

## ALBIAN PLANKTONIC FORAMINIFERA FROM THE SABINAS BASIN OF NORTHERN MEXICO

JOSÉ FRANCISCO LONGORIA AND MARTHA ALICIA GAMPER

Instituto de Geología, UNAM Apartado Postal 70-296  
México 20, D.F. Mexico

---

### ABSTRACT

A study of the planktonic foraminiferal faunas of the Albian Stage indicates that Albian Hedbergelloidea are quite diversified. About twenty species of planktonic foraminifera are present in the Albian of the Sabinas Basin of northern Mexico.

The Albian Stage is subdivided into four zones which are, from older to younger: the *Ticinella bejaouaensis* Zone, the *Ticinella primula* Zone, the *Ticinella breggiensis* Zone and the *Thalmanninella ticinensis* Zone.

It is suggested that the Albian Stage be regarded as the interval of time comprised from the first evolutionary appearance of *Ticinella bejaouaensis* Sigal to just below the biohorizon offered by the first stratigraphic occurrence of *Thalmanninella evoluta* (Sigal). These boundaries more or less correspond to the base of the *H. jacobi* Zone and to the base of the *Mantelliceras mantelli* Zone, respectively, of the ammonite scheme of zonation.

---

### INTRODUCTION

Although planktonic foraminifera have been regarded as excellent tools for stratigraphic correlations, to date there has been little attempt to make a detail study of planktonic foraminifera occurring in Albian strata. The lack of taxonomic and morphologic studies of Albian planktonic foraminifera has impeded the elaboration of an adequate system of zonation based on these microfossils.

Albian biostratigraphy is quite complicated. A more precise definition of the Albian Stage is needed; however, it is difficult to find a complete or nearly complete Albian section where a bed-to-bed control of the fauna can be utilized to establish the stage's boundaries based on multiple criteria, i.e., on the stratigraphic distribution of several fossil groups.

In this report we have presented a system of planktonic foraminiferal zonation for the Albian which can be used as a framework for biostratigraphic correlations of Albian strata. Hopefully, the taxonomic analysis of

the Albian planktonic foraminifera presented here will contribute to a better knowledge of this important group of microfossils.

### GEOLOGICAL SETTING

The term "Sabinas Basin" was first proposed by M. Alvarez (1949, 1958) to designate a Jurassic and Cretaceous feature in western Nuevo León and eastern Coahuila. According to him, the Sabinas Basin lies between the Coahuila shelf and the El Burro-Picachos Massif. The precise extent of the Sabinas Basin is still unknown. However, it extends northwest from the vicinity of Monterrey for approximately 350 km and averages about 100 km in width. The Sabinas Basin contains about 3500 to 5000 meters of sedimentary rocks which represent continuous sedimentation from Late Jurassic to Late Cretaceous (middle Maestrichtian). Several rock types are present: micrite and biomicrite are the predominant components of the section; and chert and terrigenous clay are present.

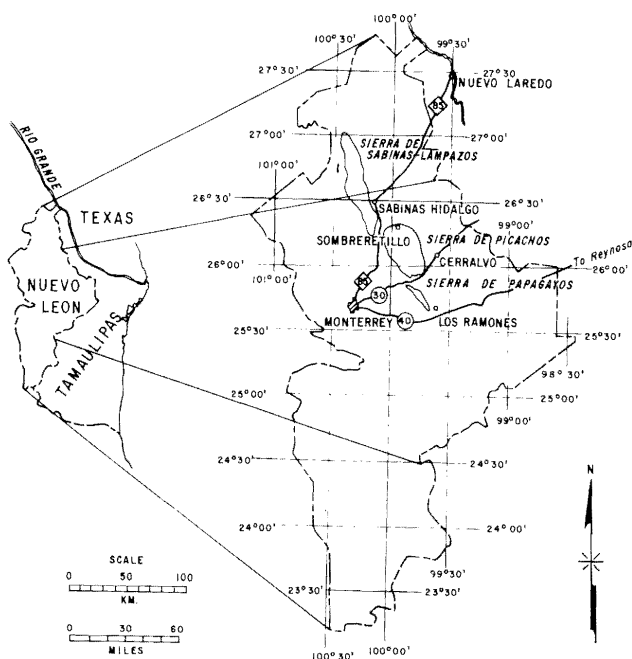


FIGURE 1

Location of area investigated.

During Albian time, the region occupied by the Sabinas Basin is clearly differentiated into two different biofacies: 1) the rudist facies to the northwest and 2) the pelagic facies to the southeast. The pelagic facies is represented by several lithologic types. At the beginning of the Albian, micrite was deposited; however, terrigenous clay was transported to the basin during several continuous intervals. Three lithic units are recognized in the pelagic facies of the Sabinas Basin, from bottom to top: the Tamaulipas Limestone, the Sombreretillo Formation and the Cuesta del Cura Formation. The rudist (shelf) facies is represented by the Aurora Limestone. More detailed field work is still needed to define the precise limits of those two facies. The present study shows that the pelagic facies extends far to the west of Monterrey.

#### MATERIAL STUDIED

More than 150 samples from different lithic units were studied. The samples are from a section measured in the Sierra de Papagayos (Fig. 1). The stratigraphic position of the samples is shown in Fig. 2.

The rock samples were processed following the procedure outlined by E. S. Pessagno (1967, p. 375). The fauna was first studied under a stereoscopic microscope

and a few specimens were selected for photography with the light microscope.

#### LITHOSTRATIGRAPHY

##### DEFINITION OF THE LITHIC UNITS

In the Sabinas Basin of northern Mexico, Albian strata are well exposed and they are referred to several lithologic units. In the area of study these units are named and characterized as follows:

*Tamaulipas limestone.* Under the name "Tamaulipas Limestone" the present authors include a lithologically homogeneous unit composed mainly of thick- to massive-bedded limestone. This limestone is a very pure micrite containing abundant pelagic microfauna (planktonic foraminifera and tintinnids) and forming layers of from 35 cm to 1.50 m thick.

Several stratigraphers (PEMEX unpublished report) have used Aurora Limestone for the "Tamaulipas Formation" and treated both units as synonyms. However, petrographic and field observations demonstrate that both formations are valid and actually represent two different types of rock units of approximately the same age. The Tamaulipas Limestone is used here in the restricted sense as emended by W. E. Humphrey and T. Diaz (1953). The original description given by Stephenson (1921) for the Tamaulipas (*fide* J. Muir, 1936) is quite wide including all the strata from the base of the Cupido Formation to the base of the Agua Nueva Formation. In this wide sense all the strata above the Le Peña Formation would be included under the Upper Tamaulipas, in the sense of Muir (1936). While the Aurora Limestone is a rudist reef limestone, in contrast, the Tamaulipas Formation is a nonreef limestone facies with a pelagic fauna.

In the region under study the La Peña-Tamaulipas contact is placed arbitrarily at the point where the intercalations of limestones and marls change to massively bedded limestone. The upper contact with the Sombreretillo Formation is quite sharp. The lower 100 meters are composed of thick-to massive-bedded limestone with some marls and shale intercalations. The upper 60 meters of the formation consist of an alternation of thick limestone and thin layers of shale and clay. All the samples collected contain abundant planktonic foraminifera; however, samples from the lower part of the formation were mainly studied in thin sections of limestones. The base of the *Ticinella bejaouaensis* Zone more or less coincides with the arbitrarily chosen boundary of the formation.

*Sombreretillo Formation.* The Sombreretillo Forma-

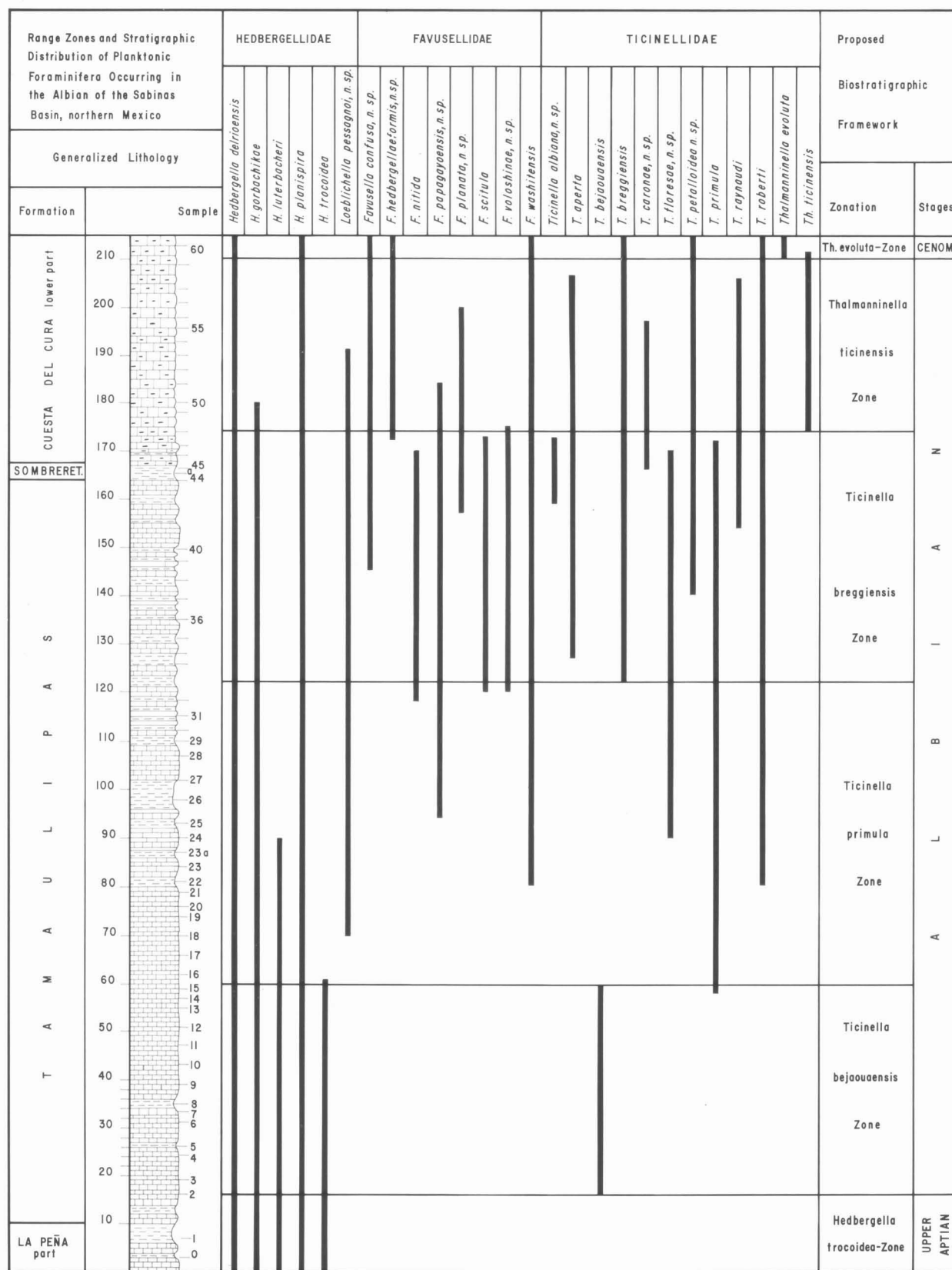


FIGURE 2

Range zones and stratigraphic distribution of planktonic foraminifera occurring in the Albian of the Sabinas Basin, northern Mexico.

tion was recently created by Bishop (1970, p. 1256). Bishop chose the high east-trending ridge about 2.4 km southwest of the village of Sombreretillo as to type locality. Unfortunately, the type section chosen by Bishop is so badly covered by soil that it is not suitable for biostratigraphic studies.

