THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

FORAMINIFERA OF THE AUSTIN GROUP IN NORTHEAST TEXAS

A THESIS

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

CHARLES LEE MC NULTY, JR.

Norman, Oklahoma

1955

FORAMINIFERA OF THE AUSTIN GROUP IN NORTHEAST TEXAS

APPROVED BY

R. W. Harris

[signature]

[signature]

C. A. Merritt

E A Frederickson

K. Asbury

THESIS COMMITTEE

ACKNOWLEDGMENT

The writer is considerably indebted to far more people than can be acknowledged practically here. However, he wishes to express his sincere and deep gratitude to Dr. R. W. Harris, Professor of Micropaleontology, University of Oklahoma, whose incalculable assistance as thesis professor was vital. In addition, members of the thesis committee were readily helpful and encouraging, as were all members of the faculty of the School of Geology. The writer is also eager to express his deepest appreciation to Carlyle B. Campbell, designer of the Campbell sample washer, who most generously washed the many samples studied in this report. Through the efforts of Dr. C. C. Albritton and Dr. Arthur Richards, Southern Methodist University, laboratory and library facilities were made available for well beyond a year. Finally, the writer wishes to thank the Continental Oil Company for assistance in many ways.

FORAMINIFERA OF THE AUSTIN GROUP IN NORTHEAST TEXAS

APPROVED BY

R. W. Harris

[signature]

[signature]

C. A. Merritt

E. A. Frederickson

K. Asbury

THESIS COMMITTEE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

FORAMINIFERA OF THE AUSTIN GROUP IN NORTHEAST TEXAS

INTRODUCTION

The area of this report is located in northeast Texas. It includes the arcuate belt of the Austin group, cropping out from Dallas County on the south to Fannin County on the northeast (see Plate 11).

The Austin strata dip eastward and southward into the East Texas Basin. This regional dip is modified by a series of anticlinal noses which increase in relief to the northeast (see figure 1).

Topographically the area is a part of the Black Prairie. The prairie is interrupted along the contact of the Eagle Ford shale and the Austin chalk by the White Rock cuesta, which decreases gradually in relief to the northeast as the Austin group changes in lithology. Limited exposures of Austin strata are common. However, the area is rather heavily mantled, and the low topographic relief and the low rate of dip of the wide band of outcrop makes difficult even approximate determination of stratigraphic position. Consequently, many published collecting localities are loosely located stratigraphically.

The Austin formation was named by Shumard (1860, pp. 583, 585) and has been studied since by many workers. In 1932 Adkins (pp. 439-451) elevated the formation to the status of group and recognized two facies: a calcareous facies, dominated by chalk, chalky limestone, and chalky marl; and an argillaceous facies, containing chalk units, but dominantly composed of clay and marl. In the area considered in this report, the calcareous facies extends

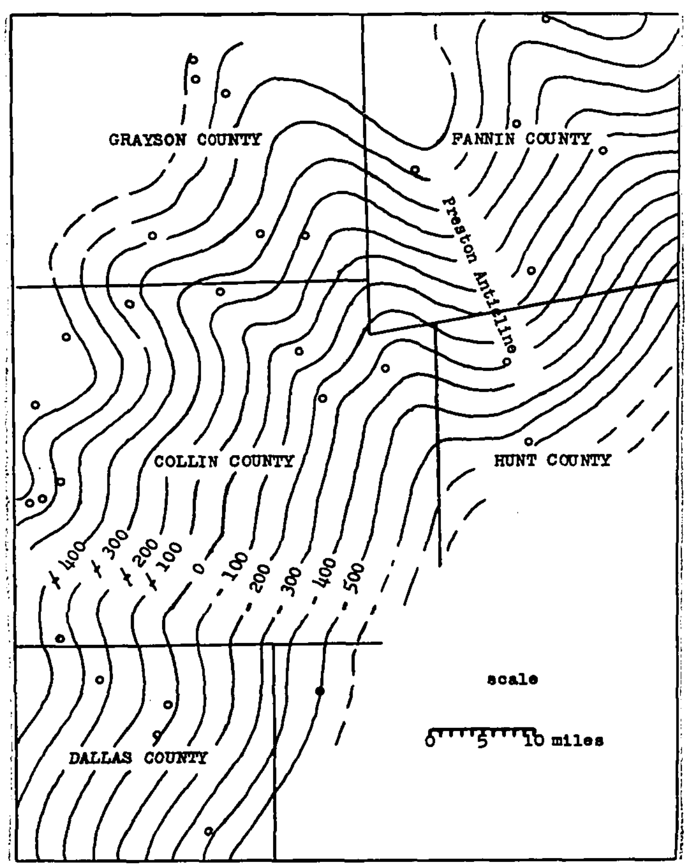


Figure 1.--Generalized subsurface structure map contoured on the base of the Austin group in northeast Texas. Contour interval = 100 feet.

from Dallas County to east-central Grayson County, whence the argillaceous facies extends eastward through and beyond Fannin County.

In 1889 Hill recognized Foraminifera in Austin strata, and many geologists since have studied the Austin microfauna to a limited extent. Of all the workers, however, only Dr. J. A. Cushman has published extensively concerning Austin Foraminifera. His publications have been mainly taxonomic, erecting many new species from the Austin group. His monographic Professional Paper 206 (1946) is a summary of the results of the previous twenty years of work upon the fauna of the Upper Cretaceous of the Gulf Coastal Plain. This report lists 143 species in the Austin group of Texas, as determined from seventy-eight outcrop samples.

Although the 143 species reported by Cushman constitute the bulk of the Austin fauna, the limited number of samples (seventy-eight from a unit several hundred feet thick) and the generality of their stratigraphic position justify a more intensive and systematic study of the Austin group as a faunal unit. Such a study is the primary purpose of this paper. It is also hoped that such study will provide some basis for zonation of the unit and will shed additional light upon the proper correlation of its calcareous and its argillaceous facies.

To overcome the difficulty of determining exact stratigraphic position of sample localities, a somewhat unorthodox procedure of sample collecting was employed. Certain highways, which crossed the belt of outcrop perpendicular to the strike, were selected as traverses. Profiles of these were obtained from the Texas Highway Department. Samples collected were located on the profiles and their stratigraphic position above the base of the Austin group, also located on the profiles, was calculated, using the distances and elevations of the profiles and the rates of dip as determined from subsurface study.

Samples were collected along highway traverses in Dallas, Collin, and Fannin Counties (see Plate 11). However, the Ector chalk of Fannin County is so thin that it could not be sampled satisfactorily by traverse and, accordingly, was sampled in a streamway and a quarry (see Appendix for locations) between Bonham and Ravenna in Fannin County. No highway profile existed across the Gober chalk; consequently, this profile was made by plane table and alidade. In addition, a traverse by plane table and alidade was made along Brushy Creek in northern Travis County with the aim of obtaining data from the type locality for comparison purposes. A list of the approximately three hundred samples collected, the traverses run, and the individual collecting localities will be found in the Appendix.

Samples collected were ground and washed in a Campbell washer (Campbell, 1951; Hussey and Campbell, 1951).

All were sieved in four size grades for picking, and a faunal slide was prepared for each sample. A complete set of the different species identified has been mounted and deposited at the School of Geology, University of Oklahoma.

In the construction of the range chart, each sample was considered representative of five to six feet of vertical section both above and below its calculated stratigraphic position. Stratigraphic sections for which samples were not collected or were not usable, are indicated on the range chart by gaps in the stratigraphic sequences. Species which occurred in only one sample are not posted on the range chart.

Sample coverage of the Austin sequence is very satisfactory, except for two gaps in the middle and upper Austin in Collin County and very poor sample representation from the lower Bonham clay of Fannin County. Results of this study have revealed the former to be relatively unimportant in an established mid-Austin section, but the latter is regrettable, as is explained in the conclusion. The area of outcrop of the lower Bonham is one of heavy soil cover and/or rapidly changing strike, with the result that exposures are few and very difficult to locate stratigraphically with accuracy.

The taxonomic form employed in this report follows in general that of Frizzell (1954, pp. 11-13).

STRATIGRAPHY

Calcareous Facies

In the area of this report the calcareous facies of the Austin group extends northward from Dallas County to east-central Grayson County. It includes a basal chalk unit, a middle marl unit, and an upper chalk unit (Adkins, 1932, p. 447; Dallas Petroleum Geologists, 1941, p. 43). The basal one to four feet of phosphatic chalk in Dallas County have been recognized as an additional stratigraphic unit (Dallas Petroleum Geologists, 1941, p. 43), but they are included in the basal chalk unit in this report. The basal chalk is generally considered to lie disconformably upon the Eagle Ford shale, but the relation of the upper chalk unit to the overlying Taylor marl remains to be demonstrated. Stephenson (1937, p. 138) reported an unconformity at the top of the Austin chalk in Dallas County, whereas the Dallas Petroleum Geologists (1941, pp. 61-63) presented evidence of a gradational contact. From personal observation the writer considers the Austin-Taylor contact to be gradational from Dallas County northward through Grayson County. The contacts of the middle marl with the overlying and the underlying chalk units are gradational.

The basal chalk thins northward from 200 feet in Dallas County to approximately 75 feet in Grayson County. The middle marl thickens northward from 240 feet in Dallas County to approximately 350 feet in Grayson County. The upper chalk also thickens northward from 210 feet in Dallas County to approximately 325 feet in Grayson County.

Argillaceous Facies

In the area of this report the argillaceous facies of the Austin group appears first in Fannin County, from which it extends eastward beyond the area of the report. The Austin group in Fannin County has been variously defined in the past (Stephenson, 1918, 1927, 1937; Adkins, 1932). In this report it is considered to include the Ector chalk, the Bonham clay, and the Gober chalk.

The Ector chalk (Stephenson, 1918, p. 149) is a thinner eastward extension of the basal chalk of the calcareous facies. It is composed of approximately thirty feet of well-indurated, medium-bedded chalk. It has been thought to pinch out in northwestern Fannin County (Stephenson, 1918, p. 150; Adkins, 1932, p. 443), but it is well exposed in normal thickness at Lake Crockett in northeasternmost Fannin County, and it undoubtedly extends into adjoining Lamar County. Because the basal five feet are clastic limestone, and because it is an extension of the basal chalk of the calcareous facies that lies disconformably upon the

Eagle Ford, the writer considers the Ector to be disconformable upon the Eagle Ford shale. No good exposure of its upper contact was found, but the Ector formation is generally considered to be conformable with the overlying Bonham formation.

In central Fannin County the Ector chalk is overlain by approximately 500 feet of non-calcareous clay, named Bonham by Stephenson (1927, p.8). In eastern Fannin County the upper Bonham becomes marly and is correlated with the Brownstown marl. The lower Bonham becomes micaceous and silty, suggesting the possibility of correlation with the Tokio sand. Between the towns of Bonham and Randolph the lower Bonham contains a five-foot stratum of white glauconitic clay which has been correlated with the Blossom sand (Stephenson, 1918, p. 150). Near the town of Lannius the upper Bonham contains a fossiliferous, organic sandstone which has also been correlated with the Blossom (ibid.). In a northward flowing gully on the west side of the Sowell's Bluff highway, approximately three miles north of Bonham, the writer found a six-inch stratum of phosphatic conglomerate in approximately the same stratigraphic position as the glauconitic clay. It is suggested that the Bonham clay contains lenses of differing lithology and stratigraphic position, which may correlate approximately with the Blossom sand, rather than a single stratigraphic unit that extends directly into the Blossom sand. The contact of the Bonham clay and the overlying Gober chalk was observed to be gradational at all exposures examined by the writer.

The Bonham clay is overlain by approximately 320 feet of medium- to thin-bedded, argillaceous and chalky limestone, known as the Gober chalk (Stephenson, 1927, p. 8). The topmost twenty feet of the Gober is composed of creamy-white, soft but tough, thick-bedded, glauconitic chalk. The Gober chalk is considered to be unconformable with the overlying Taylor marl (Stephenson, 1937, p. 136).

The outcrops of the Gober chalk and Bonham clay appear to extend directly into those of the upper chalk and middle marl respectively of the calcareous facies, but the relations of the Gober to the Brownstown and other units east of Fannin County and the abrupt change from middle marl to Bonham clay have produced much difficulty in correlation of the calcareous and argillaceous facies. Consequently, the Austin group in Fannin County at different times has been suggested to: (a) include a part of the present uppermost Eagle Ford shale, (b) exclude the upper Bonham and all of the Gober formation, (c) include the upper Bonham and the Gober formation.

Because of the extreme difficulty of mapping the correlative units of the Bonham clay (e.g., Brownstown marl), the field work of this study was not adequate to determine their disposition and relations accurately;

consequently, the accompanying areal map (Plate 11) must be considered very generalized insofar as these units are concerned.

SYSTEMATIC DESCRIPTIONS

Family SACCAMMINIDAE

Genus PROTEONINA Williamson, 1858

"PROTEONINA DIFFLUGIFORMIS (H. B. Brady)"

Plate 1, figure 1

Reophax difflugiformis H. B. Brady, Quart. Jour. Micr. Sci., new ser., vol. 19, p. 51, pl. 4, figs. 3a,b, 1879.
Proteonina difflugiformis (H. B. Brady). Rhumbler, Archiv Protistenkunde, vol. 3, p. 245, text figs. 80a,b, 1903.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 15, pl. 1, figs. 7, 8, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 2, pl. 1, fig. 1, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 57, pl. 1, fig. 4, 1954.

There is some variation in the forms which have been placed in P. difflugiformis (H. B. Brady), but this appears reasonable in view of the morphological simplicity of this primitive arenaceous species.

Although often composed of somewhat finer sand grains, the Austin specimens are evidently the same as those identified by Cushman as P. difflugiformis (H. B. Brady) from Navarro strata of the American Gulf Coastal Plain.

