bluff along the southern bank of Post Oak Creek (text fig. 14), 3.0 miles south 27 degrees west of Powell, Navarro County, Texas. To reach this site proceed east from the intersection of State Highway 287 and Farm Road 637 about 3.8 miles along Farm Road 637 to an unnumbered dirt road; turn north on dirt road and continue about 2.0 miles to bridge over Post Oak Creek. Walk west along southern bank of creek about 200 yards to exposure.

This site consists of about six feet of light gray to tan, thinly bedded, ferruginous stained, highly quartzose silty and fine sandy, slightly calcareous mudstone. No foraminifera were observed.

Locality TX7.–Exposure in roadside ditch along northwest side of Farm Road 739 (text fig. 15), 1.3 miles southwest of the intersection of Farm Road 739 and Southern Pacific Railway tracks southwest of Angus, Navarro County, Texas.

Exposure of about three feet of light tan, massively bedded, ferruginous, quartzose silty mudstone. Contains a sparse, dwarfed benthonic foraminiferal fauna.

Limestone County, Texas

Locality TX4.–Exposure in roadside gulley along northwest side of Farm Road 27 just northeast of its intersection with Texas Highway 171 (text fig. 16), 2.6 miles south 84 degrees east of the intersection of Texas Highway 171 and Farm Road 1951 in Cooledge, Limestone County, Texas.

This site exposes about thirteen feet of light tan to light gray, massively bedded, blocky fracturing, slightly ferruginous stained, highly calcareous mudstone. Washed residues consist of an excellently preserved, planktonic foraminiferal fauna (refer to text fig. 6). Sample TX4AA collected at base of exposure; TX4AB at three feet; TX4AC at seven feet; TX4AD at ten feet; and sample TX4AE was taken at the top (thirteen feet above base) of the exposure near the culvert under Texas Highway 171.

Falls County, Texas

Locality TX8.–Exposure in bluff along western bank of Big Creek, about 150 yards south of the bridge along Farm Road 147 (text fig. 17), 1.4 miles west along Farm Road 147 from the Falls-Limestone County Line, or 11.0 miles north 56 degrees east from the intersection of Farm Road 147 and Texas Highway 7 in Marlin, Falls County, Texas.

Exposure consists of about three feet of light gray, weathering tan, massive, nonbedded, calcareous, highly quartzose silty and fine sandy, nonfossiliferous mudstone.

Locality TX20.–Exposures along bank and in bluff of Brazos River extending from about 100 yards north to about 600 yards south of the Farm Road 413 bridge over the Brazos River (text fig. 18), 0.5 miles southwest of the intersection of Farm Roads 413 and 1373 in southeastern Falls County, Texas.

All samples contain a diverse and well preserved planktonic foraminiferal fauna (see text fig. 7) unless otherwise noted. Samples TX20XA and TX20XB (text fig. 19) were collected about 100 yards and 20 yards respectively north of the bridge and along the eastern bank of the river. Samples TX20XC and TX20XD were taken about 10 yards and 100 yards respectively south of the bridge and along the western bank. Remainder of samples were collected from bluffs about 600 yards south and along the western bank of the Brazos River, Falls County, Texas.

Unit A. Dark greenish-gray, massive, blocky fracturing, slightly quartzose silty and fine sandy, glauconitic and calcareous mudstone. Base of unit not observed. Lower five feet of unit containing numerous small pockets and lenses of clayey coquina. Disconformable contact with Unit B marks the Cretaceous-Tertiary boundary.

Unit B. Light greenish-gray, thinly bedded, glauconitic and calcareous, very fossiliferous mudstone. This unit contains abundant reworked molluscan shell fragments, common fish-teeth, pyrite nodules, and small phosphatic pebbles. Disconformity at base of unit marks the Cretaceous Corsicana Formation–Tertiary Kincaid Formation boundary.

Unit C. Light gray to tan, very dense, indurated, muscovitic, glauconitic, clayey, highly calcareous, medium to coarse grained quartzose siltstone. Contains a sparse and poorly preserved foraminiferal fauna.

Unit D. Light greenish-gray, thinly bedded, somewhat fissile, glauconitic, silty and fine quartzose sandy, calcareous mudstone. Unit not sampled.

Unit E. Light gray, flaggy, calcilute. Not sampled. This unit is resistive to weathering, forming a topographic bench and riffles extending midway into the river at low water level.

Unit F. Lithology as Unit D. Washed sample consists of medium to coarse grained quartzose silt containing a sparse, poorly preserved fauna of reworked Cretaceous and early Tertiary foraminifera.

Unit G. Dark greenish-gray mudstone similar to Unit A. Washed residue contains a well preserved early Paleocene benthonic foraminiferal fauna with rare reworked *Guembelitria cretacea* and several species of *Heterohelix*.

Unit H. Light gray to tan, massive, somewhat indurated, glauconitic, calcareous, fossiliferous, silty and fine quartzose sandy mudstone. This unit contains abundant early Tertiary mollusks.

Unit I. Lithology as Unit G. Prominent bluff-forming unit exposed in the upper scarp along the western bank of the Brazos River.

Locality TX3.–Sample taken from shallow subsurface by hand auger (about three feet below surface). From roadside ditch along southeastern side of Farm Road 413 (text fig. 20), 3.4 miles north 78 degrees east of the intersection of U. S. Highway 77 with Texas Highway 53 in Rosebud, or 2.8 miles southwest along Farm Road 413 from the blinking light marking its intersection with Farm Road 2027 in Wilderville, Falls County, Texas.