The Sombreretillo Formation is a very distinctive horizon which is easy to distinguish from the underlying Tamaulipas and the overlying Cuesta del Cura Formations. The Sombreretillo Formation is mainly composed of marls and calcareous shale which weather white. The samples collected yield a rich planktonic foraminiferal assemblage mainly composed of species of *Favosites*.

**Cuesta del Cura Formation.** The Cuesta del Cura Formation was first proposed by Imlay in 1936 (p. 1125–1126) for the thin-bedded, dark-gray limestone and black cherts cropping out in the western part of the Sierra de Parras.

Limestone strata overlying the Sombreretillo and the Tamaulipas Formations in the Sabinas Basin are in their gross lithologic features comparable to those of the Cuesta del Cura Formation. The Cuesta del Cura is characterized by its wavy bedding and abundant stringers, lenses and nodules of black chert forming thin- to medium-bedded, light olive-gray beds interbedded with thin layers of calcareous shale. Overlying the Cuesta del Cura Formation is the Agua Nueva Formation. The contact between these two lithic units is transitional and was arbitrarily selected at the point where wavy bedding changes to even stratification. At this horizon there is a characteristic change in color from the gray color of Cuesta del Cura to the rusty brown of the Agua Nueva Formation.

## BIOSTRATIGRAPHY

As was the case of the majority of the Cretaceous stages, the Albian Stage was defined on the basis of its ammonite content. The definition of the Albian Stage dates back to 1847 when d'Orbigny created the term "Albian" to designate three different isochronous facies (the Argiles du Gault, gres vert inférieur et glauconite Sableuse) which occur in the Anglo-Parisian Basin. D'Orbigny (1850) characterized the Albian Stage by the following species of ammonites: *Ammonites auritus*, *A. lautus*, *A. comatatus*, *A. tardifurcatus*, *A. mamillatum*, *A. legelli*, *Scaphites haugardianus*, *Arcyloceras saussureanum* and *Turrilites bergeri*.

D'Orbigny's original concept of Albian was modified by Jacob (1905) and by Breistroffer (1947). The lat-

ter author subdivided the Albian Stage into four successive ammonite zones, the uppermost of which, Zone IV, was termed by him the "Vraconian Substage". The term "Vraconian" was created by Renevier (1867) from the type locality of the ammonite assemblage, La Vraconne, near Sainte Croix. However, as the latter author did not define this "stage," the Vraconian remained out of the stratigraphic nomenclature. With Breistroffer's redefinition of the Vraconian, a series of nomenclatural and stratigraphic problems were introduced. Several questions immediately occurred in connection with the nomenclature of the Vraconian: 1) is the Vraconian a valid stage? 2) should it be regarded as a substage of the Albian Stage in the Lower Cretaceous? and 3) should the Vraconian be placed in the lower Cenomanian with the Upper Cretaceous?

Most of the problems related to the stratigraphy of the Lower Cretaceous stages were extensively treated in the "Colloque sur le Crétacé Inférieur" (1963). In the conclusions of the colloquium (M. Collignon, 1965, p. 313–318), it was stated that the Albian Stage should be subdivided into three successive parts: lower, middle and upper Albian as defined by ammonites. The lower and middle Albian were subdivided into two zones, while the upper Albian was subdivided into three zones (Fig. 3).

The subdivision of the Albian Stage into substages and zones, as proposed by the colloquium is not clear. Several basic problems were raised concerning the boundaries of the stage and its substages. The following are the factors that influence the lack of an adequate definition of the Albian Stage: 1) the stages are in most cases defined on basis of only ammonites; 2) the stratotypes are far from being the ideal sections upon which any international decision on the boundaries can be established; 3) the precise stratigraphic distribution of the ammonites used to define the zones is not well documented; 4) the ammonite zones only in very rare cases are well defined (the type of zone, e.g. concurrent-range zone or range zone is never stated); and 5) in the great majority of cases the biostratigraphy based on ammonites lacks bed-to-bed control. All of these factors have led to a great deal of confusion and misinterpretation, impeding the correlation of Albian strata on the regional and intercontinental scales.

Practically no work has been done on the planktonic foraminiferal biostratigraphy of the Albian. Bolli (1959) made the first attempt at Albian zonation based on foraminifera. Moullade (1966) attempted to integrate both ammonite and foraminiferal zonations of the Albian Stage. Contrary to the decisions of the "Colloque



boundaries should be placed at a horizon delineated on the basis of maximum faunal change. Since the boundary Albian-Cenomanian also defines the Upper and Lower Cretaceous boundary, the solution of this problem should be reconciled through careful deliberation by an International Committee.

The Albian-Cenomanian boundary as proposed by Pessagno (1969) and recently adopted by Michael (1972), at the first occurrence of keeled Hedbergelloidea, is somewhat misleading because the first keeled species of planktonic foraminifera that appears in the geological record is *Thalmanninella ticinensis*. This species first appears considerably below the base of the *Mantelliceras mantelli* Zone (lower Cenomanian), that is, considerably below the first stratigraphic occurrence of *Thalmanninella evoluta* (= *Thalmanninella appenninica* of European authors). Because no international agreement exists concerning the stratigraphic nomenclature of the Albian Stage the present authors regard the Albian Stage on the basis of foraminiferal content as the interval of time comprised between the first evolutionary appearance of *Ticinella bejaouaensis* and the first stratigraphic occurrence of *Thalmanninella evoluta*. These boundaries correspond with the base of the *H. jacobi* Zone and the base of the *Mantelliceras mantelli* Zone respectively of the ammonite scheme of zonation.

#### PLANKTONIC FORAMINIFERAL ZONATION OF ALBIAN STRATA

In the present system of zonation, zonal units are based on: 1) a combination of taxon ranges; 2) concurrences of taxon ranges and 3) the distinctive first and last occurrence of taxa. The zonal units proposed herein are "interval zones" (International Subcommission on Stratigraphic Classification, circular no. 36, July 15, 1971). The stratigraphic distribution of the species found in the present investigation is shown in Fig. 2. The Albian Stage as defined here is subdivided into four zones. These zones are named and defined as follows, from oldest to youngest.

##### *TICINELLA BEJAOUAENSIS* ZONE

*Remarks.* The *Ticinella bejaouaensis* Zone was recently defined by Longoria (1974) to include the interval of time represented by the stratigraphic range of *Ticinella bejaouaensis* Sigal. The top of the zone occurs immediately below the first stratigraphic appearance of *Ticinella primula* Luterbacher.

In the area of study, the precise faunal content of this zone was not possible to define since the *Ticinella*

*bejaouaensis* Zone is represented chiefly by hard limestones, and only a few shale intercalations were suitable for the study of the isolated fauna. The tintinnid genus *Colomiella* is quite abundant in this zone.

##### *TICINELLA PRIMULA* ZONE

*Definition.* The base of the *Ticinella primula* Zone is placed at the horizon of the first stratigraphic appearance of *Ticinella primula* Luterbacher. The top of this zone occurs below the biohorizon offered by the first stratigraphic occurrence of *Ticinella breggiensis* Gandolfi.

*Remarks.* This zone is characterized by the occurrence of the stratigraphic range of *Ticinella primula* Luterbacher, *Hedbergella luterbacheri* Longoria and *Hedbergella gorbachikae* Longoria. The first stratigraphic appearance of members of the genus *Favusella* is in the middle part of the *Ticinella primula* Zone.

##### *TICINELLA BREGGIENSIS* ZONE

*Definition.* The lower limit of the *Ticinella bejaouaensis* Zone is defined at the first stratigraphic appearance of *Ticinella breggiensis* (Gandolfi). The top of the zone occurs below the biohorizon defined by the first stratigraphic appearance of *Thalmanninella ticinensis* (Gandolfi).

*Remarks.* The *Ticinella breggiensis* Zone is characterized by the concurrence of *Ticinella breggiensis* (Gandolfi), *Ticinella roberti* (Gandolfi) and *Hedbergella gorbachikae* Longoria. Several species of *Favusella* are also present in this zone. *Favusella nitida* Michael and *Favusella scitula* Michael are restricted to this zone.

##### *THALMANNINELLA TICINENSIS* ZONE

*Definition.* The base of the *Thalmanninella ticinensis* Zone is placed at the horizon of the first biostratigraphic appearance of *Thalmanninella ticinensis* (Gandolfi). The upper limit of this zone occurs below the biohorizon offered by the first stratigraphic occurrence of *Thalmanninella evoluta* (Sigal) (= *Thalmanninella appenninica* Renz, of European authors).

*Remarks.* The *Thalmanninella ticinensis* Zone is herein considered as the uppermost zone of the Albian Stage. Other important characteristics of this zone are: 1) the concurrence of the stratigraphic range of *Thalmanninella ticinensis* (Gandolfi); *Ticinella roberti* (Gandolfi) and *Globigerinelloides caseyi* (Bolli and others); 2) the first occurrence of the genera *Heterohelix* and *Guembelitria* in the upper part of the zone; and 3) the

last stratigraphic occurrence of *Hedbergella gorbachikae* Longoria in the lower part of the zone.

Any attempt at correlation between the system of zonation herein proposed with those previously used by other authors (Moullade, 1966; Salaj and Samuel, 1966) is impeded because of the imprecise definition of the zones given by these authors. In order to avoid further problems with the stratigraphical nomenclature of the Albian Stage, the integration of ammonite and foraminiferal as well as other microfossil zonations should be done in more complete sections where multiple criteria can be used in defining the boundaries of the stage.

### CONCLUSIONS

1) The Albian Stage is considered as the interval of time from the first evolutionary appearance of *Ticinella bejaouaensis* Sigal to just below the biohorizon of the first stratigraphic occurrence of *Thalmanninella evoluta* (Sigal).

2) The Albian of the Sabinas Basin is subdivided into four zones, from older to younger: The *Ticinella bejaouaensis* Zone, the *Ticinella primula* Zone, the *Ticinella breggiensis* Zone and the *Thalmanninella ticinensis* Zone.

3) After comparing the Albian foraminiferal faunas from the Sabinas Basin with those of the Paris Basin, the following summary can be made: a) the planktonic foraminiferal faunas of the Albian in the Sabinas Basin are remarkably similar to the planktonic faunas of the Paris Basin, the two basins having a great number of species in common; and b) the system of planktonic foraminiferal zonation herein proposed can also be applied to the Albian of the Paris Basin.