In describing the new species, P. alexanderi

Loeblich and Tappan, from the Lower Cretaceous Kiowa shale of Kansas, the authors (1950, p. 5) evidently restricted P. *difflugiformis* (H. B. Brady) rigidly by characteristics specifically stated and illustrated in the original description. No mention was made of the variation heretofore accepted in the species by other workers nor of the relations of P. *alexanderi* Loeblich and Tappan to those forms formerly placed in, but forced from, P. *difflugiformis* (H. B. Brady) by rigid definition.

Such a rigid view of P. *difflugiformis* (H. B. Brady) may be both desirable and taxonomically proper, but it necessitates a complete re-examination of the species and related forms. Such a task is not within the scope of this report, and, therefore, the identification of these forms as P. *difflugiformis* (H. B. Brady) will be maintained.

Family AMMODISCIDAE

Genus AMMODISCUS Reuss, 1861

AMMODISCUS CRETACEUS (Reuss)

Plate 1, figure 2

Operculina cretacea Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 35, pl. 13, figs. 64, 65, 1845.
Cornuspira cretacea (Reuss). Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 177, pl. 1, fig. 1, 1860.
Cornuspira involvens (Reuss). W. Berry (not of Reuss), in Berry and Kelley, U. S. Nat. Mus., Proc., vol. 76, art. 19, p. 15, pl. 1, fig. 15, 1929.
Ammodiscus cretacea (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 10, p. 45, 1934.
Ammodiscus cretaceus (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 20, p. 2, pl. 1, fig. 2, 1944; U. S. Geol. Survey, Prof. Paper 206, p. 17,

pl. 1, fig. 35, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 2, pl. 1, fig. 3, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 245, pl. 21, fig. 1, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 58, pl. 1, fig. 15, 1954.
Ammodiscus cf. A. cretaceus (Reuss). Cushman, U. S. Geol. Survey, Prof. Paper 232, p. 4, pl. 1, fig. 3, 1951.

This finely arenaceous, smoothly finished, simply coiled species is recorded from the Lower Cretaceous to the Paleocene. It is uncommon in Austin samples.

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

REOPHAX CONSTRICTA (Reuss)

Plate 1, figure 3

Haplostiche constricta Reuss, in Geinitz, Palaeontographica, vol. 20, pt. 2, p. 122, pl. 24, figs. 9-12, 1874.
Reophax constrictus (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 20, p. 1, pl. 1, fig. 1, 1944; U. S. Geol. Survey, Prof. Paper 206, p. 16, pl. 1, figs. 21, 22, 1946 (see this reference for synonymy to 1946).
Reophax constricta (Reuss). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 57, pl. 1, fig. 6, 1954.

Each of some half-dozen samples from the middle Bonham formation supplied one or two poorly preserved specimens referable to this species. The figured specimen, the best preserved of the suite, is from sample FC-18, collected on a roadside two miles due south of Bonham.

This species can be distinguished from R. texanus Cushman and Waters, a Saratoga-Navarro form by its apertural neck, deeper constriction between adjacent chambers, somewhat more elongate chambers, and smaller size.

REOPHAX HARRISI n. sp.

Plate 1, figure 4

Test regularly uniserial, slightly arcuate and slightly tapering, chambers spherical, neither overlapping nor attenuate; wall coarsely agglutinated, composed of calcite prisms from the prismatic layer of pelecypod shells, with calcareous cement; aperture terminal at the end of a short neck; length 1.87 mm., diameter .50 mm.

This species is easily distinguished from others of the genus by the composition of the test wall, which is constructed of cement and prisms of calcite from the middle layer of pelecypod shells.

This form was recovered from chalk-marl sample DA-1 from the uppermost Austin chalk of Dallas County. Although only a single specimen was found in the sample, the characteristics are so distinctive that erection of the new species is permissible.

The specific name is erected in respect to Dr. R. W. Harris, Professor of Micropaleontology, University of Oklahoma.

Genus HORMOSINA H. B. Brady, 1879

HORMOSINA? sp.

Plate 1, figures 5, 6

Test strongly compressed, apparently because of collapse of crushed wall; smoothly finished and composed of very fine, uniform quartz grains with considerable calcareous cement; monothalmous and globular or polythalmous and uniserial; aperture terminal, at the end of a well developed neck; length .40 mm. to .80 mm., breadth .27 mm. to .40 mm.

This form occurred uncommonly in only three samples from the upper Bonham formation. All except one specimen were of the monothalmous type illustrated in Plate 1, figures 5a,b. However, the single polythalmous specimen, illustrated in Plate 1, figure 6, so closely resembles the monothalmous type that polythalmous structure must be inf inferred for the species, which must, therefore, be assigned to the Reophacidae. Furthermore, the neck is too well developed for assignment to the genus Reophax Montfort; consequently, the form is referred to Hormosina H. B. Brady, although it lacks the stoleniferous structure of occasional species of the genus.

The form is apparently a new species; but, because of the rarity of specimens, their poor state of preservation, and their rather generalized, simple, characteristics, it appears injudicious to assign it a specific name at this time.

Family LITUOLIDAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES FRASERI Wickenden

Plate 1, figures 7a,b

Haplophragmoides fraseri Wickenden, Royal Soc. Canada, Trans., 3rd ser., vol. 26, sec. 4, p. 86, pl. 1, figs. 2a,b, 1932.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 21, pl. 3, figs. 1a,b, 1946.
Trochamminoides proteus Karrer. White (not of Karrer), Jour. Paleontology, vol. 2, p. 308, pl. 42, fig. 2, 1928.

Test planispiral and umbilicate, somewhat evolute; periphery broad and well rounded; chambers distinct to indistinct, very gradually and regularly increasing in size, nine to eleven in the final whorl; sutures slightly curved, very slightly depressed; wall composed of very fine quartz grains and much calcareous cement, smoothly finished; aperture interio-marginal, a lunate opening at the base of the apertural face of the final chamber; color white to yellowish white; diameter .55 mm. to .75 mm., thickness .25 mm.

This species was described from the Upper Cretaceous Bearpaw formation of Canada. Austin specimens were found only in the Bonham formation. The much enlarged terminal chamber of the paratype illustrated by Cushman (1946, pl. 3, figs. 1a,b) was not displayed by any of the Austin specimens. It is not depicted in the type illustration nor mentioned in the original description, and it must be considered aberrant.

In Austin strata, these specimens resemble and accompany forms that have been identified by Cushman as Haplophragmoides coronata (H. B. Brady). It is likely that the two are related, and they may well be identical. The ramifications of this possible relation are discussed more fully in the remarks concerning the following species.

H. *irregularis* (White).

HAPLOPHRAGMOIDES IRREGULARIS (White)

Plate 1, figures 8, 9

Trochamminoides irregularis White, Jour. Paleontology, vol. 2, p. 307, pl. 42, fig. 1, 1928.
Haplophragmoides coronata (H. B. Brady). Cushman (not of Brady), U. S. Geol. Survey, Prof. Paper 206, p. 20, pl. 2, figs. 20-22, 1946.

This species is unquestionably the same as that identified as H. *coronata* (H. B. Brady) by Cushman. As he mentions (1946, p. 20), the specimens are usually badly distorted. However, some fairly well preserved specimens occur in Austin strata, and they reveal that the apparent specific coronate character is a result of chamber distortion; accordingly, assignment to Brady's species is erroneous. Also it is evident that these forms are, as Cushman stated (*ibid*.), planispirally haplophragmoid rather than trochoid, as suggested by White in *Trochamminoides irregularis* White.

As suggested in remarks concerning the preceding species, H. *fraseri* Wickenden may well be conspecific with H. *irregularis* (White), in which case the latter specific name would possess priority. However, White's species is inadequately described and poorly illustrated; consequently, it appears advisable to maintain the two forms.

Haplophragmoides irregularis (White) has been reported from the Upper Cretaceous of Mexico and Trinidad.

Austin specimens are restricted to the Bonham formation.

Genus AMMOBACULITES Cushman, 1910

AMMOBACULITES BOONI n. sp.

Plate 1, figures 10a,b

Test clavate; early portion planispiral, possibly partially evolute, with rounded periphery, smaller than remainder of test, later portion uniserial and cylindrical; five or six chambers in uniserial portion, globular and overlapping, indistinct, somewhat broader than high, increasing regularly in size and thereby producing the clavate form of test, final chamber highly vaulted terminally; sutures depressed; wall composed of very fine, well sorted, sub-angular to sub-rounded quartz grains and some cement, smoothly finished; aperture obscure, a small, rounded opening at the apex of the terminal chamber; color white to brownish white; length .87 mm., breadth .25 mm.

This form is similar to _A. fragmentarius_ Cushman, but the Austin form displays smoother finish as a result of its much finer sand grains and higher proportion of cement, and it lacks the flaky character of sand grains ascribed to _A. fragmentarius_ Cushman.

All specimens are more or less deformed by fossilization, a confusing factor in determination of details. However, the form is so unusual that it warrants description.

Ammobaculites booni n. sp. is confined to the Bonham formation.

The species is named for Professor J. D. Boon, Department of Geology, Arlington State College, Arlington, Texas.

Genus AMMOMARGINULINA Wiesner, 1931

AMMOMARGINULINA STEPHENSONI (Cushman)

Plate 1, figure 11

Ammobaculites stephensoni Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 49, pl. 5, figs. 2a,b, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 24, pl. 3, figs. 17a,b, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 62, pl. 2, figs. 26a,b, 1954.

Because of its strong compression in the plane of coiling, this species must be assigned to the genus *Ammomarginulina* Wiesner.

Sample FC-9 near the middle of the Bonham formation yielded two fragmentary specimens of this species.

The species has been recorded from many localities in the Taylor group of Texas and from Taylor strata of Arkansas. It has been recorded also from the Eagle Ford shale of Dallas County.

Genus FLABELLAMMINA Cushman, 1928

FLABELLAMMINA CLAVA Alexander and Smith

Plate 1, figure 12

Flabellammina clava Alexander and Smith, Jour. Paleontology, vol. 6, p. 304, pl. 45, figs. 12, 14, 1932.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 24, pl. 4, figs. 1, 2, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 63, pl. 3, figs. 11, 12, 1954.

Specimens of this species were found only in sample DA-1 from the uppermost Austin chalk of Dallas County.

The only previous record of the species also involves the upper part of the Austin chalk, but the form occurred considerably lower in the section than does sample DA-1.

Genus FRANKEINA Cushman and Alexander, 1929

FRANKEINA RUGOSISSIMA Alexander and Smith

Plate 1, figures 13a,b

Frankeina rugosissima Alexander and Smith, Jour. Paleontology, vol. 6, p. 311, pl. 47, figs. 12, 13, 1932.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 25, pl. 4, figs. 13, 14, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 65, pl. 4, figs. 4, 5, 1954.

This species was found only in sample DA-1 from the uppermost Austin chalk of Dallas County.

Its only previous record is from the lower Taylor marl of Travis County.

Family TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

"SPIROPLECTAMMINA" LAEVIS (Roemer) var. CRETOSA Cushman

Plate 1, figures 14a,b

Spiroplectammina semicomplanata (Carsey). Plummer (in part), Univ. Texas, Bull. 3101, pl. 8, fig. 8 (not fig. 7), 1931.
Spiroplectammina laevis (Roemer) var. cretosa Cushman, Cushman Lab. Foram. Research, Contr., vol. 8, p. 87, pl. 11, figs. 3a, b, 1932.
Kline, Mississippi State Geol. Survey, Bull. 53, p. 13 pl. 1, fig. 1, 1943.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 27, pl.

6, figs. 1-3, 1946 (see this reference for other synonymy to 1946).
Cushman and Todd, Cushman Lab. Foram. Research, Contr., vol. 22, p. 46, pl. 7, fig. 1, 1946.
Cushman, Maryland Dept. of Geology, Mines and Water Resources Bull. 2, p. 245, pl. 21, fig. 2, 1949; U. S. Geol. Survey, Prof. Paper 232, p. 6, pl. 1, fig. 24, 1951.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 9, pl. 1, fig. 11, 1951.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 66, pl. 4, figs. 24a,b, 1954.

According to Glaessner (1945, p. 98):

> The name _Spiroplectammina_ Cushman is often applied to textularid species in which the initial coil forms a considerable portion of the test. This name must be replaced by _Bolivinopsis_ Yakovlev, 1871 (Genotype _B. capitata_ Yakovlev = _Spiroplecta rosula_ Ehrenberg). In the genotype species of _Bolivinopsis_ the wall is arenaceous (Kalinin, 1937). It is indistinguishable in other features from _S. rosula_.

"_Spiroplectammina_" _laevis_ (Roemer) var. _cretosa_ Cushman has been reported from the Austin to the Paleocene, most commonly from Taylor strata. It is uncommon in Austin strata.

Family VERNEUILINIDAE

Genus TRITAXIA Reuss, 1860

TRITAXIA sp.

Plate 2, figures 1a,b

Test elongate, but not slender, triangular in transverse section, sides strongly concave, initial portion sharply pointed, but tapering rather rapidly and obtusely, mid-region with sides sub-parallel, final portion tapering gradually to a rather truncate terminus; chambers distinct, not inflated, enlarging regularly, but rapidly in the early portion, gradually in the mid-region, and decreasing in breadth in the final portion; sutures distinct, flush with the surface, weakly limbate, slightly and obliquely curved at an angle of approximately forty-five degrees to the vertical axis of the test; wall very finely arenaceous and smoothly finished; aperture indistinct, an irregularly oval opening in the flattened terminal face, slightly within the base of the apertural face.

Although this form appears to be a new species, the single specimen recovered from these samples is insufficient to erect a new species. The specimen occurred in sample BC-30 from the upper Bonham formation. In its triangular shape it resembles both T. pyramidata Reuss and T. tricarinata (d'Orbigny).