Hand auger sample consists of light gray, weathering light tan, massive, poorly bedded, slightly quartzose silty and fine sandy, calcareous mudstone. Washed residues contain a well preserved and diverse planktonic foraminiferal fauna.

Milam County, Texas

Locality TX9.–Exposure in a small bluff along the southern bank of Walkers Creek (text fig. 21), 5.6 miles north 21 degrees east of Cameron, Milam County, Texas. To reach this locality proceed east from Ben Arnold 2.2 miles along Farm Road 1444 to an unnumbered gravel road; turn south on gravel road 1.1 miles to the bridge over Walkers Creek. Walk east about 0.7 miles to the site (text fig. 22) just beyond the intersection of a major tributary from the northwest.

Unit A. Corsicana Formation. Dark gray to light brown, finely laminated, conchoidal fracturing, slightly quartzose silty, calcareous mudstone. Lower portion of unit ferruginous stained, and containing thin limonite lenses and selinite seams. Lower portion of unit (samples TX9XA through TX9XD) containing a predominately arenaceous and calcerous benthonic fauna. Upper portion of unit becoming more thickly bedded and blocky fracturing. Samples TX9AD and TX9XE contain an abundant, excellently preserved planktonic foraminiferal fauna dominated by the Heterohelicidae (see text fig. 8).

Unit B. Littig Member, Kincaid Formation. Light gray, somewhat indurated and massively bedded, blocky fracturing, silty and fine quartzose sandy, slightly glauconitic, highly calcareous mudstone. Contact with Unit A unconformable. Lower portion of unit containing abundant small phosphatic pebbles, reworked fish-teeth and shell debris, in part filling borings which extend from six to eight inches into the underlying unit. Unit B abundantly fossiliferous and showing excellent preservation of planktonic fauna. No Paleocene foraminiferal species were observed.

Unit C. Pisgah Member, Kincaid Formation. Light gray to tan, finely laminated, blocky fracturing, coarse silty and fine quartzose sandy, highly calcareous mudstone. Contact with Unit B gradational. Lower portion of unit containing scattered small phosphatic pebbles and reworked shell debris. Unit C overlain by alluvium. No Paleocene foraminiferal species were observed.

Locality TX19.–Exposures in a bluff along the northeastern bank of Hog Creek (text fig. 23), about 200 yards southeast of the Farm Road 486 bridge over Hog Creek, about 2.0 miles northeast of the Farm Road 486 bridge over Little River, or 4.1 miles south 20 degrees east of the center of Buckholts, Milam County, Texas.

Exposure consists of about twelve feet of light gray, weathering tan, massive, blocky fracturing, slightly glauconitic, quartzose silty and fine sandy, calcareous mudstone. Washed residue contains abundant phosphatic fish bone debris, small phosphatic pebbles, and common dark brown chert (probably a contaminant from the overlying alluvium). Sample TX19XA was taken two feet above the base of the dry creek bed, about ten feet below the top of the exposure. Sample TX19XB was collected eight feet above the base, or about four feet below the top of the exposure. Both samples contain a diverse and well preserved planktonic foraminiferal fauna (see text fig. 6).

Travis County, Texas

Locality TX25.–Corsicana Formation. Exposure in bluff along southeast bank of Onion Creek (text fig. 24), 1.5 miles south 57 degrees east of the intersection of Texas Highway 71 and Farm Road 973, or 0.2 miles northeast of Texas Highway 71 bridge crossing over Onion Creek, in the southern portion of Travis County, Texas.

This exposure consists of 106 feet of dark gray, blocky fracturing, calcareous mudstone. The upper thirteen feet of the section weathers to a buff, calcareous mudstone. Sixteen samples (TX169–TX184) were collected from the measured section. Sample TX169 was collected five feet above the base of the exposure; TX173 at 29.5 feet; TX176 at 51.0 feet; TX178 at 72.5 feet; TX181 and 87.5 feet; and sample TX184 was collected at the top of the exposure, 106 feet above the base. This site yields a diverse and well-preserved planktonic foraminiferal fauna (text fig. 4).

Medina County, Texas

Locality DR27.–Escondido Formation. This site consists of yellowish-gray, silty and fine quartzose sandy, calcareous mudstone, interbedded with thin, brownish-gray, indurated, silty limestone beds. The exposure is along the western bank of Seco Creek, 3.0 miles north of D'Hanis and about one mile west of the entrance to the Rowe Ranch along Farm Road 1796. Sample DR27-3 of Martin (1972) was collected eighteen feet above the base of the exposure.

Southwestern Arkansas

Localities AR8, AR18.–Arkadelphia Marl, *G. gansseri* Subzone (see Pessagno, 1967, p. 380; 1969, p. 107).

Mexico

Locality MX78.–Mendez Shale, *A. mayaroensis* Subzone (see Pessagno, 1969, pp. 45–46, 124; Plate 26).

Locality MX174.–Papagallos Shale, *G. gansseri* Subzone (see Pessagno, 1969, pp. 50, 127).

Locality MX206.–Type Mendez Shale, *A. mayaroensis* Subzone (see Pessagno, 1967, p. 377; 1969, p. 42).

Puerto Rico

Localities PR789.00, PR789.32, PR789.34.–Rio Yauco Mudstone, *R. subcircumnodifer* Subzone (see Pessagno, 1960, pp. 88, 90; text fig. 1).

Joides Leg III

Station 21, Core 4, Sections 1–3, *G. gansseri* Subzone. Located on the northeastern edge of the Rio Grande Rise in the South Atlantic (refer to Maxwell, et al., 1970, pp. 367–411).

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