4) In the region under study the Tamaulipas Limestone was deposited in shallow neritic water. This conclusion is documented by an abundance of favusellids in the planktonic foraminiferal fauna and, at the same time, by the absence of radiolaria in the section. The region occupied by the Sierra de Papagayos was a considerable distance from the coastline as can be judged from the lack of arenaceous foraminifera and the rarity of benthonic calcareous foraminifers. The abundance of species of *Hedbergella* and *Ticinella* such as *T. primula*, *T. breggiensis*, indicates that this region was connected to the open sea.

### ACKNOWLEDGMENTS

The present project was undertaken at the Paleozoological Institute of the Polish Academy of Sciences

(Warsaw, Poland) while the writers were supported by a Research Fellowship from this Institution. The authors wish to express their gratitude to the authorities of the Polish Academy of Sciences for having kindly granted the research fellowships. The writers are particularly grateful to both Prof. Zofia Kielan Jaworowska, Director of the Paleozoological Institute, and Prof. Krysztyna Pozaryska, head of the micropaleontological Laboratory, of the same Institute who were instrumental in obtaining the fellowships and for their interest in this study.

Special thanks are extended to Mme. M. Neumann, Director of the Laboratory of Micropaleontology (Paris University), for allowing the authors to study the foraminiferal collections and for providing access to other facilities at her Laboratory.

Thanks are also extended to F. Y. Michael (ARCO, Dallas, Texas) for critically reviewing the manuscript. The authors are indebted to Dr. Emile A. Pessagno Jr. (University of Texas at Dallas) for his valued comments on Cretaceous biostratigraphy and for having kindly reviewed the manuscript.

### REFERENCES

- ALVAREZ, M. JR., 1949, Tectonics of México: Am. Assoc. Petroleum Geologists Bull., v. 33, no. 8, p. 1319-1335.  
 ———, 1958, Tectónica profunda de México: Bol. Asoc. Méx. Geol. Petr., v. 10, nos. 3 and 4, p. 163-182.  
 BISHOP, B. A., 1970, Stratigraphy of Sierra de Picachos and Vicinity, Nuevo León, México: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 7, p. 1245-1270, 25 text-figs.  
 BOLLI, H. M., 1959, Planktonic foraminifera from the Cretaceous of Trinidad, B.W.I.: Am. Paleontology Bull., v. 39, no. 179, p. 257-277.  
 BREISTROFFER, M., 1947, Sur les zones d'ammonites dans l'Albien de France et d'Angleterre: Trab. Lab. Geol. Fac. Sc., Grenoble, v. 26, p. 17-104.  
 CARSEY, D. O., 1926, Foraminifera of the Cretaceous of Central Texas: Texas Univ., Bull. no. 2612, p. 1-56.  
 COLLIGNON, M., 1965, Rapport sur l'étage Albien, in Colloque sur le Crétacé Inférieur: Mém. Bur. Res. Geol. Min., 34, p. 313-318.  
 COLLOQUE SUR LE CRÉTACÉ INFÉRIEUR, 1963, Mém. Bur. Res. Geol. Min., no. 34, Lyon, Editions B.R.G.M., 1965, 840 p.  
 GANDOLFI, R., 1942, Recherche micropaleontologique e stratigraphiche sulla Scaglia e sul flysch Cretacici: Riv. Italiana Paleontologia e Stratigrafia, Mem. IV, Milano, 160 p. 14 pls.  
 HUMPHREY, W. E., and DIAZ, T., 1953, Excursión al Cañón de Peregrina Ciudad Victoria, Tamaulipas: Asoc. Mexicana Geol. Petroleros (Primera Convención).  
 IMLAY, R. W., 1936, Evolution of the Coahuila Peninsula, México. Part IV. Geology of the Western part of the Sierra de Parras: Geol. Soc. America Bull., v. 47, p. 1091-1152, 10 pls. 3 figs.  
 INTERNATIONAL SUBCOMMISSION ON STRATIGRAPHIC CLASSIFI-

- CATION, 1971, Report 5, Preliminary report on biostratigraphic units: 24th Inst. Geol. Congr., 50 p.
- JACOB, CH., 1905, Etude sur les ammonites et sur l'horizon stratigraphique du gisement de Clansayes: Soc. Geol. France Bull., ser. 4, v. 5, p. 399-432, pls. 12-13.
- KUHRY, B., 1971, Lower Cretaceous planktonic foraminifera from the Miravetes, Argos and Represa Formations (S.E. Spain): Rev. Española Microp., v. 3, no. 3, p. 219-237.
- LONGORIA, J. F., 1974, Stratigraphic, morphologic and taxonomic studies of Aptian planktonic foraminifera: Rev. Española Micropaleontologie, Núm. extraordinario, 107 p. 27 pls.
- LONGORIA, J. F., and GAMPER, M. A., 1975, The Classification and evolution of Cretaceous planktonic foraminifera. Part 1: The Superfamily Hedbergelloidea: Rev. Española Micropaleontologie, Numero Especial, Enero, 1975, p. 61-96.
- MICHAEL, F. Y., 1972, Planktonic foraminifera from the Comanchean Series (Cretaceous) of Texas: Jour. Foramin. Research, v. 2, no. 4, p. 200-220, 7 pls.
- MOULLADE, M., 1966, Etude stratigraphique et micropaleontologique du Crétacé Inférieur de la "Fosse vocontienne": Doc. Lab. Geol. Fac. Sci., Lyon, v. 15, 369 p. 17 pls. 27 text-figs.
- MUIR, J. M., 1936, Geology of the Tampico Region: Am. Assoc. Petroleum Geologists, 280 p.
- ORBIGNY, A. D', 1850, *Prodrome de Paléontologie stratigraphique*, tome II: Paris, V. Masson.
- PESSAGNO, E. A., JR., 1967, Upper Cretaceous planktonic foraminiferal from the western Gulf Coastal Plain: Paleontographica Americana, v. 5, no. 37, p. 245-445, pls. 48-101.
- , 1969, Upper Cretaceous stratigraphy of the western Gulf Coast Area of Mexico, Texas, and Arkansas: Geol. Soc. America Mem. 111, p. 1-139, pls. 1-60.
- PLUMMER, H. J., 1931, Some Cretaceous Foraminifera in Texas: Univ. Texas Bull. 3101, p. 109-203.
- RENEVIER, E., 1867, Notices géologiques et paléontologiques sur les Alpes vaudoises et les régions environnantes. V. Complément de la faune de Cheville: Bull. Soc. Vaudoise Sci. Nat., v. 9.
- SALAJ, J., and SAMUEL, O., 1966, Foraminiferen der Westkarpaten-Kreide: Geologicky Ustav Dionyza Stura.
- SIGAL, J., 1966, Contribution a une monographie des Rosalines. I. Le genre *Ticinella* Reichel, souche des Rotalipores: Ecologiae, Geol. Helvetiae, v. 59, no. 1, p. 185-217, pls. 1-6, 1 table.

Revised Ms accepted November 1976

#### APPENDIX.—SYSTEMATIC PALEONTOLOGY

The classification of the Cretaceous planktonic foraminifera outlined by Longoria and Gamper (1975) is followed here. The reader is referred to the previous paper for details on the definition of taxa above the generic level.

Holotypes of the new species described here will be deposited in the Micropaleontological Collections of the U.S. National Museum in Washington, D.C.

#### Order FORAMINIFERIDA

##### Superfamily HEDBERGELLOIDEA *nom. transl.*

Longoria and Gamper, 1975; *ex* Hedbergellinae

Loeblich and Tappan, 1961

Family HEDBERGELLIDAE Loeblich and Tappan, 1961;  
*nom. transl.* Longoria, 1974; *ex* Hedbergellinae

Loeblich and Tappan, 1961

Subfamily HEDBERGELLINAE Loeblich and Tappan,  
1961

Genus *Hedbergella* Bronnimann and Brown, 1956

*Hedbergella delrioensis* (Carsey), 1926

*Globigerina cretacea* d'Orbigny var. *delrioensis* CARSEY, 1926,  
p. 43, no. illustr.

*Hedbergella delrioensis* (Carsey). LONGORIA, 1975, p. 54, pl.  
10, figs. 1-3 (neotype), figs. 4-12; pl. 13, figs. 3-5, 15-18.

*Remarks.* The lack of a type figure to be referred to for comparisons has complicated the identification of this taxon. The taxonomic history of *Hedbergella delrioensis* was summarized by Longoria (1974). The specimens of *H. delrioensis* from the Albian of northern Mexico show all of the diagnostic features of this taxon, and they were compared with the neotype of the species.

*Range.* *Leupoldina cabri* Zone (Aptian) to *Thalmaninella evoluta* Zone (Cenomanian).

*Occurrence.* *Hedbergella delrioensis* has been reported from Aptian and Albian deposits of Tethyan, Austral and Boreal faunal provinces.

##### *Hedbergella gorbachikae* Longoria, 1973

Pl. 2, Figs. 7-12

*Hedbergella* sp. cf. *H. delrioensis* (Carsey). KUHRY, 1971, p.  
229, pl. 1, figs. 7a-c.

*Hedbergella gorbachikae* LONGORIA, 1975, p. 56, pl. 15, figs.  
1-16.

*Remarks.* *Hedbergella gorbachikae* is a quite distinctive species which can be distinguished from other hedbergellas by: 1) its umbilico-convex test with the umbilical side convex; 2) its last whorl consisting of five to six inflated chambers protruding into the umbilical area covering great part of the umbilicus.

*Hedbergella gorbachikae* shows little morphologic variation. The number of chambers in the last whorl varies from 5 to 6; however, individuals with five chambers are more often found.

*Range.* Uppermost *Globigerinelloides algerianus* Zone to lowermost *Ticinella ticinensis* Zone.

*Occurrence.* *Hedbergella gorbachikae* was first described from the La Peña Formation of northern México. It was also recorded from the La Drome and from Formation 6 of the French Aptian Stratotype by J. F. Longoria (1974). This species has also been reported from the Represa Formation of Spain by H. Kuhry (1971) as *Hedbergella* sp. cf. *H. delrioensis* (Carsey).

##### *Hedbergella luterbacheri* Longoria, 1975

Pl. 6, Figs. 1-3

*Hedbergella luterbacheri* LONGORIA, 1975, p. 61, pl. 26, figs.  
15-17.

*Remarks.* *Hedbergella luterbacheri* is somewhat similar to *Hedbergella planispira* since both species have low trochospire;

however, *H. luterbacheri* can easily be separated from the latter species by its lobate periphery and its narrow umbilical area.

**Range.** Upper part of *Globigerinelloides algerianus* Zone (Aptian) to middle part of *Ticinella primula* Zone (Albian).

**Occurrence.** This species has only been reported from the Sabinas Basin of northern México.

### *Hedbergella planispira* (Tappan), 1940

*Globigerina planispira* TAPPAN, 1940, p. 122, pl. 9, figs. 12a-c.

*Hedbergella planispira* (Tappan). LONGORIA, 1974, p. 64, pl. 20, figs. 4 (topotype); pl. 23, figs. 1-2 (topotypes). Extensive synonymic list is given.