Genus GAUDRYINA d'Orbigny, 1839

GAUDRYINA AUSTINANA Cushman

Plate 2, figures 2a-c

Gaudryina (Siphogaudryina) austinana Cushman, Cushman Lab. Foram. Research, Spec. Publ. 6, p. 10, pl. 2, figs. 6a, b, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 35, pl. 8, figs. 5-7, 1946 (see this reference for synonymy to 1946).

Gaudryina (Siphogaudryina) austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 71, pl. 5, figs. 23a, b, 1954.

This common Austin species is readily recognized by its sharply quadrate, cross sectional shape, and broad, inclined chambers. It has been recorded from strata of Austin age in Texas, Arkansas, and Mississippi and from basalmost Taylor strata of Texas.

GAUDRYINA DALLASENSIS n. sp.

Plate 2, figures 4a,b

Test of medium size, early portion comprising one-fifth to two-fifths the length, very regularly triserial and comprising approximately four whorls, generally rapidly tapering and obtusely pointed, but occasionally more gradually tapering and acutely pointed, triangular in transverse section with flat faces, but with bluntly rounded angles, later portion regularly biserial, consisting of approximately eight chambers, cylindrical to oval in transverse section, sides parallel to slightly tapering; chambers of the triserial portion indistinct, those of the biserial portion low and broad; sutures of the triserial portion indistinct, those of the biserial portion deeply depressed; wall arenaceous, composed of poorly sorted sand grains with considerable cement, but roughly finished; aperture a high, semicircular, basal opening that extends well into the apertural face; length .90 mm., breadth .37 mm., thickness .30 mm.

The species can be distinguished from G. rudita Sandige by its better defined triserial portion, less tapering shape, lower and broader chambers, and deeply depressed sutures.

The specific name is derived from Dallas County, Texas.

GAUDRYINA ELLISORAE Cushman

Plate 2, figures 5a-c

Gaudryina (Pseudogaudryina) ellisorae Cushman, Cushman Lab. Foram. Research, Spec. Publ. 6, p. 13, pl. 2, figs. 12a,b, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 35, pl. 8, figs. 12, 13, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 72, pl. 5, figures 37a,b, 1954.

Although the species has been recorded from only one locality in the lower Taylor of Travis County, Texas, and one locality in the Selma chalk of Itawamba County, Mississippi, it is fairly common in the samples of this study. However, as Cushman has explained (1937, p. 74; 1946, p. 35), G. austinana Cushman closely resembles and apparently develops into G. ellisorae Cushman. Presumably G. ellisorae Cushman has been overlooked in the Austin because of confusion with its contemporary G. austinana Cushman.

GAUDRYINA FAUJASI (Reuss)

Plate 2, figures 6a,b

Textularia faujasi Reuss, Akad. Wiss. Wien., Math-naturwiss. Kl., Proc., vol. 44, p. 320, pl. 3, figs. 9a,b,1862.
Gaudryina faujasi (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 8, p. 91, 1932; U. S. Geol. Survey, Prof. Paper 206, p. 32, pl. 7, figs. 14a,b, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 70, pl. 5, figs. 12a,b, 1954.

The species has been recorded from the Vincetown marl of New Jersey, the Brownstown marl of Arkansas, and the Taylor marl of Texas. It is uncommon in Austin strata.

GAUDRYINA JOBEAE n. sp.

Plate 2, figures 7-10

Test small and slender, early portion comprising less than one-fourth the length, regularly triserial and involving approximately four whorls, moderately tapering and rather acutely pointed, tri-pyramidal with flat to slightly concave faces and rounded edges, later portion biserial, compressed and occasionally somewhat twisted, consisting of six to eight chambers, sides parallel; chambers of early portion indistinct, those of later portion approximately of equal thickness and height, but definitely broader, producing a thimble-like shape, markedly oblique to the long axis of the test; sutures indistinct in early portion, in later portion distinct and depressed, at an angle of forty-five degrees or more to long axis; wall arenaceous, composed of very fine quartz grains and much calcareous cement, smoothly finished; aperture a very large opening occupying virtually all of the apertural face, but separated slightly from the basal margin; length .50 mm. to .75 mm., breadth .22 mm. to .25 mm., thickness .15 mm. to .20 mm.

The peculiar, thimble-shaped, strongly oblique, uniserially tending chambers and slight twisting of the biserial portion are the distinguishing characteristics of this species. It is somewhat similar to G. panoides Wickenden, but it is larger and has a better defined, more regular, and less twisted biserial stage.

The species occurs in the Bonham formation.

The species is named for Mrs. Billye Irene Jobe, micropaleontologist for the Humble Oil and Refining Company, Tyler, Texas.

GAUDRYINA NEBRASCENSIS Loetterle

Plate 2, figures 11a,b

Gaudryina nebrascensis Loetterle, Nebraska Geol. Survey, Bull., ser. 2, no. 12, p. 20, pl. 1, figs. 3a,b, 1937.

In these samples this species appears to be a variety of G. austinana Cushman, into which the form apparently develops. Occasionally development is sufficient to justify identification as G. nebrascensis Loetterle, as illustrated in Plate 2, figures 11a,b.

Genus GAUDRYINELLA Plummer, 1931

GAUDRYINELLA BENTONENSIS (Carman)

Plate 2, figure 3

Spiroplectammina bentonensis Carman, Jour. Paleontology, vol. 3, p. 311, pl. 34, figs. 8, 9, 1929.
Gaudryinella bentonensis (Carman). Cushman, Cushman Lab. Foram. Research, Contr., vol. 8, p. 96, 1932; U. S. Geol. Survey, Prof. Paper 206, p. 33, pl. 7, figs. 15, 16, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 70, pl. 5, figs. 14a,b, 1954.

The species was originally described from the Benton shale of Wyoming and has been recorded from strata of Austin and Taylor age in Alabama, Arkansas, and Texas. Although occuring fairly often in Austin strata of Fannin and

Collin Counties, this form was not found in the Austin of Dallas County; consequently, doubt is cast on the reported (but questioned) occurrence in the Eagle Ford of Dallas County (Cushman, 1946, p. 33).

GAUDRYINELLA FREDERICKSONI n. sp.

Plate 2, figures 16-18

Test elongate, but stout, early portion triserial, its three whorls comprising one-fifth or less of the total length, weakly tri-pyramidal with convex faces, rounded edges and obtuse apex, later portion biserial, occasionally somewhat loosely so, cylindrical and expanding, final portion irregularly uniserial; chambers of triserial portion very obscure, those of intermediate and final portions inflated, somewhat irregular in size and in rate of growth in larger and better developed specimens; sutures of triserial portion very obscure, of adult stage distinct and deeply depressed; wall arenaceous, composed of very fine quartz grains and much calcareous cement, smoothly finished except for occasional incrustations of larger quartz grains; terminal aperture large and circular; length .62 mm. to .87 mm., breadth .25 mm. to .37 mm., thickness .20 mm. to .30 mm.

Several specimens of this distinctive species were recovered approximately one hundred feet above the base of the Gober chalk. Associated with them were such undeveloped specimens as illustrated in Plate 2, figures 16a-c. These ~~appear to be merely less developed specimens of the type~~

and, except for a more rounded triserial portion and a smoother finish, are also similar to _G_. _shuleri_ n. sp. Consequently, it is suggested that _G_. _fredericksoni_ n. sp. is closely related to, if not derived from, _G_. _shuleri_ n. sp.

Gaudryinella fredericksoni n. sp. is readily distinguished from _G_. _pseudoserrata_ Cushman, its nearest affinity, by its lack of compression, its lack of markedly lobulate periphery, and its smooth finish.

This species is named for Dr. E. A. Frederickson, Professor of Paleontology, University of Oklahoma.

GAUDRYINELLA SHULERI n. sp.

Plate 2, figures 12-15

Test elongate but stout, early portion triserial, tri-pyramidal, faces generally flat, but occasionally slightly convex or concave, edges rounded, apex somewhat acute, later portion biserial, comprising approximately one-half the length and including two or more pairs of chambers, cylindrical to elliptical in transverse section, expanding aperturally, with uniserial tendency, final portion uniserial, including one or two chambers and comprising one-fourth the length, cylindrical to elliptical in transverse section; chambers of triserial portion obscure, those of later and final portions increasing regularly and gradually in size, inflated, equidimensional; sutures of triserial portion obscure, those of biserial and uniserial portions distinct and depressed; wall arenaceous, gradually in size; sutures of early portion obscure, those of later and final portions distinct, depressed; wall arenaceous, composed of very fine quartz grains and much calcareous cement, varying from smoothly to rather roughly finished; terminal aperture large and circular; length .55 mm., breadth .20 mm., thickness .18 mm.

This species is similar in size and general appearance to Pseudoclavulina clavata (Cushman), but lacks the greatly reduced biserial and extended uniserial stages typical of the microspheric form of that species. The similarity suggests that P. clavata (Cushman) may be derived from Gaudryinella sp., but P. clavata (Cushman) was not found below the upper Austin, whereas G. sp. was not found above the lower Austin.[1] The resulting gap in the ranges of these species casts doubt upon their apparent relation.

This form is uncommon in the lower Austin of Dallas County and is rare in the lower Austin elsewhere. It appears to be new, but all except the illustrated specimen are severely abraded, and determination of characteristics is difficult. Accordingly, a new name will not be assigned.

---

[1]The record of P. clavata (Cushman) from the "Ector" of Grayson County (Cushman, 1946, p. 36) is questionable. The fauna recorded for this locality is marked by several species whose first occurrence is manifestly much higher in the section.

Genus PSEUDOCLAVULINA Cushman, 1936

PSEUDOCLAVULINA CLAVATA (Cushman)

Plate 2, figure 20

Clavulina clavata Cushman, Am. Assoc. Petr. Geol., Bull. vol. 10, p. 589, pl. 17, fig. 4, 1926.

Pseudoclavulina clavata (Cushman). Cushman, Cushman Lab. Foram. Research, Spec. Publ. 7, p. 108, pl. 15, figs. 1-13, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 36, pl. 8, figs. 22-31, pl. 9, figs. 1, 2, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 246, pl. 21, fig. 7, 1949.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 72, pl. 5, figs. 32, 33, 1954.

This distinctive species occurs in several horizons of the Gober chalk, but in only the uppermost Austin chalk of Collin and Dallas Counties. It has been widely recorded from the Upper Cretaceous of the Gulf Coastal Plain of the United States and from Mexico and Peru.

Genus PSEUDOGAUDRYINELLA Cushman, 1936

PSEUDOGAUDRYINELLA CAPITOSA (Cushman)

Plate 2, figure 21

Gaudryinella capitosa Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 52, pl. 5, figs. 8a-c, 1933.

Pseudogaudryinella capitosa (Cushman). Cushman, Cushman Lab. Foram. Research, Spec. Publ. 7, p. 139, pl. 19, fig. 12, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 40, pl. 10, figs. 15-19, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 247, pl. 21, fig. 8, 1949.

Pseudogaudryinella capitosa Cushman var. serrulata Cushman, Cushman Lab. Foram. Research, Spec. Publ. 7, p. 140, pl. 19, figs. 13-16, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 40, pl. 10, figs. 20-23, 1946 (see this reference for synonymy to 1946).

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 73, pl. 6, figs. 8a,b, 1954.

Pseudogaudryinella capitosa (Cushman) var. capitosa (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 73, pl. 6, figs. 7a,b, 1954.

Pseudogaudryinelline Austin forms display such variations in characteristics supposedly diagnostic that the writer discovers it impossible to differentiate between the type P. capitosa (Cushman) and the variety P. capitosa (Cushman) var. serrulata (Cushman). Consequently, the writer considers the variety invalid and abandons it in this report.

Pseudogaudryinella capitosa has been recorded from strata of upper Austin and Taylor age in Texas, Arkansas, and Mississippi. This study reveals that it occurs in the upper Bonham and the Gober formations of Fannin County, but is restricted to the uppermost Austin chalk of Collin and Dallas Counties.

Genus HETEROSTOMELLA Reuss, 1865

HETEROSTOMELLA AUSTINANA Cushman

Plate 2, figure 24

Heterostomella austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 53, pl. 6, figs. 1-3, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 41, pl. 11, figs. 2-7, 1946 (see this reference for synonymy to 1946); Maryland Dept of Geology, Mines and Water Resources, Bull. 2, p. 247 (no illustration), 1949.

Heterostomella austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 74, pl. 6, figs. 12a,b, 1954.

This species has been recorded from Austin and lower Taylor strata of Texas. It is uncommon in the Austin. The record from the "Ector" of Grayson County is questionable (see footnote 1, p. 30).

Family VALVULINIDAE

Genus ARENOBULIMINA Cushman, 1927

ARENOBULIMINA AMERICANA Cushman

Plate 2, figures 22a,b

Arenobulimina presli (Reuss). Cushman (not Bulimina preslii Reuss), Jour. Paleontology, vol. 5, p. 303, pl. 34, figs. 13a,b, 1931.
Arenobulimina americana Cushman, Cushman Lab. Foram. Research, Spec. Publ. 6, p. 27, pl. 4, figs. 9a,b, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 42, pl. 12, figs. 1a,b, 1946 (see this reference for synonymy to 1946); Cushman Lab. Foram. Research, Contr., vol. 23, p. 7, pl. 2, fig. 9, 1947; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 247, pl. 21, fig. 14, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 74, pl. 6, figs. 13a,b, 1954.

This species has been widely recorded from the Upper Cretaceous (Senonian) of the Gulf Coastal Plain of the United States and Mexico. It is fairly common in the Austin.

Genus MARSSONELLA Cushman, 1933

MARSSONELLA OXYCONA (Reuss)

Plate 2, figure 23

Gaudryina oxycona Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 229, pl. 12, fig. 3, 1860.
Marssonella oxycona (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 36, pl. 4, figs. 13a,b, 1933.
Bandy, Jour. Paleontology, vol. 25, p. 492, pl. 72, figs. 8a,b, 1951 (see this reference for synonymy to 1951).
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 11, pl. 2, fig. 12, 1951.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv.

no. 22, p. 75, pl. 6, figs. 17a,b, 1954.