**Remarks.** *Hedbergella planispira* has served as a wastebasket name for almost 30 years. Almost any hedbergellid of unknown affinities has been referred to *H. planispira*. The examination of topotypic material helped to clarify the taxonomic status of the species. Our specimens from the Albian of Mexico show all the features characteristic of this species. See Longoria, 1974.

**Range.** Uppermost *Globigerinelloides gottisi* Zone (lower Aptian) to *Marginothracana renzi* Zone (Coniacian).

### *Hedbergella trocoidea* (Gandolfi), 1942

Pl. 6, Figs. 13-15

*Anomalina lorneiana* (d'Orbigny) var. *trocoidea* GANDOLFI, 1942, p. 99, pl. 2, figs. 1a-c.

*Hedbergella trocoidea* (Gandolfi). LONGORIA, 1974, p. 69, pl. 17, figs. 1-4, 8-9 (topotypes); 5-7, 10-16; pl. 18, figs. 3-5. (Detailed synonymic list is given.)

**Remarks.** *Hedbergella trocoidea* is abundant in material studied. Our specimens from northern México are quite similar to the topotypes from La Breggia section. This species displays considerable morphologic variation. Specimens with low and high trochospiral are often observed. *Hedbergella trocoidea* gives rise to *Ticinella bejaouaensis* via the acquisition of a porticus and the umbilical cover-plate. It also seems to give rise to *Ticinella roberti* from which it can be distinguished by its smaller umbilical area. Both species are very similar and more detailed work based on well preserved material is needed in order to clarify the phyletic relationships of this group of species.

**Range.** Upper part of *Globigerinelloides algerianus* Zone (upper Aptian) to upper *Ticinella bejaouaensis* Zone (lower Albian).

**Occurrence.** This species is geographically widely distrib-

uted. It has been reported from Aptian-Albian deposits of Switzerland, France, Rumania, Czechoslovakia, Germany, Trinidad and México.

Subfamily LOEBLICHELLINAE Pessagno, 1967, emend. Longoria, 1974

Genus *Loeblichella* Pessagno, 1967, emend.

Longoria, 1974

*Loeblichella pessagnoei* Longoria and Gamper n. sp.

Pl. 2, Figs. 4-6

**Description.** Test large, biconvex, formed by about three whorls; peripheral outline elliptical; lobate; five to six chambers in the last whorl, increasing rapidly in size as added; earlier chambers on spiral side aspherical to petaloid, later becoming subtrapezoidal; subtriangular on umbilical side; spherical to angular in peripheral view; sutures straight, depressed on both spiral and umbilical sides; primary aperture extra-umbilical-spiroumbilical; umbilicus narrow.

**Variation of the species.** *Loeblichella pessagnoei* n. sp. is common in the material studied, and about 45 specimens were analyzed. This is quite a diagnostic species whose features are constant.

**Remarks.** *Loeblichella pessagnoei* n. sp. differs from other biconvex species of *Loeblichella*, like *L. convexa* Longoria, by the distinctive arrangement of its chambers in the last whorl.

This species is named for E. A. Passagno, Jr., in honor of his contributions to the study of Cretaceous Hedbergelloidea.

**Range.** *Ticinella primula* Zone (lower Albian) to lower part of *Thalmaninella ticinensis* Zone (upper Albian).

Family FAVUSELLIDAE Longoria, 1974

Genus *Favusella* Michael, 1972

*Favusella confusa* Longoria and Gamper n. sp.

Pl. 3, Figs. 4-6, 10-12; Pl. 4, Figs. 25-27

*Globigerina washitensis* Carsey. PLUMMER, 1931, pl. 13, figs. 12a-b.

*Favusella* sp. LONGORIA, 1974, p. 74, pl. 26, figs. 8-9.

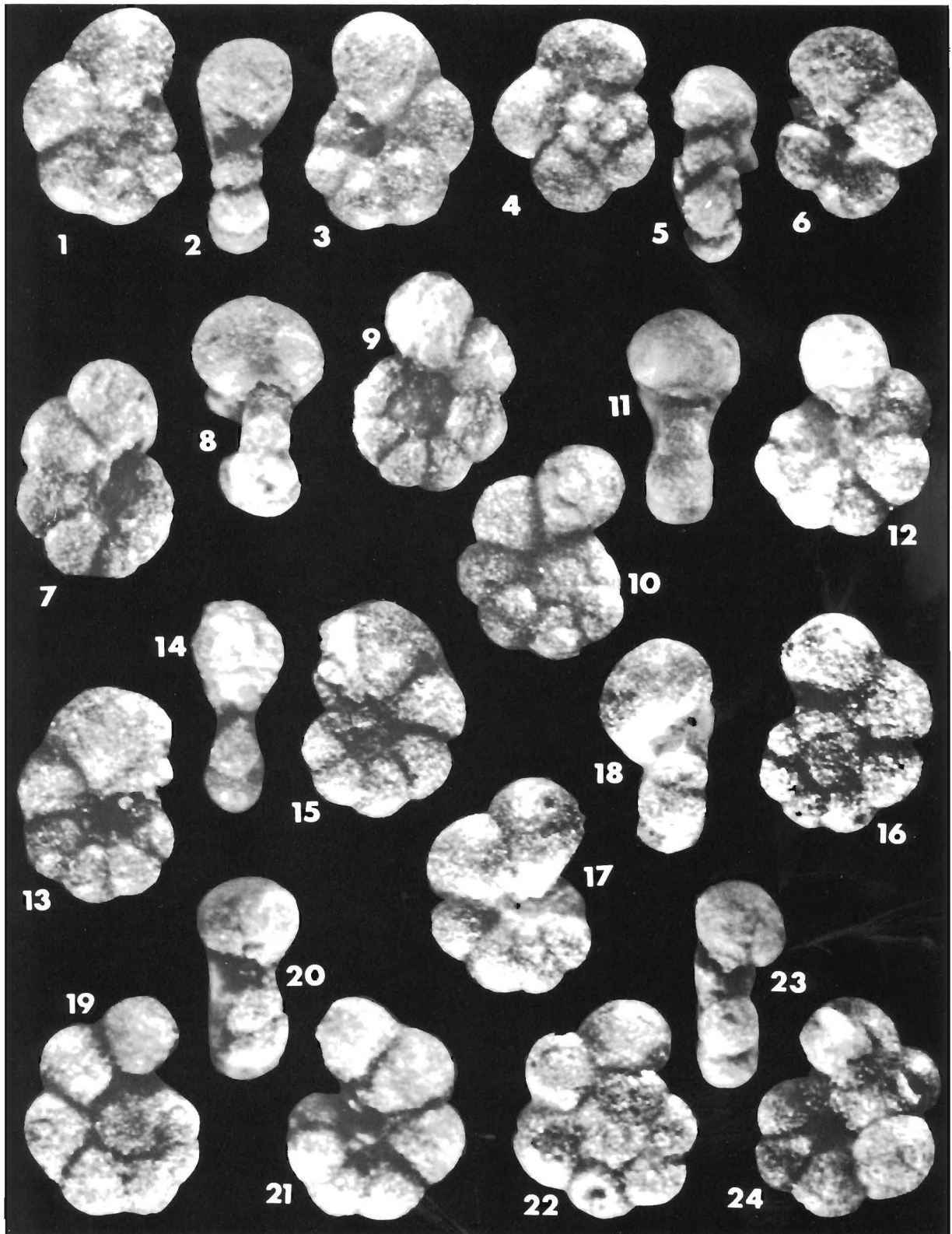
**Description.** Test of medium size, low trochospire, formed by two or three whorls; peripheral margin elongate, strongly lobate; generally four chambers in the last whorl, first chambers increasing gradually in size as added; ultimate chamber considerably larger, comprising about one half of the total diameter of the test, crescent-shaped on both spiral and umbilical sides; primary aperture umbilical in position; surface cancellate; umbilicus narrow and shallow.

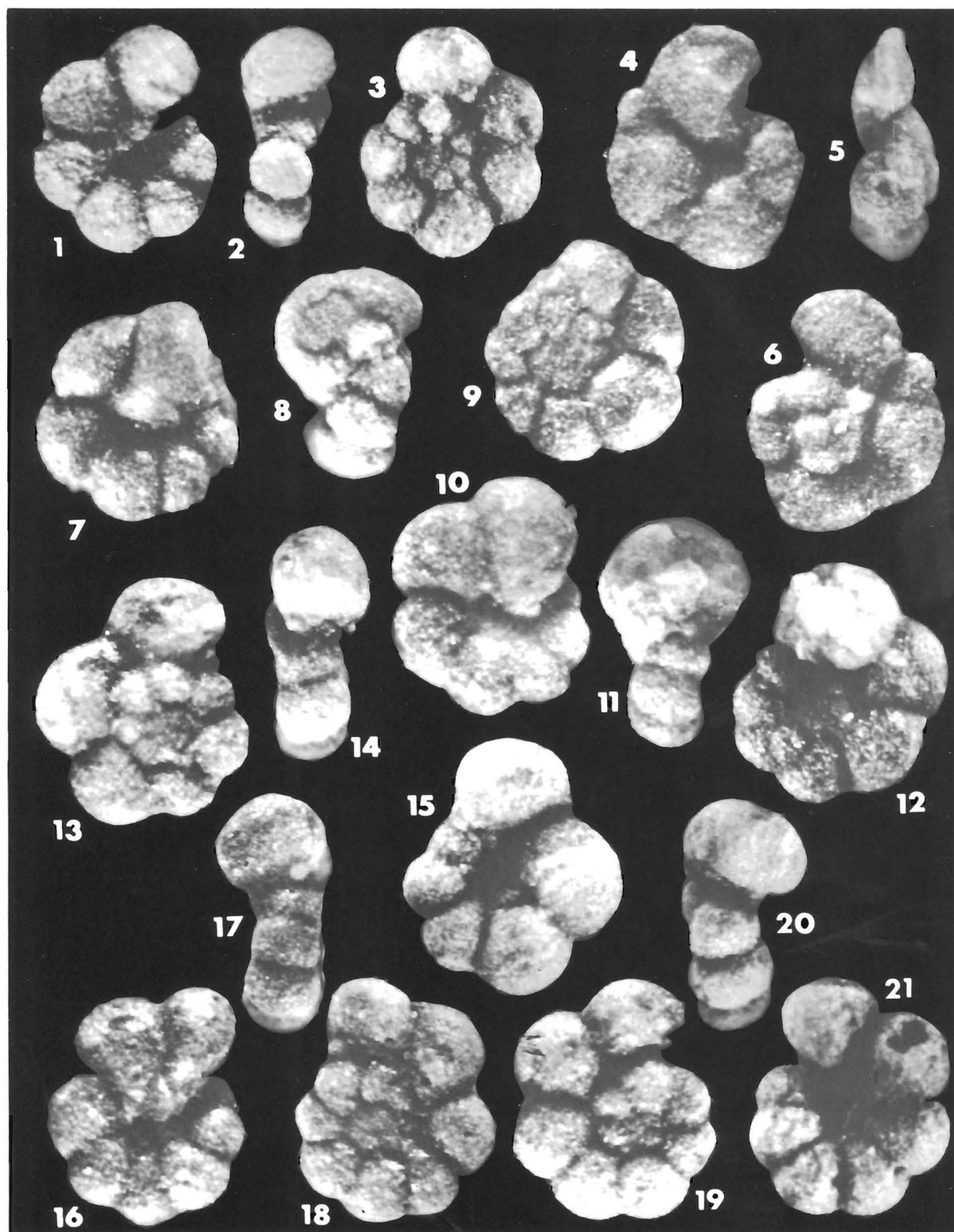
**Variation of the species.** *Favusella confusa* n. sp. is abun-

## PLATE 1

- 1-3 *Ticinella caronae* Longoria and Gamper, n. sp. G1-14; paratype. Sample 44.  
4-6 *Ticinella albiana* Longoria and Gamper, n. sp. M4-3; holotype (USNM 207233). Sample 44.  
7-9 *Ticinella primula* Luterbacher. G1-6; hypotype. Sample 36.  
10-12 *Ticinella aperta* Sigal. G1-8; hypotype. Sample 40.

- 13-15 *Ticinella caronae* Longoria and Gamper, n. sp. G1-15; holotype (USNM 207234). Sample 44.  
16-18 *Ticinella primula* Luterbacher. G1-7; hypotype. Sample 36.  
19-21 *Ticinella roberti* (Gandolfi). M4-7; hypotype. Sample 45.  
22-24 *Ticinella roberti* (Gandolfi). M4-2; hypotype. Sample 45.





dant in the material studied, and more than 100 specimens were observed. This species displays little morphologic variation. The test shows a low trochospire and the last chambers always comprise one half of the total diameter of the test.

**Remarks.** *Favusella confusa* was confused with *Favusella washitensis* by Plummer (1931, pl. 31, figs. 12a-b). However, the study of topotypic material and close comparison with the type figure by D. O. Carsey (1926) allowed the senior author to clarify the taxonomic status of both species. *Favusella confusa* basically differs from *F. washitensis* by its ultimate chamber which comprises one half of the total diameter of the test. This characteristic basically separates *Favusella confusa* from other species of *Favusella*.

**Range.** Upper *Ticinella breggiensis* Zone (upper Albian) to lower *Thalmaninella evoluta* Zone (lower Cenomanian).

**Occurrence.** *Favusella confusa* has been reported from the Grayson Formation of Texas (USA) by Plummer (1931) as *Globigerina washitensis* Carsey and by Longoria (1974) from the same locality as *Favusella* sp.

***Favusella hedbergellaeformis* Longoria and Gamper  
n. sp.**

Pl. 4, Figs. 1-3, 7-9

**Description.** Test large, medium-high trochospire; formed by approximately three to four whorls; peripheral margin ellipsoidal, strongly lobate; five to six chambers in the last whorl, increasing gradually in size as added; chambers of last whorl globular on both umbilical and spiral sides giving to the test an arched appearance; globular in apertural views; primary aperture umbilical-extraumbilical; umbilicus small, partly obscured by the last chamber.

**Variation of the species.** *Favusella hedbergellaeformis* n. sp. shows considerable variation in the degree of protrusion of the last chamber. The majority of the specimens observed show small umbilical area and the last whorl formed by five globular chambers. Specimens with six chambers in the last whorl are rare.

**Remarks.** *Favusella hedbergellaeformis* n. sp. differs from *Favusella washitensis* (Carsey) by its arched test and by its *hedbergella*-like arrangement of the chambers, a feature which gives the name to the species. The holotype of *F. hedbergellaeformis* will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.).

**Range.** *Thalmaninella ticinensis* Zone (upper Albian to *Thalmaninella evoluta* Zone (lower Cenomanian).

***Favusella nitida* Michael, 1972**

Pl. 3, Figs. 7-9

*Favusella nitida* MICHAEL, 1972, p. 214, pl. 3, figs. 10-12.

**Remarks.** The more diagnostic feature of *Favusella nitida* is the subtrapezoidal to crescent-shaped chambers of the spiral side of the test. This characteristic basically separates *F. nitida* from other species of *Favusella*.

The holotype and unfigure paratypes of *F. nitida* were analyzed by the authors. The specimens from México are remarkably similar to the holotype of this species.

**Range.** *Ticinella breggiensis* Zone (upper Albian).

**Occurrence.** *Favusella nitida* is only known from its type locality, the Duck Creek Formation of Texas, USA.

***Favusella papagayosensis* Longoria and Gamper n. sp.**

Pl. 4, Figs. 16-21; Pl. 5, Figs. 16-21

**Description.** Test of medium size, low trochospire, formed by approximately three whorls; peripheral margin elongate, strongly lobulate; generally four chambers in the last whorl which increase gradually in size as added; chambers of the last whorl inflated, petalloid on both umbilical and spiral sides; spherical to ovoid in peripheral view; primary aperture umbilical-extraumbilical; umbilicus small and deep.

**Variation of the species.** *Favusella papagayosensis* n. sp. is abundant in the material studied; and more than 80 specimens were analyzed. Generally, *F. papagayosensis* displays little morphologic variation. All the specimens observed show four petalloid chambers in the last whorl. The majority of the specimens show an umbilical primary aperture; however, it is common to find specimens with an extraumbilical primary aperture.

**Remarks.** *Favusella papagayosensis* n. sp. resembles *Favusella confusa* n. sp. It differs from the latter by the gradual increase in size of the chambers of the last whorl.

This species derives its name from the geographic locality where it was found, the Sierra de Papagayos.

**Range.** Upper *Ticinella primula* Zone to lower *Thalmaninella ticinensis* Zone.

***Favusella planata* Longoria and Gamper n. sp.**

**Description.** Test large, high trochospire, formed by about three whorls; peripheral margin circular, lobulate; last whorl formed by six to seven chambers, coiled in a lower plane; chambers increasing gradually in size as added; last two or three chambers flattened laterally; early chambers globular

PLATE 2

- 1-3 *Ticinella roberti* (Gandolfi). M4-21; hypotype. Sample 46.  
4-6 *Loeblichella pessagno* Longoria and Gamper, n. sp. G1-4; holotype (USNM 207235). Sample 41.  
7-9 *Hedbergella gorbachikae* Longoria. G1-9; hypotype. Sample 41.  
10-12 *Hedbergella gorbachikae* Longoria. G1-10; hypotype. Sample 41.

- 13-15 *Ticinella petalloidea* Longoria and Gamper, n. sp. M4-6; holotype (USNM 207236). Sample 41.  
16-18 *Ticinella bejaouaensis* Sigal. G1-3; hypotype. Sample 11.  
19-21 *Ticinella roberti* (Gandolfi). M4-8; hypotype. Sample 44.

on both spiral and umbilical sides; primary aperture extra-umbilical; umbilical area subcircular.

*Variation of the species.* *Favusella planata* n. sp. is rare in the material studied. Only about 25 specimens were observed, and all of them show the last two or three chambers laterally compressed.

*Remarks.* *Favusella planata* n. sp. is a very distinctive species which can easily be distinguished from other members of the genus by its last whorl of chambers being coiled in a lower plane and by its last two or three chambers being laterally compressed.

This species derives its name from *planatus-a-um* (Latin) = flattened, which refers to its last whorl of chambers. The holotype will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.).

*Range.* Upper *Ticinella breggiensis* Zone (upper Albian) to upper *Thalmaninella ticinensis* Zone (upper Albian).

***Favusella scitula* Michael, 1972**

Pl. 4, Figs. 13–15, 22–24

*Favusella scitula* MICHAEL, 1972, p. 215, pl. 4, figs. 10–12.

*Remarks.* *Favusella scitula* can be distinguished from other species of *Favusella* by: 1) its high trochospire with the earlier whorl coiled in a higher plane and 2) by generally having five globular chambers in the last whorl.

The writers have examined the holotype of *Favusella scitula* in the University of Texas at Dallas before it was sent to its depository in the U.S. National Museum, Washington, D.C.

*Range.* *Ticinella breggiensis* Zone.

*Occurrence.* Until now, *Favusella nitida* had only been recorded from its type locality in the Duck Creek Formation of Texas, USA.

***Favusella voloshinae* Longoria and Gamper n. sp.**

Pl. 3, Figs. 1–3, 16–18

*Description.* Test large, medium high trochospire, formed by about three whorls; peripheral margin irregular, strongly lobate; four to five chambers in the last whorl, increasing gradually in size as added; last chamber generally smaller than the penultimate chamber; earlier chambers petaloid; final chambers crescent-shaped on the spiral side, subtrapezoidal on umbilical side; spherical in apertural view; primary aperture extraumbilical; umbilical area small.

*Variation of the species.* The more significant variation displayed by *Favusella voloshinae* is the number of chambers in the last whorl. The majority of the specimens observed (about 80) show five chambers in the last whorl. The last chamber

always is smaller and possesses the characteristic ornamentation.

*Remarks.* *Favusella voloshinae* n. sp. differs from *F. washitensis* by its smaller number of chambers in the last whorl and by the narrower umbilical area.

This species is named after A. M. Voloshina in honor of her contributions to the study of Albian foraminifera. The holotype and unfigured paratypes of this species will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.).

*Range.* *Favusella voloshinae* seems to be restricted to the *Ticinella breggiensis* Zone (upper Albian).

***Favusella washitensis* (Carsey), 1926**

Pl. 3, Figs. 13–15; Pl. 4, Figs. 4–6, 10–12;

Pl. 5, Figs. 22–24

*Globigerina washitensis* CARSEY, 1926, p. 44, pl. 7, fig. 10 (holotype).

non: *Globigerina washitensis* Carsey. PLUMMER, 1931, p. 193, pl. 13, figs. 12a–b (“neoholotype”).

non: *Favusella washitensis* (Carsey). MICHAEL, 1971, p. 64, pl. 4, figs. 1–3.

*Favusella quadrata* MICHAEL, 1971, p. 61, pl. 4, figs. 7–9.

*Favusella washitensis* (Carsey). LONGORIA, 1974, p. 74, pl. 26, figs. 4–6 (neotype).

*Remarks.* The complicated taxonomic history of *Favusella washitensis* was recently summarized by Longoria (1974). It is characterized: 1) by its subquadrate test; 2) by having wide umbilical area; and 3) by its spherical chambers.

The specimens from the Albian of the Sabinas Basin were compared with the neotype and topotypes of *F. washitensis*. They are in all respects similar to the neotype of this species.

*Range.* Upper *Ticinella primula* Zone (lower Albian) to *Thalmaninella evoluta* Zone (lower Cenomanian).

*Occurrence.* The type specimen of *Favusella washitensis* is from the early Cenomanian of Texas. It has also been recorded from the “Vraconian” of Madagascar by Sigal (1966) and from late Albian of Texas by Michael (1972).