This species has been widely recorded from the Lower Cretaceous to the Paleocene in Europe, North America, and South America. It is fairly common in the Austin.

Genus DOROTHIA Plummer, 1931

DOROTHIA? ALEXANDERI Cushman

Plate 3, figures 1-3

Dorothia alexanderi Cushman, Cushman Lab. Foram. Research, Spec. Publ. 6, p. 28, pl. 4, figs. 13a, b, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 45, pl. 12, fig. 15, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 75, pl. 6, figs. 18a,b, 1954.

This species was originally assigned to the genus Dorothia Plummer. The writer has examined scores of specimens of the species, but has never seen one displaying four or more initial chambers. However, several specimens clearly exhibit three initial chambers in the earliest stage of an acuminate, strongly triserial juvenile portion, such as is typical of Gaudryina d'Orbigny. Consequently, the writer questions the assignment of this species to Dorothia Plummer.

As Cushman notes (1946, p. 45), this species displays great variation in characteristics. In fact, the extremes of variation are sufficiently dissimilar that end members seem properly separable as two varieties. But it is so difficult, when "running" a series of samples of a stratigraphic section, to determine varietal boundaries of a given species, that the writer is reluctant to establish new varieties. However, it has been observed that the large, rugose, obese form, such as is illustrated in Plate 3, figures 2, 3, is characteristic of the upper Austin group, and especially of the chalkier beds therein.

Dorothia? alexanderi Cushman is one of the most common Austin species. Its only record of occurrence other than in the Austin is from the lowermost Taylor of Williamson County, Texas.

DOROTHIA STEPHENSONI Cushman

Plate 3, figures 4a,b

Dorothia stephensoni Cushman, Cushman Lab. Foram. Research, Spec. Publ. 6, p. 28, pl. 4, fig. 15, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 45, pl. 12, figs. 16, 17, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 76, pl. 6, fig. 23, 1954.

Dorothia stephensoni occurs widely in the Upper Cretaceous of the Gulf Coastal Plain, especially in Texas. It occurs throughout the Austin section in Fannin County, but is restricted to the middle and upper Austin of Dallas and Collin Counties.

DOROTHIA? sp.

Plate 3, figures 5a-c

Test elongate but stout; early portion comprising one-fourth or less the total length, trochospiral, roundly conical and obtuse, initial whorl apparently (but not positively) quadriserial, followed by two or three triserial whorls, later and larger portion biserial, including three or four pairs of chambers, slightly tapering to parallel; chambers initially obscure,but rapidly becoming distinct, increasing gradually in size and inflation, approximately equidimensional; sutures initially obscure, rapidly becoming distinct, gradually becoming more depressed, horizontal to slightly oblique; wall essentially of calcareous cement, with some very fine quartz grains, smoothly finished and polished; aperture large, broad and high, extending from the base well into the somewhat flattened apertural face; length .57 mm., breadth .30 mm., thickness .25 mm.

This species most closely resembles Dorothia conulus (Reuss) Cushman, but differs in possessing a better developed biserial stage, a large, high aperture, and higher, more inflated chambers. Perhaps because of its very small size, the dorothian initial stage could not be observed satisfactorily. Consequently, although apparently a new species, its generic status is questioned and no specific name will be assigned.

Family ORBITOLINIDAE

Genus POLYPHRAGMA Reuss, 1871

POLYPHRAGMA sp.

Plate 3, figures a,b

Cushman (1946, p. 51) has identified as Polyphragma sp. some incomplete, uniserial, arenaceous forms from Austin, Taylor, and Navarro strata of Texas. Fragmentary specimens of this form are common in the Austin of Travis County but are uncommon elsewhere.

Family LAGENIDAE

Genus LENTICULINA Lamarck, 1804

LENTICULINA KANSASENSIS Morrow?

Plate 3, figures 7a,b

Lenticulina kansasensis Morrow, Jour. Paleontology, vol. 8, p. 189, pl. 30, figs. 23a,b, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 56, pl. 18, figs. 15a,b, 1946 (see this reference for synonymy to 1946).

Specimens in the basal Austin appear conspecific with the type species from Kansas, although they are poorly preserved.

LENTICULINA MÜNSTERI (Roemer)

Plate 3, figures 8-12

Robulina münsteri Roemer, Verstein. norddeutschen Oolithengebirges, Nachtrag., p. 48, pl. 20, fig. 29, 1839.
Cristellaria münsteri (Roemer). Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 46, p. 77, pl. 9, figs. 3, 4, 1863.
Robulus münsteri (Roemer). Cushman, Jour. Paleontology, vol. 6, p. 334, pl. 50, figs. 2a,b, 1932; U. S. Geol. Survey, Prof. Paper 206, p. 53, pl. 17, figs. 3-9, 1946 (see this reference for synonomy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 4 (no illustration), 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 81, pl. 8, figs. 1-4, 1954.
Lenticulina münsteri (Roemer). Dam, Jour. Paleontology, vol. 22, p. 176 (list), 1948.

The writer has been unable to detect a definite, robuline, keyhole aperture on specimens from Austin samples and, accordingly, considers this species referable to the genus Lenticulina Lamarck. Dam (1948, p. 176) has so allocated the species in a faunal list.

Lenticulina münsteri (Roemer) has been recorded from the Upper Cretaceous of Texas, Arkansas, Mississippi, and Tennessee. It is rather common in middle and upper Austin strata in the area of this report. It appears to range throughout the Austin sequence in Travis County, the type locality.

Plate 3, figures 10-12, depict peculiar forms of L. münsteri (Roemer) which have fewer and much reduced initial chambers in the final whorl. These forms occur with the normal form and may be simply abraded specimens, although some display no definite signs of abrasion.

"LENTICULINA ROTULATA (Lamarck)"

Plate 3, figure 13

?Lenticulites rotulata Lamarck, Mus. Nat. d'Histoire Naturelle, Ann., vol. 5, p. 188, 1804.

Cristellaria rotulata (Lamarck) d'Orbigny, Soc. géol. France, Mem., 1st ser., vol. 4, p. 26, pl. 2, figs. 16-18, 1840.

Carsey, Univ. Texas, Bull. 2612, p. 39, pl. 6, fig. 2, 1926.

Plummer, Univ. Texas, Bull. 2644, p. 91, pl. 7, figs. 8a,b, 1927.

Lenticulina rotulata (Lamarck). Plummer, Univ. Texas, Bull. 3101, p. 142, pl. 11, figs. 20a,b, 1931.

Kline, Mississippi Geol. Survey, Bull. 53, p. 21, pl. 1, fig. 4, 1943.

Cushman (in part), U. S. Geol. Survey, Prof. Paper 206, p. 56, pl. 19, figs. 1-5 (not figs. 6, 7; pl. 18, figs. 19a,b), 1946.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 82, pl. 8, fig. 14, 1954.

Lenticulina cf. rotulata (Lamarck). Cushman, U. S. Geol. Survey, Prof. Paper 221-A, p. 4, pl. 2, fig. 8, 1949. Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 18, pl. 3, fig. 12, 1951.

The very common Austin form assigned to this species is close-coiled, but the radius of coiling expands in the final whorl, and the chambers, consequently, increase in height. This results in an apparent crowding of early sutures of the final whorl. The sutures are raised in the initial portion of the final whorl, but they decrease in relief terminally and often become flush in the final chamber. They join tangentially the large, well defined umbo and are very slightly curved. The test varies somewhat in thickness. The form is rather stout, occasionally obese, but the fairly straight sutures cause it to appear thinner in illustrations than in actuality. On well preserved specimens the keel is broad, although most specimens have preserved only a moderate keel. No keyhole aperture was observed.

This is the form which Cushman (1946) identified as L. rotulata (Lamarck), but which Bandy (1951, p. 493, pl. 72, figs. 5a,b) placed in synonymy with Robulus pseudocultratus Cole. Although resembling the latter, the Austin species has raised sutures and taller chambers and, consequently, a larger apertural face. Furthermore, it is primarily a Cretaceous form, although it has been found rarely in Paleocene strata -- where it may not be indigenous --

while R. pseudocultratus Cole is an Eocene type. Consequently, the writer cannot confidently accept Bandy's assignment of this form and deems it judicious to maintain the earlier designation of Cushman and others as L. rotulata (Lamarck).

Genus ASTACOLUS Montfort, 1808

ASTACOLUS TAYLORENSIS Plummer

Plate 3, figures 14a-c

Cristellaria gibba d'Orbigny. Carsey (not of d'Orbigny), Univ. Texas, Bull. 2612, p. 37, pl. 5, fig. 4, 1926.
Astacolus taylorensis Plummer, Univ. Texas, Bull. 3101, p. 143, pl. 11, fig. 16, pl. 15, figs. 8-11, 1931.
Robulus taylorensis (Plummer). Cushman, Cushman Lab. Foram. Research, Contr., vol. 17, p. 57, pl. 15, fig. 5, 1941; U. S. Geol. Survey, Prof. Paper 206, p. 53, pl. 18, figs. 20a,b, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 81, pl. 8, figs. 11a,b, 1954.

Inasmuch as this species displays characteristic uncoiling and has no keyhole aperture, there is no apparent reason for assigning it to the genus Robulus Montfort. Furthermore, Mrs. Plummer's original generic designation of Astacolus Montfort has even recently been said to be "available for tests which become evolute in the adult stage and have an aperture of the Lenticulina-type" (Glaessner, 1945, p. 129).

Most records of this species involve strata of lower Taylor age of Texas. There are a few accounts of its occurrence from upper Taylor beds of Texas and Arkansas and from upper Taylor equivalents in Alabama. Several specimens were found in the single Sample 1 of station F-2, which was collected ten feet below the top of the Gober chalk in Fannin County.

Genus RIMALINA Perebaskine, 1946

"RIMALINA" GOBERANA n. sp.

Plate 9, figures 6a-c

Test marginuline, compressed initially but expanding rapidly to subglobular terminal chamber which composes one-half to three-fourths the test, initial portion displaying slight, but definite, characteristics of coiling, later portion rectilinear and globular; four to five overlapping chambers, initially compressed, broad and uncoiling in an arcuate series, rapidly becoming subglobular and rectilinear; sutures faint, flush and sinusoidally curved, bending aperturally at the dorsal margin and conversely at the ventral margin; surface smooth and vitreous; aperture a slit parallel to the plane of coiling, with radiate margins, height .50 mm., breadth .30 mm., thickness .27 mm.

The nearest affinity to this species is Rimalina pinatensis Perebaskine, which can be distinguished readily from "R." goberana n. sp. by its much greater development of the coiled stage, its medial ridges on the apertural face, its evenly curved, aperturally convex sutures, and its regularly expanding chambers.

In the erection of Rimalina Perebaskine, the author made no mention of its relation to Rimulina d'Orbigny, which closely resembles and, because of its abbreviated and general definition, includes the former. However, d'Orbigny's genotype, Rimulina glabra d'Orbigny, displayed no definite sign of initial coiling, was essentially dentaline, and was compared, in fact, with Dentalina d'Orbigny. In addition it possessed a slit-like aperture, located on the dorsal margin of the final chamber and centered some distance from the apex of the test. No mention was made of the aperture being radiate, and there was no indication of such character displayed by the original illustrations. Consequently, the writer prefers to assign the Austin form to the more fully described and apparently more similar genus Rimalina Perebaskine.

This species was found at several localities in the Gober chalk, but was confined to the uppermost Austin of Collin and Dallas Counties. It is uncommon at all localities.

The species is named for the Gober formation of Fannin County, Texas.

Genus SARACENARIA Defrance, 1824

SARACENARIA TRIANGULARIS (d'Orbigny)

Plate 3, figures 19a-c

Cristellaria triangularis d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 27, pl. 2, figs. 21, 22, 1840.
Saracenaria triangularis (d'Orbigny). Cushman and Church, California Acad. Sci., Proc., 4th ser., vol. 18, p. 505, pl. 37, figs. 13, 14, 1929.
Bandy, Jour. Paleontology, vol. 25, p. 494, pl. 72,

figs. 11a,b, 1951 (see this reference for synonymy to 1951).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 83, pl. 8, figs. 28a,b, 1954.

This species has been widely recorded from the Upper Cretaceous. It is uncommon in a number of samples from the middle and upper Austin.

Genus PLANULARIA Defrance, 1824

PLANULARIA COLLINENSIS n. sp.

Plate 3, figures 15-18

Test initially planispiral, becoming evolute and compressed, strongly umbonate, periphery acute and carinate; chambers numerous, ten to twelve in final whorl; sutures flush with surface of test, strongly limbate, straight and tangential, umbo large, very prominent and limbate; entire test quite glassy; aperture radiate at the peripheral angle; height .52 mm., breadth .32 mm., thickness .18 mm.

Plate 3, figures 15, 16, display the planispiral type from which this species develops and which may be the megalospheric stage. These are similar to Robulus sternalis Berthelin, from the Lower Cretaceous, but the Austin form bears a less prominent keel, smaller umbones, and more chambers per whorl.

Planularia collinensis n. sp. is apparently restricted to middle Austin strata, where it is uncommon.

The specific name is derived from Collin County, Texas.

PLANULARIA PLANOTROCHIFORMIS Hussey and McNulty

Plate 4, figures 2a,b

<u>Planularia planotrochiformis</u> Hussey and McNulty, Jour. Paleontology, vol. 24, p. 472, figs. 1-9, 1950.

A single specimen of this species was found in Sample 1 of station F-14 from the middle Gober of Fannin County. The species was reported originally from the Navarro.

PLANULARIA UMBONATA Loetterle

Plate 4, figures 1a,b

<u>Planularia umbonata</u> Loetterle, Nebraska Geol. Survey, 2nd ser., Bull. 12, p. 23, pl. 2, figs. 2a,b, 1937.