**Family TICINELLIDAE Longoria, 1974**

Genus *Ticinella* Reichel, 1949

***Ticinella albiana* Longoria and Gamper n. sp.**

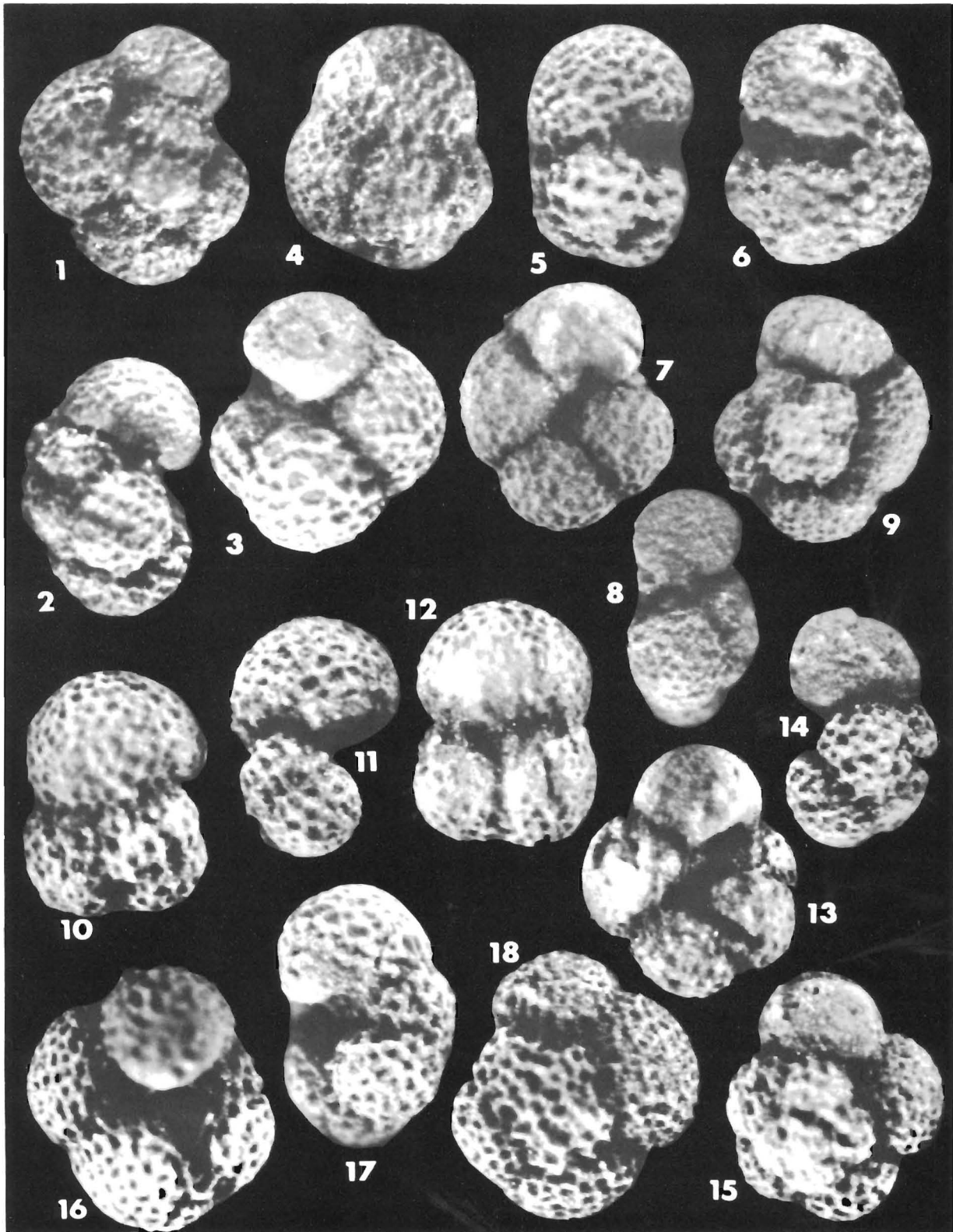
Pl. 1, Figs. 4–6

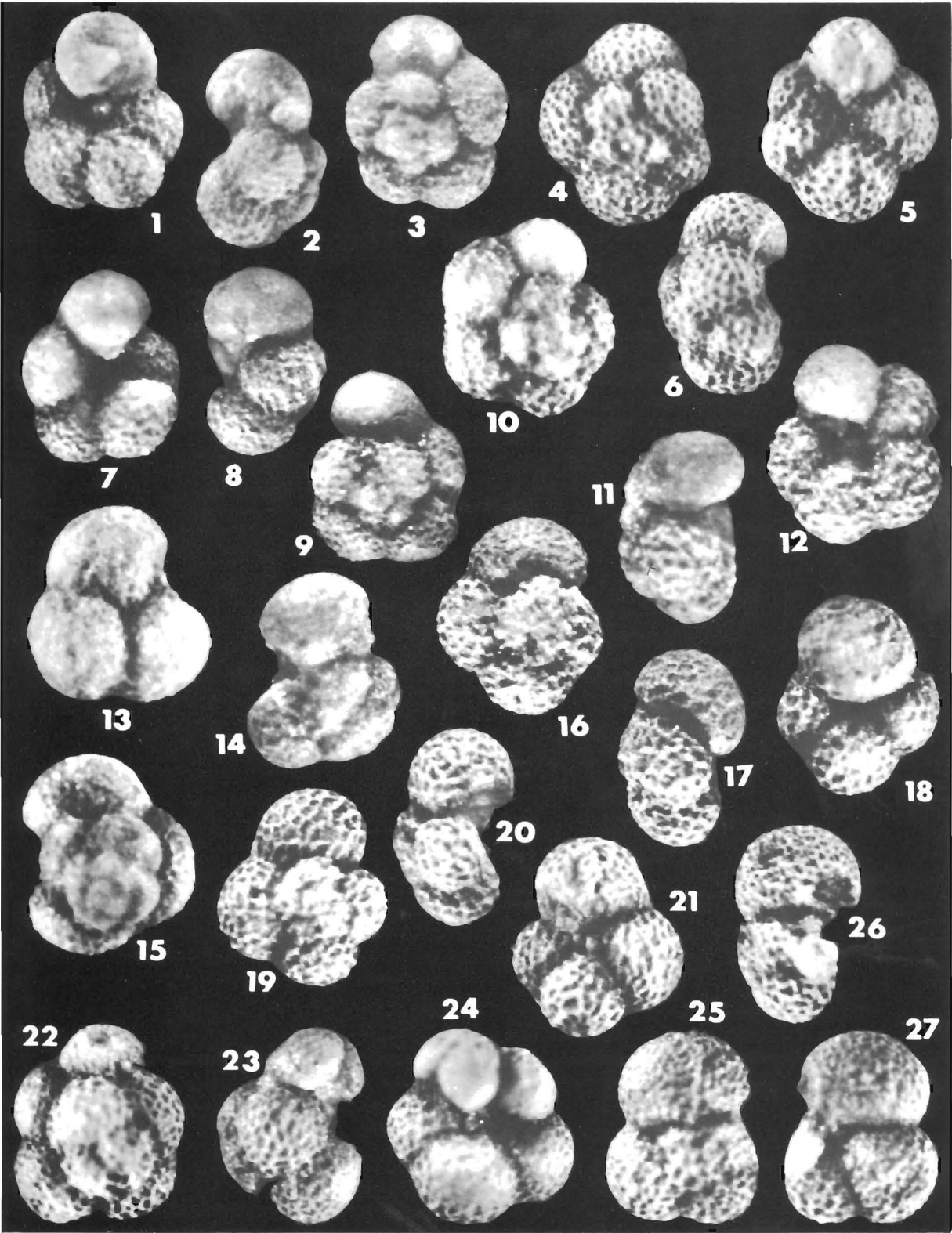
*Description.* Test of medium size, low trochospire; peripheral margin elliptical, strongly lobate; generally five chambers in the last whorl, increasing gradually in size as added; chambers petaloid to crescent-shaped on both spiral and umbilical sides; ovoid in apertural view; sutures straight, depressed; pri-

**PLATE 3**

- 1–3 *Favusella voloshinae* Longoria and Gamper, n. sp. M4-4; holotype (USNM 207237). Sample 44.  
4–6 *Favusella confusa* Longoria and Gamper, n. sp. G1-20; paratype. Sample 41.  
7–9 *Favusella nitida* Michael. G1-1; hypotype. Sample 45.

- 10–12 *Favusella confusa* Longoria and Gamper, n. sp. M4-20; paratype (USNM 207238). Sample 41.  
13–15 *Favusella washitensis* (Carsey). M4-18; hypotype. Sample 47.  
16–18 *Favusella voloshinae* Longoria and Gamper, n. sp. M4-16; paratype. Sample 44.





mary aperture extraumbilical-spiroumbilical in position; umbilicus small, circular.

*Variation of the species.* *Ticinella albiana* n. sp. is common in the material studied. More than 85 specimens were examined. It is a distinctive species whose diagnostic features are constant. All the specimens observed show five chambers in the last whorl.

*Remarks.* *Ticinella albiana* n. sp. differs from *T. caronae* n. sp. in having five petaloid chambers in the last whorl instead of six to seven subtriangular chambers.

This species derives its name from its stratigraphic range, the Albian, since it seems to be restricted to the Albian. The holotype of *Ticinella albiana* will be deposited in the Micropaleontology Collection of the U.S. National Museum (Washington, D.C.).

*Range.* Upper *Ticinella breggiensis* Zone.

#### *Ticinella aperta* Sigal, 1966

Pl. 1, Figs. 10–12; Pl. 5, Figs. 7–9

*Ticinella raynaudi* var. *aperta* SIGAL, 1966, p. 206, pl. 6, figs. 11a–b, 13a–b.

*Ticinella raynaudi aperta* Sigal. RISCH, 1970, p. 114, pl. 11, figs. 10–12.

*Description.* Test small, low trochospire; peripheral margin elongate; six to seven chambers in the last whorl progressively increasing in size as added giving the test an evolute appearance; early chambers of the last whorl ovoid; latter chambers subtrapezoidal on both spiral and umbilical sides; spherical to ovoid in apertural view; sutures straight and deep on both spiral and umbilical sides; primary aperture extraumbilical-spiroumbilical in position; umbilicus shallow.

*Variation of the species.* Little morphologic variation was observed in *Ticinella aperta* (Sigal). The specimens analyzed (about 40) always show the diagnostic evolute appearance of the test. The chambers in the last whorl vary from six to seven.

*Remarks.* *Ticinella aperta* was considered by Sigal (1966) as a variation of *Ticinella raynaudi*. The present authors feel that both *T. aperta* and *T. raynaudi* are separate species and furthermore that they are not so closely related phylogenetically.

*Ticinella aperta* differs from *Ticinella primula* by its elongate rather than circular peripheral margin.

*Range.* *Ticinella breggiensis* Zone to upper *Thalmaninella ticinensis* Zone (upper Albian).

*Occurrence.* *Ticinella aperta* has been recorded from the Albian of Madagascar, Spain and Germany.

#### *Ticinella bejaouaensis* Sigal, 1966

Pl. 2, Figs. 16–18

*Ticinella roberti* var. *bejaouaensis* SIGAL, 1966, p. 207, pl. 5, figs. 5–9.

*Ticinella bejaouaensis* Sigal. RISCH, 1970, p. 111, pl. 10, figs. 4–12.

*Remarks.* *Ticinella bejaouaensis* is characterized by its circular periphery and by its last whorl formed by eight to nine subtrapezoidal chambers. This feature separates *T. bejaouaensis* from *T. roberti*. The phyletic relationships between *T. bejaouaensis* and *T. roberti* as stated by J. Sigal (1966) still remain to be proven. The present authors regard *T. bejaouaensis* as a separate species which may not be directly related to *T. roberti*.

In the material studied *T. bejaouaensis* was mainly recognized in thin sections of limestone. Its large dimensions and characteristic axial section allowed the easy identification of this species. Only a few poorly preserved isolated specimens were observed in the material studied.

*Range.* *Ticinella bejaouaensis* Zone (lower Albian).

*Occurrence.* *Ticinella bejaouaensis* has been found in a few places. It was reported from Madagascar, France, Germany and México.

#### *Ticinella breggiensis* (Gandolfi), 1942

Pl. 5, Figs. 10–12; Pl. 6, Figs. 7–12, 16–21

*Anomalina breggiensis* GANDOLFI, 1942, p. 102, pl. 3, figs. 6a–c; pl. 5, fig. 3; pl. 9, fig. 1; pl. 13, fig. 7–8.

*Biticinella breggiensis* (Gandolfi). CARON AND LUTERBACHER, 1969, p. 25, pl. 7, figs. 4a–c.

*Ticinella breggiensis* (Gandolfi). LONGORIA, 1974, p. 95, pl. 25, figs. 14–16. (Detailed synonymic list is given.)

*Remarks.* The details of the taxonomic history of *Ticinella breggiensis* were given by J. F. Longoria (1973). The species is characterized by being coiled in a low trochospire and by having eight to nine subtriangular chambers in the last whorl. In the material studied *T. breggiensis* is always abundant. Some specimens give the appearance of being planispiral; however, they always show bisymmetric tests with each side of the test different.

*Range.* *Ticinella breggiensis* Zone (upper Albian) to *Thalmaninella evoluta* Zone (lower Cenomanian).

*Occurrence.* *Ticinella breggiensis* has been reported from

←

## PLATE 4

- 1–3 *Favusella hedbergellaeformis* Longoria and Gamper, n. sp. G2-14; holotype (USNM 207239). Sample 46.  
4–6 *Favusella washitensis* (Carsey). G2-1; hypotype. Sample 37.  
7–9 *Favusella hedbergellaeformis* Longoria and Gamper, n. sp. G2-6; paratype. Sample 46.  
10–12 *Favusella washitensis* (Carsey). G2-4; hypotype. Sample 46.

- 13–15 *Favusella scitula* Michael. G2-10; hypotype. Sample 44.  
16–18 *Favusella papagayoensis* Longoria and Gamper, n. sp. G2-5; holotype (USNM 207240). Sample 41.  
19–21 *Favusella papagayoensis* Longoria and Gamper, n. sp. G2-8; paratype. Sample 34.  
22–24 *Favusella scitula* Michael. G2-21; hypotype. Sample 44.  
25–27 *Favusella confusa* Longoria and Gamper, n. sp. G2-18; holotype (USNM 207241). Sample 45.

the upper Albian-lower Cenomanian deposits of Switzerland, Italy, France, Germany, Morocco and Spain.

***Ticinella caronae* Longoria and Gamper n. sp.**

Pl. 1, Figs. 1-3, 13-15

**Description.** Test of medium size, low trochospire; peripheral margin elliptical, lobate; six to seven chambers in the last whorl, increasing gradually in size, except for the ultimate chamber which is two or three times higher than the penultimate chamber; early chambers subtriangular, last chambers crescent-shaped on both spiral and umbilical sides; sutures strongly depressed and straight on both spiral and umbilical sides; primary aperture extraumbilical-spiroumbilical in position; umbilicus narrow and shallow.

**Variation of the species.** *Ticinella caronae* n. sp. shows little morphologic variation. All the specimens observed (about 80) show the diagnostic last chamber which is about three times bigger than the penultimate. Some specimens have the tendency to develop more inflated chambers on the umbilical side; however, they possess the other diagnostic features of the species.

**Remarks.** *Ticinella caronae* n. sp. is characterized by its ultimate chamber that is about three times bigger than the penultimate chamber and by its subtriangular earlier chambers of the last whorl. These features basically separate *T. caronae* n. sp. from *Ticinella primula* Luterbacher and *Ticinella petalloidea* n. sp.

This species is named for M. Caron in honor of her contributions to the study of the Lower Cretaceous Hedbergelloidea. The holotype of *T. caronae* n. sp. will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.). The figured paratypes will be deposited in the Longoria Collection of the Instituto de Geología, UNAM.

**Range.** *Thalmanninella ticinensis* Zone (upper Albian).

***Ticinella floresae* Longoria and Gamper n. sp.**

Pl. 5, Figs. 1-3, 13-15

**Description.** Test of medium size, low trochospire; peripheral margin circular, lobate; seven to eight chambers in the last whorl arranged in an alternation of lower and higher planes, increasing gradually in size as added; chambers petaloid on spiral side, subtriangular on umbilical side; ovoid in apertural view; primary aperture extraumbilical-spiroumbilical in position; umbilicus shallow.

**Variation of the species.** *Ticinella floresae* n. sp. displays little morphologic variation. It is one of the most diagnostic

species of *Ticinella*, and is abundant in the material studied. More than eighty specimens were observed, and all show a low trochospiral coil. The number of chambers in the last whorl varies from seven to eight; however, specimens with seven chambers in the last whorl are more common.

**Remarks.** *Ticinella floresae* n. sp. differs from *T. primula* Luterbacher and *T. aperta* Sigal by its diagnostic ultimate whorl with chambers arranged in an alternation of lower and higher planes, where one chamber is up and the next is down.

This species is named for María Clara Flores de Hernández in honor of her many years of working with the foraminiferal faunas of México. The holotype of *T. floresae* will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.). An illustrated paratype will be kept in the Longoria Collection of the Instituto de Geología, UNAM.

**Range.** *Ticinella primula* Zone (lower Albian) to *T. breggiensis* Zone (upper Albian).

***Ticinella petalloidea* Longoria and Gamper n. sp.**

Pl. 2, Figs. 13-15

**Description.** Test of medium size, low trochospire; peripheral margin subcircular, lobate; six to seven chambers in the last whorl, increasing gradually in size as added, early chambers petaloid; later chambers crescent-shaped on spiral side; early chambers subtriangular; later chambers crescent-shaped on umbilical side; sutures strongly depressed and straight on both spiral and umbilical sides; primary aperture extraumbilical-spiroumbilical in position; umbilical area wide and shallow.

**Variation of the species.** *Ticinella petalloidea* n. sp. is abundant in the material studied, and more than 90 specimens were analyzed. It shows little morphologic variation. The height of the spire is constant; all the specimens observed have low trochospiral coil. Individuals with seven chambers in the last whorl are rarely observed.

**Remarks.** *Ticinella petalloidea* n. sp. differs from *T. primula* Luterbacher by its crescent-shaped chambers and by its subcircular instead of elliptical peripheral outline.

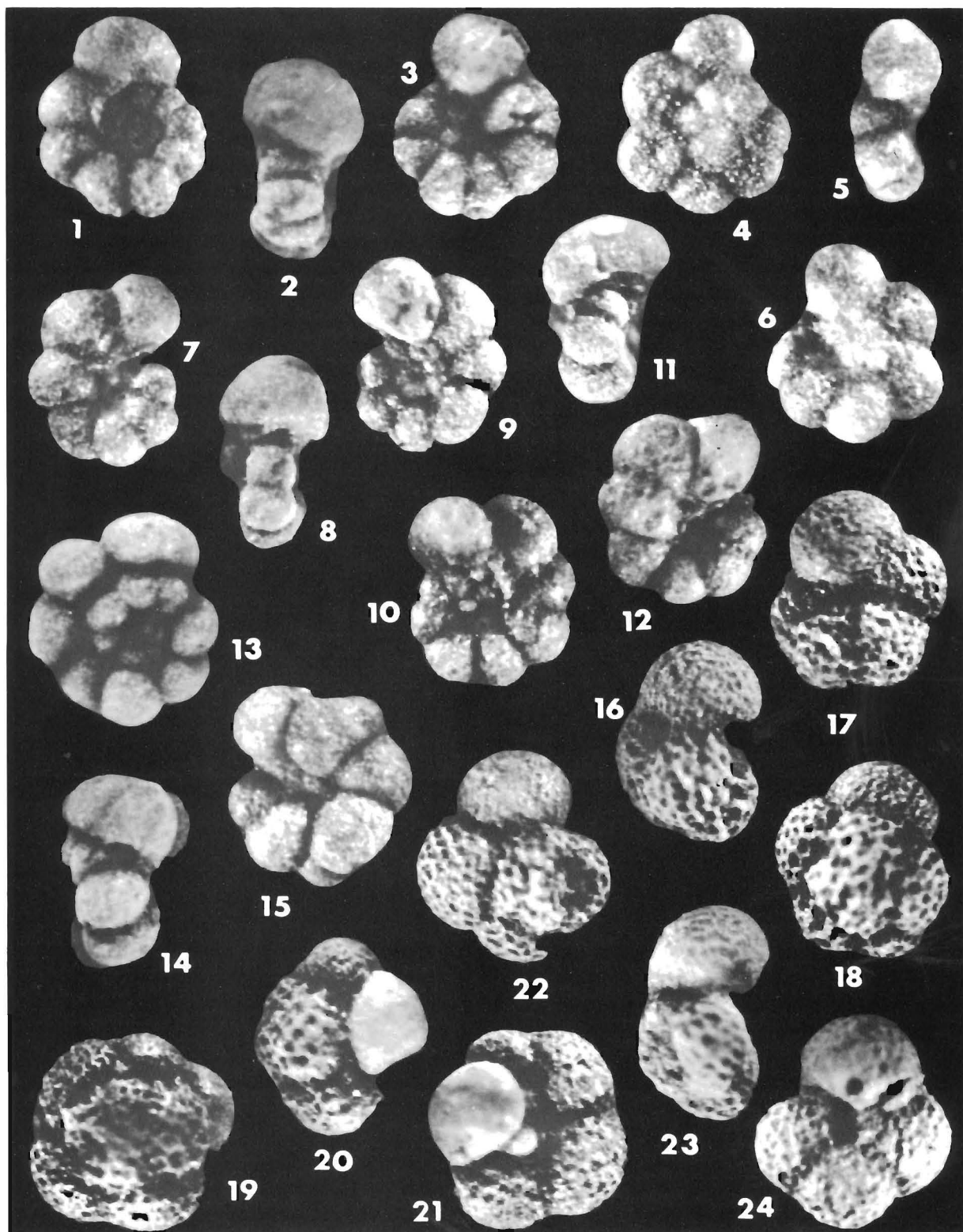
This species derives its name from the petaloid-shape of the chambers of the last whorl. The holotype and unfigured paratypes of *T. petalloidea* will be deposited in the Micropaleontological Collection of the U.S. National Museum (Washington, D.C.). Other unfigured paratypes will be deposited in the Longoria Collection of the Instituto de Geología, UNAM.