This species was described originally from the Niobrara chalk, where it is uncommon. It occurs fairly frequently in lower Austin strata of Dallas and Collin Counties, but was found in only the lowermost Bonham of Fannin County.

Genus MARGINULINOPSIS Silvestri, 1904

MARGINULINOPSIS STEPHENSONI (Cushman)

Plate 4, figures 3a,b

<u>Marginulina stephensoni</u> Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 93, pl. 13, figs. 10, 11, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 59, pl. 20, figs. 25, 26, 1946 (see this reference for synonymy to 1946).

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 85, pl. 9, figure 18, 1954.

The variably developed, but conspicuous coiled, stage of this form necessitates its transference from <u>Marginulina</u> d'Orbigny to <u>Marginulinopsis</u> Silvestri.

Most records of this species are of specimens from Taylor strata of Texas. In addition, the species has been reported from the Marlbrook marl of Arkansas, the Ripley formation of Tennessee, and uppermost Austin strata of Dallas County, Texas. It was found at one locality in the Bonham and throughout the Gober formation of Fannin County.

Genus MARGINULINA d'Orbigny, 1826

MARGINULINA AUSTINANA Cushman

Plate 4, figures 4, 5

Marginulina austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 92, pl. 13, figs. 1-4, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 59, pl. 20, figs. 5-10, 1946.

Marginulina austiniana Cushman var. austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, figs. 32, 33, 1954.

Plate 4, figures 5a,b, illustrate the planispiral type of this species. It is considered to be the megalospheric stage and was found to be most common in samples from Fannin County.

The record of this species confines it to strata of Austin age in Texas. It occurs throughout the Austin in Fannin County, but was not found in the lower Austin of Collin and Dallas Counties.

MARGINULINA BULLATA Reuss

Plate 4, figures 12a,b

Marginulina bullata Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 29, pl. 13, figs. 34-38, 1845.
Bandy, Jour. Paleontology, vol. 25, p. 498, pl. 72, figs. 13a,b, 1951 (see this reference for synonymy to 1951).

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, figs. 34-36, 1954.

This species is distinguished by its peculiar, bulbous, terminal chambers and cylindrical, apertural neck. It has been recorded from the Upper Cretaceous of Europe and the North American Gulf Coastal Plain, but it has not been reported heretofore from the Austin. It is very uncommon in the Gober chalk of Fannin County and in the uppermost Austin of Collin and Dallas Counties.

MARGINULINA CRETACEA Cushman

Marginulina intermedia (Philippi). Cushman (not Planularia intermedia Philippi), Jour. Paleontology, vol. 6 p. 334, pl. 50, figs. 4a,b, 1932.

Marginulina cretacea Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 94, pl. 13, figs. 12-15, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 61, pl. 21, figs. 16-20, 39, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 250, pl. 21, fig. 22, 1949.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, figs. 37-39, 1954.

There are numerous reports of this species from the Taylor and one from the Navarro. It has not been reported previously from Austin strata. It was found in only the uppermost Gober chalk of Fannin County, where it is uncommon.

MARGINULINA CURVATURA Cushman?

Plate 4, figures 9a,b

Marginulina curvatura Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 34, pl. 5, figs. 13, 14, 1938.

Cushman and Todd, Cushman Lab. Foram. Research, Contr., vol. 19, p. 56, pl. 10, fig. 3, 1943.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 63, pl. 22, figs. 11-14, 1946; U. S. Geol. Survey, Prof. Paper 221-A, p. 5, pl. 2, fig. 13, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, figs. 40, 41, 1954.

Occasional specimens from the Gober of Fannin County and the uppermost Austin of Collin County are provisionally assigned to this species. They do not display the strong curvature exhibited by some representatives of the species, but do resemble the slightly curved holotype. Previous records of the species have confined it to Navarro strata.

MARGINULINA DIRECTA Cushman

Plate 4, figure 6

Marginulina _austinana_ Cushman var. _directa_ Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 93, pl. 13, figs. 5-8, 1937.
Marginulina _directa_ Cushman. Bandy, Jour. Paleontology, vol. 25, p. 498, pl. 73, figs. 1a,b, 1951 (see this reference for synonymy to 1951).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, figs. 42,43, 1954.

There are numerous records of occurrences of this species from Austin and lower Taylor strata of Texas. It was found to be common in Dallas County, uncommon to rare in Collin County, and missing in Fannin County, although it has been recorded from single localities in the Bonham and the Gober of Fannin County. Its distribution appears complementary to that of _M._ _austinana_ Cushman, which is most common in Fannin County and decreases southwardly.

MARGINULINA INCONSTANTIA Cushman

Plate 4, figures 7a,b

Marginulina inconstantia Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 33, pl. 5, figs. 4-9, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 59, pl. 20, figs. 18-23, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 84, pl. 8, fig. 46, 1954.

This species has been reported from only three localities in the lowermost Taylor strata of Dallas County. It is uncommon in Austin strata, occurring at a few localities in the Gober chalk of Fannin County and at one locality in the uppermost Austin chalk of Collin County.

MARGINULINA PSEUDOMARCKI Cushman

Plate 4, figures 8a,b

Marginulina pseudomarcki Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 94, pl. 13, figs. 19, 20, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 60, pl. 20, figs. 27, 28, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 85, pl. 9, fig. 20, 1954.

This species is known only from its type locality in the upper Taylor of Travis County, Texas. Uncommon but very good specimens were found at several horizons in the upper Austin of Dallas County.

MARGINULINA TEXASENSIS Cushman

Plate 4, figures 10, 11

Marginulina elongata d'Orbigny. Cushman (not of d'Orbigny), Jour. Paleontology, vol. 5, p. 304, pl. 35, figs. 6a,b, 1931.
Marginulina modesta Reuss. Cushman and Jarvis (not of Reuss), U. S. Nat. Mus., Proc., vol. 80, art. 14, p. 26, pl. 8, figs. 6a,b, 1932.

Marginulina texana Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 95, pl. 14, figs. 1-4, 1937.
Marginulina texasensis Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 95, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 61, pl. 21, figs. 21-29, 38, 40, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 86, pl. 9, figs. 24, 25, 1954.

This species has been recorded from Taylor and Navarro strata of Texas, Arkansas, and Mississippi. It is very uncommon in the Austin, a few specimens occurring in a locality from the upper Gober of Fannin County and another from the uppermost Austin of Dallas County.

Genus DENTALINA d'Orbigny, 1826

"DENTALINA ACULEATA d'Orbigny"

Plate 4, figure 13

?Nodosaria (Dentalina) aculeata d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 13, pl. 1, figs. 2, 3, 1840.
Lagena incidenta Carsey, Univ. Texas, Bull. 2612, p. 30, pl. 4, fig. 12, 1926.
Dentalina aculeata d'Orbigny. Cushman, Jour. Paleontology, vol. 6, p. 335, pl. 50, fig. 7, 1932; Cushman Lab. Foram. Research, Contr., vol. 20, p. 6, pl. 2, fig. 11, 1944; U. S. Geol. Survey, Prof. Paper 206, p. 67 (in part), pl. 26, fig. 17 (not fig. 18), 1946; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 251, pl. 22, fig. 8, 1949.
Bandy, Jour. Paleontology, vol. 25, p. 499, pl. 73, fig. 4, 1951.
Dentalina aculeata (?) (d'Orbigny). Kline, Mississippi State Geol. Survey, Bull. 53, p. 23, pl. 2, fig. 1, 1943.
Ramulina aculeata (d'Orbigny) Wright. Cushman (not of Wright), Cushman Lab. Foram. Research, Contr., vol. 23, p. 13, pl. 4, figs. 4-8, 1947.
Dentalina aculeata (d'Orbigny)? Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 86, pl. 9, fig. 27, 1954.

Fragmentary specimens with a densely rugose, oval chamber and opposed, stoleniferous extensions have frequently been assigned to d'Orbigny's species. This form is fairly common in Austin strata.

DENTALINA ALBRITTONI n. sp.

Plate 4, figures 15a,b

Test elongate, tapering, arcuate; chambers seven to nine, distinct, rapidly enlarging, more so in height than in breadth; sutures distinct, oblique, inclined toward concave arch; aperture attenuate, possibly radiate, terminal, but offset toward convex side of arch; length .55 mm., thickness .09 mm.

This species is characterized by its attenuate aperture, offset toward convex arch of test, its oblique sutures inclined toward concave arch of test, its lack of definite initial coiling, and its slender outline.

Curiously, some forms described under the genus Cristellaria Lamarck closely resemble the new species, for example, C. luna Karrer. However this closest affinity can be distinguished from D. albrittoni n. sp. by its more arcuate form, more tapering initial portion, and more numerous chambers.

Dentalina albrittoni n. sp. is confined to the Bonham formation of Fannin County.

This species is named for Dr. C. C. Albritton, Jr., Dean of the College of Arts and Sciences, Southern Methodist University.

DENTALINA ALTERNATA (Jones)

Plate 4, figure 14

Nodosaria zippei Reuss var. alternata Jones, in Wright, Belfast Nat. Field Club, Proc., 1884-85, App. 9, p. 330, pl. 27, fig. 10, 1886.
Nodosaria alternata Carsey (as a new species, synonym and homonym), Univ. Texas, Bull. 2612, p. 35, pl. 4, fig. 7, 1926.
Nodosaria intercostata Reuss. Cushman (not of Reuss), Tennessee Div. Geol., Bull. 41, p. 31, pl. 4, figs. 1, 2, 1931.
Nodosaria affinis Reuss. Cushman (in part) (not of Reuss) Jour. Paleontology, vol. 5, p. 305, pl. 35, fig. 2 (not figs. 3-5), 1931.
Dentalina alternata (Jones). Plummer, Univ. Texas, Bull. 3101, p. 153, pl. 11, fig. 7, 1931.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 64, pl. 22, figs. 29-33, 1946 (see this reference for additional synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 250, pl. 22, fig. 3, 1949.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 20, pl. 4, fig. 5, 1951.
Dentalina pinnigera Sandige, Jour. Paleontology, vol. 6, p. 274, pl. 42, figs. 11, 12, 1932.
Dentalina? alternata (Jones). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 86, pl. 9, figs. 28, 29, 1954.

This species has been recorded frequently from the Gulf Coastal Plain from strata ranging from the upper Austin to the Paleocene. It occurs uncommonly in the Gober chalk of Fannin County and in a single sample from the uppermost Austin of Collin County.

DENTALINA DELICATULA Cushman

Plate 4, figure 16

Nodosaria obliqua (Linné). Carsey (not of Linné), Univ. Texas, Bull. 2612, p. 35, pl. 2, fig. 6, 1926.
Dentalina obliqua (Linné). Plummer (not of Linné), Univ. Texas, Bull. 3101, p. 153, pl. 11, fig. 6, 1931.
Dentalina delicatula Cushman, Cushman Lab. Foram. Research,

Contr., vol. 14, p. 40, pl. 6, figs. 19, 20, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 70, pl. 25, figs. 1-6, 1946 (see this reference for additional synonymy to 1946).
Kline, Mississippi State Geol. Survey, Bull. 53, p. 24, pl. 2, fig. 4, 1943.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 21, pl. 4, fig. 10, 1951.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 88, pl. 9, figs. 46, 47, 1954.

This species has been recorded from the Navarro and the Paleocene. It occurs rather frequently in the Bonham and Gober of Fannin County, but at a single locality in the uppermost Austin of Collin County, and is missing in Dallas County.

DENTALINA GRACILIS d'Orbigny

Plate 4, figure 17

Nodosaria (Dentalina) gracilis d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 14, pl. 1, fig. 5, 1840.
Dentalina gracilis d'Orbigny. Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 65, pl. 23, figs. 3-6, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 5, pl. 2, fig. 18, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 250, pl. 22, fig. 5, 1949.
Dentalina gracilis (d'Orbigny). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 88, pl. 9, figs. 49, 50, 1954.

This species is common in Upper Cretaceous (Senonian) strata of the Gulf Coastal Plain. It is common throughout the Austin.

DENTALINA NIOBRARENSIS Loetterle?

Plate 4, figure 18

Dentalina niobrarensis Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 24, pl. 2, fig. 3, 1937.

This species has been recorded only from the

Niobrara chalk. Austin samples contain a few specimens apparently assignable to this species, although somewhat similar forms from the formation have been identified as Dentalina lorneiana d'Orbigny (Cushman, 1946, p. 66, pl. 23, figs. 7-11).

DENTALINA STEPHENSONI (Cushman)

Plate 4, figure 19

Ellipsonodosaria stephensoni Cushman, Cushman Lab. Foram. Research, Contr., vol. 12, p. 52, pl. 9, figs. 10-15, 1936.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 121, pl. 18, figs. 22, 23, 1954.
Dentalina stephensoni (Cushman). Bandy, Jour. Paleontology, vol. 25, p. 501, pl. 73, figs. 10, 11, 1951 (see this reference for synonymy to 1951).

Bandy (1951, p. 501) reports a radiate aperture on this species, thus allocating it to the genus Dentalina d'Orbigny.

This species has an extensive record of occurrence in Taylor and Navarro strata, but has not been reported previously from Austin strata of Texas. It is very uncommon in the formation.

Genus NODOSARIA Lamarck, 1812

NODOSARIA ALTERNISTRIATA Morrow

Plate 4, figure 21

Nodosaria alternistriata Morrow, Jour. Paleontology, vol. 8, p. 190, pl. 29, figs. 1a,b, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 71, pl. 26, figs. 3, 4, 1946.

This species was described originally from the Niobrara chalk. It is uncommon in Austin strata.

NODOSARIA FUSULA Reuss

Plate 4, figure 22

Nodosaria fusula Reuss, Palaeontographica, vol. 20, pt. 2, p. 82, pl. 2(20), fig. 9, 1874.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 71, pl. 26, fig. 5, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 252, pl. 22, fig. 20, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 90, pl. 10, fig. 15, 1954.