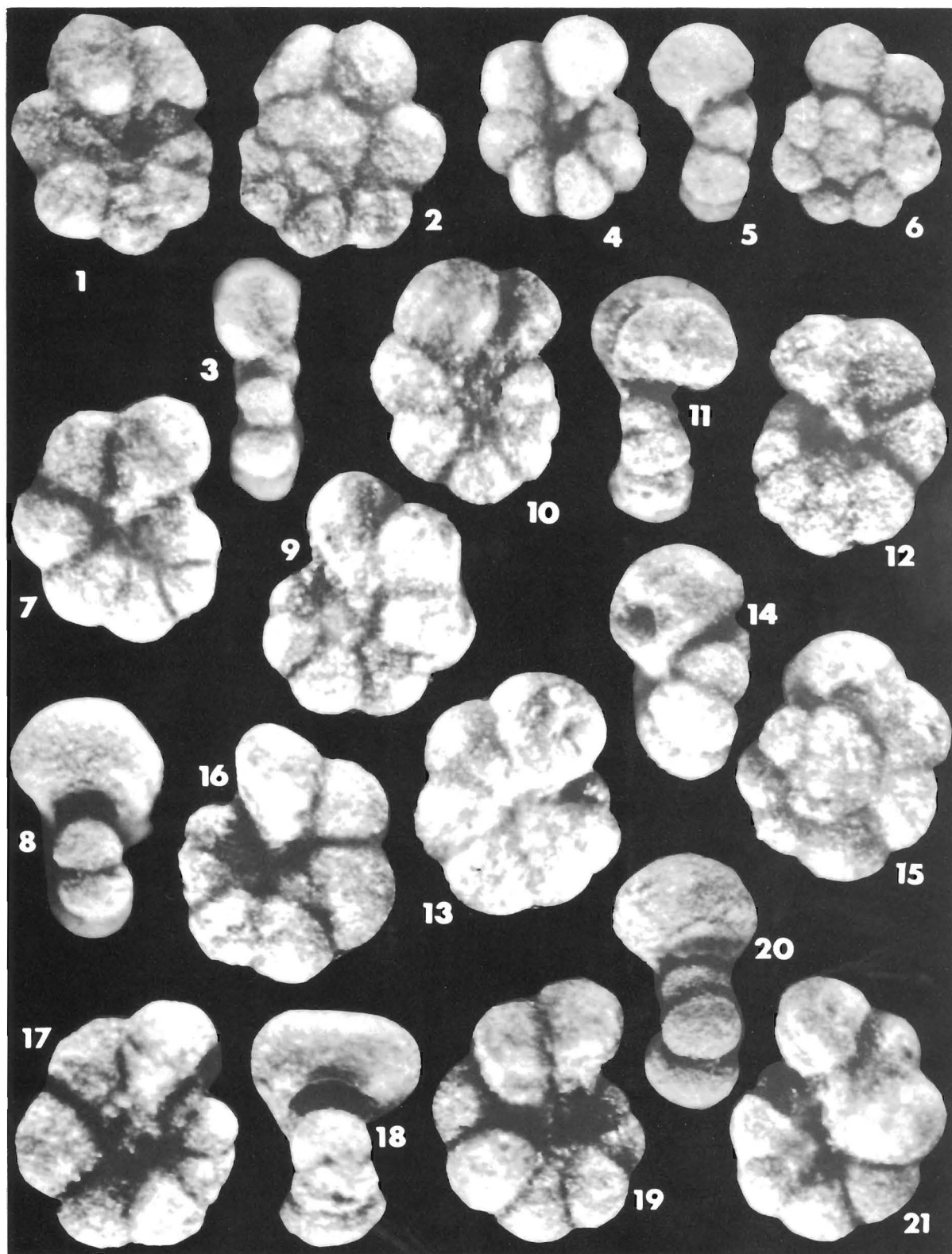
**Range.** Upper *Ticinella breggiensis* Zone (upper Albian) to lower *Thalmanninella evoluta* Zone (lower Cenomanian).

PLATE 5

- 1-3 *Ticinella floresae* Longoria and Gamper, n. sp. G2-16; paratype. Sample 51.  
4-6 *Ticinella raynaudi* Sigal. M4-11; hypotype. Sample 40.  
7-9 *Ticinella aperta* Sigal. G2-20; hypotype. Sample 40.  
10-12 *Ticinella breggiensis* (Gandolfi). M6-6; hypotype. Sample 44.

- 13-15 *Ticinella floresae* Longoria and Gamper, n. sp. M6-15; holotype (USNM 207242). Sample 45.  
16-18 *Favusella papagayoensis* Longoria and Gamper, n. sp. M6-5; paratype. Sample 51.  
19-21 *Favusella papagayoensis* Longoria and Gamper, n. sp. G2-2; paratype. Sample 51.  
22-24 *Favusella washitensis* (Carsey). M6-17; hypotype. Sample 51.





***Ticinella primula* Luterbacher, 1963**

Pl. 1, Figs. 7-9, 16-18

*Ticinella primula* LUTERBACHER, 1963, p. 1085, text fig. 4.*Ticinella raynaudi* var. *aperta* Sigal. CARON, 1971, p. 155, figs. 20a-c.*Ticinella primula* Luterbacher. LONGORIA, 1974, p. 96, pl. 25, figs. 1-6 (topotypes).

**Remarks.** *Ticinella primula* is characterized by its low trochospire consisting of about three whorls. The last whorl is formed by seven to eight chambers which expand gradually in size as added giving the test an uncoiled appearance. This feature easily separates *Ticinella primula* from *T. roberti* and *T. breggiensis*.

In the samples from the Albian of the Sabinas Basin, *Ticinella primula* is abundant. Most of the specimens observed (about 75) show seven chambers in the last whorl. Some of them display the portici.

Sigal (1966) gave a wide definition to *Ticinella primula* including in it several forms that are outside the limits of morphologic variation allowed for the species.

The authors examined the topotypic material deposited in H. P. Luterbacher's personal collection. Most of the topotypes show a gradual increase of the chambers of the last whorl and display the diagnostic uncoiled appearance as shown by the holotype and the topotypes illustrated by Longoria (1974, Pl. 25, Figs. 2-4).

**Range.** Uppermost *Ticinella bejaouaensis* Zone (lower Albian) to uppermost *Ticinella breggiensis* Zone (upper Albian).

**Occurrence.** *Ticinella primula* has been reported from Albian deposits of Switzerland, Italy, Germany, Spain, Madagascar and México.

***Ticinella raynaudi* Sigal, 1966**

Pl. 5, Figs. 4-6

*Ticinella raynaudi* SIGAL, 1966, p. 201, pl. 5, figs. 10a-b; pl. 6, figs. 1-5.*Ticinella raynaudi raynaudi* Sigal. RISCH, 1970, p. 113, pl. 11, figs. 4-6.

**Description.** Test small, moderately high trochospire; peripheral margin subcircular, strongly lobate; six to seven chambers in the last whorl increasing gradually in size as added; chambers petaloid, inflated both umbilically and spirally; sutures straight to slightly curved on both spiral and umbilical sides; primary aperture extraumbilical-spiroumbilical in position bordered by a porticus; umbilicus small and deep.

**Variation of the species.** *Ticinella raynaudi* (Sigal) displays little morphologic variation. The specimens analyzed (about

55) have a moderately high trochospire. The number of chambers in the last whorl varies from six to seven, but specimens with seven are more common.

**Remarks.** *Ticinella raynaudi* was originally described by J. Sigal (1966) to include in it three subspecies: *Ticinella raynaudi raynaudi*; *T. raynaudi aperta* and *T. raynaudi digitalis*. The present authors regard these three subspecies as separate species. *Ticinella raynaudi* differs from *T. aperta* and *T. digitalis* in having six to seven petaloid chambers which increase gradually in size as added and by having subcircular rather than substellate or evolute peripheral outlined test. *Ticinella raynaudi* somewhat resembles *T. primula*, but it differs in having a higher trochospire and deep umbilicus.

**Range.** Upper *Ticinella breggiensis* Zone to upper *Thalmaninella ticinensis* Zone (upper Albian).

**Occurrence.** This species has only been reported from Madagascar, Spain and Germany.

***Ticinella roberti* (Gandolfi), 1942**

Pl. 1, Figs. 19-24; Pl. 2, Figs. 1-3, 19-21;

Pl. 6, Figs. 4-6

*Anomalina roberti* GANDOLFI, 1942, p. 100, pl. 2, figs. 19-24.*Ticinella roberti* Gandolfi. CARON, 1960, p. 152, text figs. 14a-15c.*Ticinella roberti* Gandolfi. GORBACHICK AND KRECHMAR, 1969, pl. 2, figs. 1a-c.*Ticinella roberti* Gandolfi. LONGORIA, 1974, p. 98, pl. 12, figs. 1-6 (topotype).

**Remarks.** *Ticinella roberti* displays considerable morphologic variation. Typical specimens show the following diagnostic features: 1) large test formed by eight to nine chambers in the last whorl; 2) wide umbilical area; and 3) the ultimate whorl coiled in a lower plane.

It is possible that *T. roberti* originated from *Hedbergella trocoidea*; however, a more detailed morphologic analysis based on well preserved specimens is needed before arriving at a definitive conclusion in relation to the phyletic relationships of *Ticinella roberti*.

The specimens of *Ticinella roberti* from the Sabinas Basin were compared with the topotypes of *T. roberti* from the La Breggia section. They are in all respects within the morphologic limits allowable for this species.

**Range.** *Ticinella primula* Zone to lowermost *Thalmaninella evoluta* Zone (lower Cenomanian).

**Occurrence.** *Ticinella roberti* has been reported from Albian-Cenomanian deposits of Switzerland, France, Germany, Spain, Caucasus (USSR), Madagascar, California (USA) and México.

←

## PLATE 6

- 1-3 *Hedbergella luterbacheri* Longoria. G1-16; hypotype. Sample 36.  
 4-6 *Ticinella roberti* (Gandolfi). G1-17; hypotype. Sample 51.  
 7-9 *Ticinella breggiensis* (Gandolfi). G1-11; hypotype. Sample 44.  
 10-12 *Ticinella breggiensis* (Gandolfi). G1-18; hypotype. Sample 36.

- 13-15 *Hedbergella trocoidea* (Gandolfi). G1-2; hypotype. Sample 44.  
 16-18 *Ticinella breggiensis* (Gandolfi). G1-12; hypotype. Sample 36.  
 19-21 *Ticinella breggiensis* (Gandolfi). G1-13; hypotype. Sample 46.