This species has been recorded from Austin and Taylor strata. It is uncommon in the Austin.

NODOSARIA SEPTEMCOSTATA Geinitz

Plate 4, figure 20

Nodosaria septemcostata Geinitz, Charakteristik der Schichten und Petrefacten des sächsisch-böhmischen Kreidegebirges, Leipzig, Deutschland, Arnold, Heft 3, p. 69, pl. 17, fig. 20, 1842.
Bandy, Jour. Paleontology, vol. 25, p. 502, pl. 73, figs. 14a,b, 1951 (see this reference for synonymy to 1951).
Nodosaria affinis Reuss. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 89, pl. 10, figs. 3-7, 1954.

For many years this species has been identified as N. affinis Reuss. However, Bandy (1951, p. 502) has recently presented evidence that the species should be designated N. septemcostata Geinitz.

The species occurs widely in post-Eagle Ford strata of the Upper Cretaceous. It is common in the Austin.

Genus CHRYSALOGONIUM Schubert, 1907

CHRYSALOGONIUM TEXANUM Cushman

Plate 5, figures 1, 2

Chrysalogonium texanum Cushman, Cushman Lab. Foram. Research,

Contr., vol. 12, p. 55, pl. 9, figs. 24, 25, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 75, pl. 27, figs. 14, 15, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 92, pl. 10, figs. 40, 41, 1954.

This species has been recorded from Taylor and upper Austin strata. It occurs throughout the Austin and is especially common in Fannin County.

Genus PSEUDOGLANDULINA Cushman, 1929

PSEUDOGLANDULINA LAGENOIDES (Olszewski)

Plate 5, figure 4

Glandulina lagenoides Olszewski, Sprawozd. Kom. Fizyj. Akad. Umiej., Krakowie, vol. 9, p. 107, pl. 1, fig. 6, 1875.
Nodosaria laevigata Nilsson. Carsey (not of Nilsson), Univ. Texas, Bull. 2612, p. 32, pl. 4, fig. 13, 1926.
Pseudoglandulina sp. Plummer, Univ. Texas, Bull. 3101, p. 158, pl. 10, fig. 16, 17, 1931.
Pseudoglandulina lagenoides (Olszewski). Cushman and Hedberg, Cushman Lab. Foram. Research, Contr., vol. 17, p. 89, pl. 21, fig. 34, 1941.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 76, pl. 27, fig. 29, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 5, pl. 2, fig. 22, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 253, pl. 22, fig. 17, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 92, pl. 10, fig. 28, 1954.
Glandulina cf. lagenoides Olszewski. Bandy, Jour. Paleontology, vol. 25, p. 499, pl. 73, figs. 3a,b, 1951.

This species has been reported previously only from upper Taylor and Navarro strata. It is uncommon in Austin strata.

PSEUDOGLANDULINA MANIFESTA (Reuss)

Plate 5, figure 5

Glandulina manifesta Reuss, Haidinger's naturwiss. Abh., vol. 4, pt. 1, p. 22, pl. 1, fig. 4, 1851.

Nodosaria manifesta (Reuss). Cushman, Am. Assoc. Petr. Geol., Bull., vol. 10, p. 594, pl. 18, fig. 8, 1926.

Nodosaria larva Carsey, Univ. Texas, Bull. 2612, p. 31, pl. 2, fig. 2, 1926.

Nodosaria radicula (Linné). Plummer (not of Linné), Univ. Texas, Bull. 2644, p. 77, pl. 4, fig. 9, 1927.

Nodosaria humilis Roemer. Cushman (not of Roemer), Tennessee Div. Geol., Bull. 41, p. 32, pl. 4, fig. 5, 1931.

Pseudoglandulina manifesta (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 16, p. 60, pl. 11, fig. 1, 1940.

Toulmin, Jour. Paleontology, vol. 15, p. 590, pl. 79, fig. 32, 1941.

Kline, Mississippi State Geol. Survey, Bull. 53, p. 30, pl. 2, fig. 12, 1943.

Cushman and Todd, Cushman Lab. Foram. Research, Contr., vol. 22, p. 53, pl. 9, figs. 6-9, 1946.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 76, pl. 27, figs. 20-26, 1946 (see this reference for additional synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 5, pl. 2, fig. 21, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 253, pl. 22, fig. 18, 1949; U. S. Geol. Survey, Prof. Paper 232, p. 25, pl. 7, figs. 16, 17, 1951.

Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 25, pl. 5, figs. 1, 2, 1951.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 92, pl. 10, figs. 29-31, 1954.

This species is widely distributed in American equivalents of the Senonian and has been recorded from the Paleocene. Although a minor constituent of faunules, it occurs throughout the Austin.

Genus LINGULINA d'Orbigny, 1826

LINGULINA TAYLORANA Cushman?

Plate 5, figures 3a,b

Lingulina taylorana Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 43, pl. 7, fig. 9, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 77, pl. 27, fig. 37, 1946.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 93, pl. 10, fig. 45, 1954.

This species is known only from its type locality in lower Taylor strata of Lamar County, Texas. A single fragmentary specimen referable to the species was found in Sample BC-20 from the upper Bonham of Fannin County.

Genus VAGINULINA d'Orbigny, 1826

VAGINULINA sp. aff. V. CRETACEA Plummer

Plate 5, figures 10-12

Vaginulina gracilis Plummer var. *cretacea* Plummer, Univ. Texas, Bull. 2644, p. 172, pl. 2, fig. 8, 1927.
Vaginulina cretacea Plummer. Cushman, Geol. Soc. America Bull., vol. 47, p. 417, pl. 1, fig. 5, 1936.

Basal Ector strata of Fannin County contain a few severely abraded vaginuline specimens of uncertain affinity. All are characterized by raised sutures and broad chambers.

The specimen illustrated in Plate 5, figure 10, is more similar to that of figure 11 than is readily apparent from the illustrations. It has similar curvature, compression, chamber shape, and sutural characteristics, but it is more than twice the size of the specimen illustrated in figure 11. The specimen of figure 11 is also quite similar to that of figure 12, except for its curved dorsal outline and smaller proloculus.

The specimen of figure 10 displays the general characteristics of *Vaginulina cretacea* Plummer and is tentatively assigned to that species, although the previous record of *V. cretacea* Plummer has confined it to Navarro strata. Because of their stratigraphic association, the somewhat similar specimens illustrated in figures 11 and 12 also are assigned tentatively to *V. cretacea* Plummer.

VAGINULINA sp. cf. V. SILICULA (Plummer)

Plate 5, figures 13a,b

Hemicristellaria silicula Plummer, Univ. Texas, Bull. 3101, p. 148, pl. 10, figs. 8, 9, 1931.

Three specimens similar to this species were found in Sample FC-16 from the middle Bonham formation of Fannin County. Although smaller and lacking the typical concave dorsal outline of *V. silicula* (Plummer), these specimens display a stout initial spine, a definite though reduced initial coil, centrally raised sutures and a highly vitreous test. Accordingly, they are provisionally assigned to Plummer's species.

VAGINULINA sp.

Plate 5, figures 6-9

A few somewhat variable, simple vaginuline specimens were recovered from a locality in the middle Austin of Collin County and another in the middle Bonham of Fannin County. The scarcity and simplicity of the form do not permit identification. They are similar to specimens from the upper Taylor that have been listed by Cushman (1946, p. 64, pl. 22, figs. 25-27) as *Marginulina sp. C*.

Genus CITHARINA d'Orbigny, 1839

CITHARINA TEXANA (Cushman)

Plate 5, figure 22

Vaginulina texana Cushman, Cushman Lab. Foram. Research, Contr., vol. 6, p. 30, pl. 4, figs. 2, 3, 1930; U. S. Geol. Survey, Prof. Paper 206, p. 77, pl. 28, figs. 7-22, 1946 (see this reference for synonymy to 1946).
Vaginulina regina Plummer, Univ. Texas, Bull. 3101, p. 162, pl. 10, figs. 22a,b, 1931.
Citharina texana (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 95, pl. 11, figs. 29-32, 1954.

Citharina texana (Cushman) is the most diagnostic of Austin species. It may be recognized readily by its elongate, compressed, and heavily costate test with gradually tapering to parallel sides. The megalospheric form is much smaller in size and displays a more prominent proloculus with a slight initial spine.

It is restricted to the Austin and thus may be employed as a guide fossil for Austin strata.

Genus PALMULA Lea, 1833

PALMULA CAMPBELLI n. sp.

Plate 5, figures 14-17

Palmula cushmani (Morrow). Cushman (not of Morrow), U. S. Geol. Survey, Prof. Paper 206, p. 82, pl. 32, fig. 16, 1946.

Microspheric form elliptical in plan view and highly compressed; early portion incompletely coiled, including four to seven chambers, later portion uniserial with chevron-shaped chambers; chambers of coiled portion increasing regularly in breadth, those of uniserial portion extending backward on each side and tending to envelop the coiled portion, thus producing the elliptical shape; sutures of the coiled portion raised, straight, those of the uncoiled portion flush with surface, limbate, and convex peripherally; proloculus may be ornamented by suture-like plate and/or a small boss; aperture terminal, with a short, stout neck; height up to 1.40 mm., breadth up to 1.00 mm., thickness up to .20 mm.

Megalospheric form elliptical in plan view and highly compressed; early portion with large bulbous proloculus, succeeded by a few chambers displaying slight indication of coiling, later portion uniserial with chevron-shaped chambers tending to envelop the initial portion, thus producing the elliptical shape; initial several sutures very slightly raised, the remainder flush to slightly depressed; surface smooth except for basal few slightly raised sutures; height 1.50 to 2.00 mm., breadth approximately 1.35 mm., thickness .15 to .20 mm.

Except for the initial portion, microspheric and megalospheric forms are very similar. They occur together in basal Austin strata throughout the area of this report. Some megalospheric specimens display slightly flabelline chambers immediately succeeding the proloculus, whereas others possess symmetrical frondicularian chambers succeeding the ~~proloculus, suggesting the possibility of trimorphism.~~

The microspheric form is similar to Palmula limbata Loeblich and Tappan, from which it may be derived; but it has one or no ornamental bosses, has flush sutures in the uniserial portion, and is more elliptical in shape.

The megalospheric form is similar to Palmula cushmani (Morrow) and has been so identified incorrectly (Cushman, 1946, p. 82, pl. 32, fig. 16). It may be distinguished from Morrow's species by its more enveloped, less flabelline initial chambers, its slightly raised early sutures, and its lack of low, rounded elevations at the apex of sutures.

This species is named for Carlyle B. Campbell of Knoxville, Iowa, designer of the Campbell sample washer, to whom the writer is deeply indebted for washing the hundreds of samples considered in this report.

PALMULA CUSHMANI (Morrow)?

Plate 5, figures 18-21

Flabellina cushmani Morrow, Jour. Paleontology, vol. 8, p. 194, pl. 29, fig. 25, 1934.

A few samples from the lower Austin contain occasional specimens that may be assigned to Morrow's species. One of these, illustrated in Plate 5, figure 21, is small, but well preserved. The sutures are flush throughout; there is a small, very low, rounded elevation at the apex of some sutures, and the initial chambers display definite indications of coiling. Plate 5, figures 18-20 depict additional forms which are, however, severely abraded, and the sutures are elevated in relief as a result of etching of the chamber faces.

If these prove to be P. cushmani (Morrow), the writer agrees with Cushman (1946, p. 82) that P. cushmani (Morrow) is the progenitor of P. suturalis (Cushman).

PALMULA PILULATA Cushman

Plate 6, figure 1

Palmula pilulata Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 37, pl. 6, fig. 2, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 84, pl. 32, figs. 18-21, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 97, pl. 12, figs. 5, 6, 1954.

The figured specimen is very poorly preserved, but other specimens, which are fragmentary, effect positive identification. The species is uncommon in Austin strata.

PALMULA RUGOSA (d'Orbigny)

Plate 6, figure 2

Flabellina rugosa d'Orbigny, Soc. Géol. France, Mém., 1st ser., vol. 4, p. 23, pl. 2, figs. 4, 5, 7, 1840.
Flabellina interpunctata Von der Marck, Naturh. Ver. preuss. Reinland Verh., vol. 15, p. 53, pl. 1, fig. 5, 1858.
Frondicularia baudouiniana d'Orbigny. Cushman (not of d'Orbigny), Cushman Lab. Foram. Research, Contr., vol. 2, p. 21, pl. 3, fig. 5, 1926.
Palmula rugosa (d'Orbigny). Cushman, Cushman Lab. Foram. Research, Contr., vol. 16, p. 62, pl. 9, fig. 30, 1940.
Kline, Mississippi State Geol. Survey, Bull. 53, p. 36, pl. 3, fig. 11, 1943.
Cushman, U. S. Geol. Survey Prof. Paper 206, p. 83, pl. 31, figs. 9-17, 1946 (see this reference for additional synonymy to 1946); U. S. Geol. Survey, Prof. Paper 232, p. 29, pl. 7, figs. 36, 37, 1951.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 30, pl. 5, fig. 15, 1951.

<u>Neoflabellina</u> <u>rugosa</u> (d'Orbigny). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 97, pl. 12, figs. 15, 16, 1954.

The papillae among sutures are few and weakly developed on the majority of specimens, which, therefore, resemble <u>Palmula</u> <u>suturalis</u> (Cushman) and suggest derivation from that form.

The species has been widely recorded from the Upper Cretaceous of Europe and North America and from the Paleocene of the American Gulf Coastal Plain. Several specimens of this species were found in Sample 4, station F-2, from the uppermost Gober chalk of Fannin County.

PALMULA SUTURALIS (Cushman)

Plate 6, figures 3, 4

<u>Flabellina</u> <u>rugosa</u> d'Orbigny. Heron-Allen and Earland (not of d'Orbigny), Royal Micr. Soc., Jour., p. 422, pl. 8, fig. 7, 1910.
<u>Flabellina</u> <u>suturalis</u> Cushman, Cushman Lab. Foram. Research, Contr., vol. 11, p. 86, pl. 13, figs. 9-18, 1935.
<u>Palmula</u> <u>suturalis</u> (Cushman), Loetterle, Nebraska Geol. Survey, Bull. 12, ser. 2, p. 28, pl. 3, fig. 5, 1937.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 82, pl. 32, figs. 3-14, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 254, pl. 23, fig. 4, 1949.
<u>Neoflabellina</u> <u>suturalis</u> (Cushman). Frizzell, Univ. Texas Bureau Econ. Geol., Rept. Inv. no. 22, p. 98, pl. 12, figs. 17, 18, 1954.

Although typically rhomboidal, some of these specimens are exceedingly cordate, as depicted in Plate 6, figure 4.

Genus FRONDICULARIA Defrance, 1824

FRONDICULARIA ARCHIACIANA d'Orbigny

Plate 6, figure 5

Frondicularia archiaciana d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 20, pl. 1, figs. 34-36, 1840.
Bandy, Jour. Paleontology, vol. 25, p. 496, pl. 72, figs. 11a,b, 1951 (see this reference for synonymy to 1951).
Pseudofrondicularia archiaciana (d'Orbigny). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 99, pl. 13, figs. 6-8, 1954.

This species has been recorded frequently from strata of Taylor and Navarro age in Europe and North America, but it has not been reported previously from the Austin. It is very uncommon in Austin strata, where it is confined to the uppermost beds.

FRONDICULARIA AUSTINANA Cushman

Plate 6, figure 6

Frondicularia cordai Reuss. Cushman (not of Reuss), Cushman Lab. Foram. Research, Contr., vol. 6, p. 34, pl. 5, fig. 17, 1930.
Frondicularia austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 12, p. 13, pl. 3, figs. 12, 13, 1936; U. S. Geol. Survey, Prof. Paper 206, p. 86, pl. 33, figs. 9, 10, 1946.
Frondicularia austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 98, pl. 12, figs. 19, 20, 1954.

Specimens of this species from the Bonham clay possess weak ornamentation and closely resemble F. watersi Cushman, whereas those from the chalk units of the Austin are coarsely ornate. This fact suggests that F. watersi Cushman may be derived from F. austinana Cushman in Taylor time under the influence of changed sedimentary environment.

This species has been reported from upper Eagle Ford, Austin, and lower Taylor strata of Texas. It occurs frequently in samples from the middle and upper Austin but is lacking in those from the lower Austin.

FRONDICULARIA CORDATA Roemer

Plate 6, figure 7

Frondicularia cordata Roemer, Verstein. norddeutschen Kreidegebirges, p. 96, pl. 15, fig. 8, 1841.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 88, pl. 35, figs. 3-7, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 98, pl. 12, figs. 25, 26, 1954.
Frondicularia goldfussi Reuss. Cushman (not of Reuss), Jour. Paleontology, vol. 6, p. 336, pl. 50, figs. 8, 9, 1932.

This species was described from the Cretaceous of Europe. In the American Gulf Coastal Plain it is most common in Taylor strata, but has been recorded from the Austin. It was found in only two samples from the upper Austin.

FRONDICULARIA GOLDFUSSI Reuss?

Plate 6, figures 8-15

Plate 7, figures 1, 2

Frondicularia goldfussi Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 192, pl. 4, fig. 7, 1860.
Cushman (in part), U. S. Geol. Survey, Prof. Paper 206, p. 87, pl. 34, figs. 18, 20, (not fig. 19), pl. 35, figs. 1, 2, 1946.
Frondicularia inversa Reuss. Cushman (not of Reuss) (in part), U. S. Geol. Survey, Prof. Paper 206, p. 86, pl. 33, figs. 13-15 (not 11, 12, 16-18), 1946.

There is in Austin samples a fairly common, rather variable *Frondicularia* Defrance of doubtful affinity. The form varies from cordate to rhomboid to somewhat lanceolate in shape and possesses an oval to spherical proloculus which is enveloped by peripheral edges of the initial sagittate chamber. These edges usually join apically to form an initial stout spine. On exceptionally thick specimens the aforementioned junction of edges does not occur, and two spines may be present. A median costa extends from the apical spine, or spines, onto each side of the proloculus and is occasionally accompanied by weaker lateral prolocular costae. Sutures are practically straight on rhomboid forms, which appear to be incompletely developed specimens, but become curved on cordate forms, which are herein considered to be the adult stage. Sutures are generally flush with the surface of the chambers, but some specimens display very slight and blunt sutural elevation in strongly oblique light. The periphery of the test is strongly truncate on the earlier chambers but becomes slightly beveled on the later chambers of occasional specimens.

It appears to the writer that some of the forms identified as *F. inversa* Reuss by Cushman (see foregoing synonymy) are conspecific with this species, which differs from *F. inversa* Reuss in shape of proloculus, shape of test, curvature of sutures, and nature of periphery.

Also this species resembles closely F. alata Carsey (not d'Orbigny). Mrs. Plummer (1931, p. 172) considered F. alata of Carsey to be the youthful stage of F. clarki Bagg. Inasmuch as the Austin form occurs at several levels and localities in the Austin group without displaying adult characteristics of F. clarki Bagg, Mrs. Plummer's assignment cannot be accepted for the species.

Moreover, this species does display the properties of F. goldfussi Reuss. It appears judicious, therefore, to assign the Austin form with reservation to the latter species, with the note that it may be related to F. clarki Bagg, which occurs in the younger Navarro strata.

Frondicularia goldfussi Reuss was originally described from the Upper Cretaceous of Europe. It has been recorded from beds of Taylor and Austin age at many localities in the Gulf Coastal Plain. Paleocene specimens assigned to this species are properly referable to F. mucronata Reuss and have been placed in synonymy with that species in this report.

FRONDICULARIA INVERSA Reuss?

Plate 7, figure 3

Frondicularia inversa Reuss, Geognostische Skizzen Böhmen, vol. 2, pt. 1, p. 211, 1844.

The literature indicates extreme confusion regarding this species. Dr. Cushman reports it to be characteristic of the Austin, but it is the writer's opinion that part or all (see synonymy of F. goldfussi Reuss) of the forms that he illustrated under this name (Cushman, 1946, pl. 33, figs. 11-18) should be assigned elsewhere.

Sample BC-26 from the Bonham clay of Fannin County yielded a single specimen, which is illustrated in Plate 7, figure 3. This specimen, with its elongate, conspicuously cylindrical, spine-bearing proloculus, gradually and evenly tapering elliptical test, and gently curved but steeply inclined flush sutures, displays faithfully the characteristics originally described and illustrated as F. inversa Reuss.

FRONDICULARIA LANCEOLA Reuss

Plate 7, figure 4

Frondicularia lanceola Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 198, pl. 5, figs. 1a,b, 1860.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 85, pl. 33, figs. 1-4, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 6, pl. 3, fig. 6, 1949.
Pseudofrondicularia lanceola (Reuss) var. lanceola (Reuss). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 100, pl. 13, figs. 16, 17, 1954.

Frondicularia lanceola Reuss is differentiated with difficulty from its variety bidentata Cushman, and some of the writer's identifications are questionable.

This species was originally described from the Upper Cretaceous of Germany. It is common in Senonian equivalents of the Gulf Coastal Plain. It occurs throughout the Austin,but is much less common than the varietal form.

FRONDICULARIA LANCEOLA Reuss var. BIDENTATA Cushman

Plate 7, figure 5

Frondicularia verneuiliana d'Orbigny var. bidentata Cushman, Cushman Lab. Foram. Research, Contr., vol. 6, p. 37, pl. 5, figs. 13-15, 1930.
Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 28, pl. 3, figs. 6, 7, 1937.
Frondicularia lanceola Reuss var. bidentata Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 85, pl. 33, figs. 5-8, 1946.
Pseudofrondicularia lanceola (Reuss) var. bidentata (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 100, pl. 13, figs. 24, 25, 1954.

This varietal form has essentially the same distribution as F. lanceola Reuss, but is less abundant than the type in Taylor and Navarro strata. However, it is the more abundant of the two in Austin strata and is the most common species of Frondicularia Defrance in the unit.

It is easily identified by its large lanceolate test with stout initial spine and much thickened, rib-like sutures.

FRONDICULARIA MUCRONATA Reuss

Plate 7, figure 6

Frondicularia mucronata Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 31, pl. 13, figs. 43, 44, 1845.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 87, pl. 34, figs. 14-17, 1946 (see this reference for additional synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 99, pl. 12, figs. 36, 37, 1954.
Nodosarina (Frondicularia) goldfussi (Reuss). Kline (not of Reuss), Mississippi State Geol. Survey, Bull 53, p. 28, pl. 2, fig. 7, 1943.
Frondicularia goldfussi Reuss. Cushman (not of Reuss), U. S. Geol. Survey, Prof. Paper 232, p. 31, pl. 8, figs. 21, 23, 1951.

This species is characterized by flush sutures and chambers of asymmetrically oval outline which completely envelop a relatively large, spine-bearing, oval proloculus.

American records of the species confine it to upper Austin and Taylor strata. However, it appears that _F. mucronata_ Reuss occurs in the Paleocene, where it has been identified as _F. goldfussi_ Reuss. It occurs infrequently in samples from middle and upper Austin strata of Collin and Fannin Counties.

FRONDICULARIA UNDULOSA Cushman

Plate 7, figure 7

Frondicularia undulosa Cushman, Cushman Lab. Foram. Research, Contr., vol. 12, p. 13, pl. 3, figs. 7-11, 1936; (in part) U. S. Geol. Survey, Prof. Paper 206, p. 87, pl. 34, figs. 9-11 (not 12, 13), 1946 (see this reference for synonymy to 1946).

Pseudofrondicularia undulosa (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 101, pl. 13, figs. 34, 35, 1954.

According to Cushman (1946, p. 87) this species "seems to be characteristic of the Gober chalk member of the Austin, although a somewhat broader form, otherwise similar, occurs rarely at a few localities in the Taylor marl." Typical specimens are fairly common in samples from lower and middle Austin strata, but are lacking in those from the upper Austin. Close scrutiny of the Austin localities in Texas cited by Cushman (_ibid._) reveals that two are from the basalmost Gober and the remainder from the middle or basal Austin. In view of the range of the species displayed by the samples of this report and the questionable nature of the Taylor specimens assigned to this species, it is possible that _F._ _undulosa_ Cushman is in actuality confined to the Austin.

FRONDICULARIA VERNEUILIANA d'Orbigny

Plate 7, figure 8

Frondicularia _verneuiliana_ d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 20, pl. 1, figs. 32, 33, 1840.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 90, pl. 36, figs. 12-15, 1946 (see this reference for synonymy to 1946).
Pseudofrondicularia _verneuiliana_ (d'Orbigny) var. _verneuiliana_ (d'Orbigny). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 101, pl. 13, figs. 38, 39, 1954.

This species has been recorded from Senonian equivalents of the Gulf Coastal Plain. It is uncommon in the Austin, occurring primarily in basal strata.

Genus TRIBRACHIA Schubert, 1912

TRIBRACHIA MONNETTI n. sp.

Plate 8, figures 1a,b

Test elongate, doubly tapering with maximum breadth near mid-region, strongly tricarinate, periphery slightly lobulate, truncate, and weakly bicarinate; initial chamber a large spherical proloculus, later chambers tri-radiate, each flange strongly inclined toward the proloculus and possessing flat, parallel faces, contiguous flanges joined in a sharp angle, chambers increasing gradually in breadth to a maximum in the final chamber, but maintaining constant height and thickness; sutures distinct, limbate, strongly oblique, slightly depressed; surface smooth except for proloculus, which bears two or three large, coarse costae between each pair of flanges, and three pairs of weak carinae that extend from the edge of each of the three flanges on and around the proloculus, meeting at its ventral apex; aperture obscure, apparently a small simple opening at the terminus of the test; height 1.70 mm., breadth .45 mm.

This species is similar to T. subcretacea Bartenstein and Brand. The holotype of the latter is fragmentary, lacking the proloculus and some early chambers, and comparison, therefore, cannot be complete. In addition to possible differences in the initial portions, T. monnetti n. sp. is smaller in size and somewhat stouter in architecture. Its chambers are not so narrow, and its sutures are flush and convex peripherally rather than concave; its periphery is truncate rather than rounded, and its aperture lacks the triangular shape of T. subcretacea Bartenstein and Brand. All of these differences are rather minute, but, in view of the fact that the holotype of T. subcretacea Bartenstein and Brand is fragmentary and that it was described from the Lower Cretaceous of Germany, it appears justifiable to erect the new species.

Tribrachia monnetti n. sp. is very uncommon in the Austin, two specimens occurring in the middle Austin of

Collin County and another from a locality in the uppermost Austin of Dallas County.

The species is named for Dr. V. E. Monnett, Director of the School of Geology, University of Oklahoma.

Genus KYPHOPYXA Cushman, 1929

KYPHOPYXA CHRISTNERI (Carsey)

Plate 7, figures 9a,b

Frondicularia christneri Carsey, Univ. Texas, Bull 2612, p. 41, pl. 6, fig. 7, 1926.
Kyphopyxa christneri (Carsey). Cushman, Cushman Lab. Foram. Research, Contr., vol. 5, p. 1, pl. 1, figs. 1-7, 1929; U. S. Geol. Survey, Prof. Paper 206, p. 92, pl. 38, figs. 12-17, pl. 39, figs. 1-12, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 255, pl. 23, fig. 11, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 101, pl. 13, figs. 29-33, 1954.
Kyphopyxa undulata Loetterle, Nebraska Geol. Survey, Bull. 12, ser. 2, p. 30, pl. 4, figs. 2, 3, 1937.
Kyphopyxa cushmani Albritton and Phleger, Jour. Paleontology, vol. 11, p. 354, text fig. 1, 1937.

To the writer this is the most interesting and unique species of the American Upper Cretaceous. With its generally palmulate form and highly elevated, blade-like sutures, it resembles *Palmula suturalis* (Cushman), but displays biserial arrangement of the early chambers.

The form is common in Austin and Taylor strata of the Gulf Coastal Plain, yet only three species of the remarkable genus have been described, and two of them are here placed in synonymy with the genotype. Although common in middle and upper Austin strata of Collin and Dallas Counties~~, the form is missing in the lower Austin. In~~

Fannin County the form is found in all except the lowermost strata.

Genus LAGENA Walker and Jacob, 1798

LAGENA sp. cf. L. ACUTICOSTA Reuss

Plate 7, figure 10

Lagena acuticosta Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 44, pt. 1, p. 305, pl. 1, fig. 4, 1862.

These small, rare, abraded specimens display costae of alternating development, with the stronger converging at the short neck.

LAGENA sp. cf. L. HISPIDA Reuss

Plate 7, figure 11

Lagena hispida Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 46, p. 335, pl. 6, figs. 77-79, 1863.

These rare and very small hispid specimens could well be fragments of other forms, but the writer observed nothing to which they could reasonably relate.

LAGENA? sp.

Plate 7, figure 12

This uncommon globular form has the general shape and character of *L. globosa* (Montagu), but bears a slight basal spine.

Family POLYMORPHINIDAE

Genus GLOBULINA d'Orbigny, 1839

GLOBULINA LACRIMA Reuss

Plate 7, figure 13

Polymorphina (Globulina) lacrima Reuss, Verstein. böhm. Kreideformation, vol. 1, p. 40, pl. 12, fig. 6, pl. 13, fig. 83, 1845.
Globulina lacrima (Reuss). Reuss, Haidinger's Naturwiss. Abh., vol. 4, p. 27, pl. 4, fig. 9, 1851.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 96, pl. 40, figs. 11, 12, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 6, pl. 3, fig. 10, 1949.
Bullard, Jour. Paleontology, vol. 27, p. 342, pl. 45, figs. 19, 20, 1953 (see this reference for additional synonymy to 1953).
Polymorphina gibba d'Orbigny. Cushman (not of d'Orbigny), Amer. Assoc. Pet. Geol., Bull., vol. 10, p. 604, pl. 20, figs. 8, 15, 1926.
Globulina lacrima (Reuss) var. lacrima (Reuss). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 104, pl. 14, figs. 21a-c, 1954.

This species is widely distributed in the Cretaceous of Europe and North America. It occurs throughout the Austin, but is a minor constituent of faunule populations.

Genus PYRULINA d'Orbigny, 1839

PYRULINA CYLINDROIDES (Roemer)

Plate 7, figures 14a,b

Polymorphina cylindroides Roemer, Neues Jahrb., p. 385, pl. 3, fig. 26, 1838.
Polymorphina fusiformis Roemer. Cushman (not of Roemer), Amer. Assoc. Pet. Geol., Bull., vol. 10, p. 604, pl. 20, fig. 14, 1926.
Polymorphina gutta d'Orbigny. W. Berry (not of d'Orbigny), in Berry and Kelley, U. S. Nat. Mus., Proc., vol. 76, art. 19, p. 10, pl. 1, fig. 11, 1929.
Pyrulina cylindroides (Roemer). Cushman and Ozawa, U. S. Nat. Mus., Proc., vol. 77, art. 6, p. 56, pl. 14, figs. 1-5, 1930.

Toulmin, Jour. Paleontology, vol. 15, p. 594, pl. 80, fig. 10, 1941.
Kline, Mississippi State Geol. Survey, Bull. 53, p. 40, pl. 7, fig. 5, 1943.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 97, pl. 40, figs. 18, 19, 1946 (see this reference for additional synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 7 (no illustration), 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 257, pl. 23, fig. 20, 1949.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 34, pl. 6, fig. 19, 1951.
Bullard, Jour. Paleontology, vol. 27, p. 343, pl. 46, figs. 5, 6, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 104, pl. 14, figs. 25-27, 1954.
Pyrulina cf. P. cylindroides (Roemer). Cushman and Todd, Cushman Lab. Foram. Research, Contr., vol. 22, p. 57, pl. 10, fig. 6, 1946.
Cushman, U. S. Geol. Survey, Prof. Paper 232, p. 33, pl. 9, figs. 23, 24, 1951.

This species has not been reported previously from Austin strata, in which it occurs at a number of localities. Although the species has a long range in the Upper Cretaceous and extends even into the Paleocene, it rarely occurs in quantity at any horizon, the Austin included.

Genus VITRIWEBBINA Chapman, 1892

VITRIWEBBINA BIOSCULATA Frizzell

Plate 7, figure 18

Vitriwebbina biosculata Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 107, 158, pl. 15, fig. 7, 1954 (see this reference for synonymy).

This relatively new species includes Upper Cretaceous forms formerly assigned to Bullopora laevis (Sollas) and distinguished from the latter by the possession of two or more apertures.

The species has been recorded from Austin, Taylor, and Navarro strata. It is rather common in the Austin of Dallas County, but is uncommon in samples from Collin and Fannin Counties.

Genus RAMULINA Rupert Jones, 1875

RAMULINA LAEVIS Rupert Jones

Plate 7, figures 15-17

Ramulina laevis Rupert Jones, in J. Wright, Belfast Nat. Field Club, Proc., App. 3, p. 88(90), 1875.
Ramulina aculeata (d'Orbigny). Cushman (in part) (not of d'Orbigny), U. S. Geol. Survey, Prof. Paper 206, p. 100, pl. 43, figs. 14-16 (not figs. 11-13), 1946; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 232, pl. 17, fig. 1, 1949.

Samples from the Gober chalk of Fannin County contain thick-walled Ramulina Rupert Jones, which have been identified as R. aculeata (d'Orbigny) by Cushman (1946, p. 100, pl. 43, figs. 14-16; not figs. 11-13). Cushman's presentation of this form indicates that he considered these specimens to be the same as those which Wright (1886, p. 331, pl. 27, fig. 11) assigned to d'Orbigny's species and to the genus Ramulina Rupert Jones, although they (and Wright's forms) might not be conspecific with d'Orbigny's species. Recently Bullard (1953, p. 346, pl. 46, fig. 26) has separated Wright's species from d'Orbigny's and has assigned it the new name of Ramulina novaculeata Bullard.

However, the Austin forms assigned by Cushman to Wright's species are typically ramose, rather than irregularly globular, are less coarsely ornate, are never spicular, and closely resemble R. laevis Rupert Jones.

Occasionally occurring with tnem are smaller specimens of lighter construction that grade into the thick-walled specimens, suggesting that the latter may be variations of the former. Since this tendency for grosser character in chalk facies has been observed in other species (e.g., Frondicularia austinana Cushman) it is proper to assign all of these variants to R. laevis Rupert Jones.

Family NONIONIDAE

Genus NONIONELLA Cushman, 1926

NONIONELLA AUSTINANA Cushman

Plate 8, figures 2a-c

Nonionella austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 57, pl. 7, figs. 2a-c, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 100, pl. 43, figs. 18-20, 1946 (see this reference for synonymy to 1946).

Nonionella austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 107, pl. 15, figs. 8a-c, 1954.

This species has a modest record of occurrence from Austin and Taylor strata of Texas and Arkansas. It is a minor member of faunule populations, but occurs frequently in Austin strata, particularly in those of Dallas County.

Family HETEROHELICIDAE

Genus SPIROPLECTOIDES Cushman, 1927

SPIROPLECTOIDES ROSULA (Ehrenberg)

Spiroplecta rosula Ehrenberg, Mikrogeologie, pl. 32, fig. 26, 1854.

Spiroplectoides rosula (Ehrenberg). Cushman, Cushman Lab. Foram. Research, Contr., vol. 3, p. 62, pl. 13, figs. 9a,b, 1927.

Bolivinopsis rosula (Ehrenberg). Macfadyen, Royal Micr. Soc.,

Jour., vol. 53, p. 141, 1933.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 101, pl. 44, figs. 4-8, 1946 (see this reference for synonymy to 1946); U. S. Geol. Survey, Prof. Paper 221-A, p. 7, pl. 3, fig. 20, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 257, pl. 25, figs. 5, 6, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 108, pl. 15, fig. 11, 1954.

As previously mentioned in remarks concerning "Spiroplectammina" laevis (Roemer) var. cretosa Cushman, the term Bolivinopsis Yakovlev is no longer appropriate for Spiroplecta rosula Ehrenberg. It seems proper, therefore, to revive Cushman's genus Spiroplectoides Cushman.

Spiroplectoides rosula (Ehrenberg) was originally described from the Selma chalk, the exact locality unknown, and has been recorded extensively from Senonian strata of the Gulf Coastal Plain. It has been recorded from several localities in the Austin; however, only two samples from the upper Bonham yielded specimens of the species.

Genus GÜMBELINA Egger, 1899

GÜMBELINA GLOBULOSA (Ehrenberg)

Plate 8, figures 3a,b

Textularia globulosa Ehrenberg, K. preuss. Akad. Wiss. Berlin, Physik.-Math. Kl., Abh., p. 135, pl. 4, fig. 4, 1840.
Textilaria globifera Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 232, pl. 13, figs. 7, 8, 1860.
Gümbelina globifera (Reuss). Egger, K. bayer. Akad. Wiss. Münch., Math.-Physik. Kl., Abh., vol. 21, pt. 1, p. 33, pl. 14, figs. 35, 36, 53-55, 1899.
Gümbelina globulosa (Ehrenberg). Egger, K. bayer. Akad. Wiss. Münch., Math.-Physik. Kl., Abh., vol. 21, pt. 1, p. 32, pl. 14, fig. 43, 1899.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 105 pl. 45, figs. 9-15, 1946 (see this reference for synonymy to 1946).
Kikoine, Soc. géol. France, 5th ser., C. R., p. 17, pl. 1, fig. 3, 1948.
Cushman, U. S. Geol. Survey, Prof. Paper 221-A, p. 7, pl. 3, fig. 23, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 258, pl. 24, fig. 9, 1949.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 37, pl. 7, fig. 10, 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 234, pl. 30, fig. 15, pl. 31, fig. 9, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 109, pl. 15, figs. 24-27, 1954.

Gümbelina pupa (Reuss). White (not of Reuss), Jour. Paleontology, vol. 3, p. 38, pl. 4, fig. 11, 1929.

Gümbelina reussi Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 11, pl. 2, figs. 6-9, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 104, pl. 44, figs. 18, 19, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 110, pl. 15, figs. 15a,b, 1954.

The writer considers Gümbelina reussi Cushman an invalid species. The diagnostic characteristics of G. reussi Cushman are reported to include "a tendency for the early portion to have an entire periphery . . . less overlapping chambers, clearly set off from one another and with a triangular indented area between" (Cushman, 1946, p. 104). In a single sample from the basal Austin chalk, which is the horizon of the holotype of G. reussi Cushman, the writer has observed specimens which possess: (a) a lobulate periphery throughout, but without triangular indented areas; (b) a lobulate periphery throughout and with large, triangular indented areas; (c) an early portion with entire periphery but without triangular indented areas;

(d) an entire early portion and triangular indented areas. Some of these specimens apparently demand assignment to G. globulosa (Ehrenberg), and, if they are so identified, it becomes difficult to separate the remainder therefrom.

As a consequence of this situation, the writer would place G. reussi Cushman in synonymy with G. globulosa (Ehrenberg), from which it was originally removed. In this regard, attention is called to the fact that Kikoine (1948, p. 17) likewise has placed G. reussi Cushman in synonymy with G. globulosa (Ehrenberg).

As might be expected from its abundant, world-wide record, G. globulosa (Ehrenberg) is abundant in the Austin.

GÜMBELINA PLANATA Cushman

Plate 8, figures 4a,b

Gümbelina planata Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 12, pl. 2, figs. 13, 14, 1938; Cushman Lab. Foram. Research, Contr., vol. 20, p. 10, pl. 2, fig. 20, 1944; U. S. Geol. Survey, Prof. Paper 206, p. 105, pl. 45, figs. 6, 7, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 109, pl. 15, figs. 32a,b, 1954.

Variants of this species from the Bonham clay of Fannin County strongly suggest affinity to G. pseudotessera Cushman, raising the possibility that G. planata Cushman may be derived from G. pseudotessera Cushman.

This species has been recorded from only three localities in the Taylor of Texas. It is also very uncommon in the Austin.

GÜMBELINA PLUMMERAE Loetterle

Plate 8, figures 5a,b

Gümbelina plummerae Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 33, pl. 5, figs. 1, 2, 1937.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 104, pl. 45, figs. 1-3, 1946 (see this reference for synonymy to 1946).
Kikoine, Soc. géol. France, 5th ser., C. R., vol. 18, p. 18, pl. 1, fig. 5a-c, 1948.
Cushman, U. S. Geol. Survey, Prof. Paper 221-A, p. 7, pl. 3, figs. 21, 22, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 257, pl. 25, fig. 2, 1949.
Hamilton, Jour. Paleontology, vol. 27, p. 234, pl. 30, fig. 10, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 109, pl. 15, figs. 36a,b, 1954.

Characterized by rapidly expanding, costate, much inflated chambers, whose thickness equals or exceeds their breadth, G. plummerae Loetterle is one of the more distinctive species of Gümbelina Egger. Although apparently somewhat less abundant than G. globulosa (Ehrenberg), it is, nevertheless, very common in the American Senonian and has recently been reported from submarine Pacific seamounts (Hamilton, 1953, p. 234). It is common in Austin strata, where it seems to be developed best in somewhat argillaceous rocks.

GÜMBELINA sp.

Plate 8, figures 7a,b

This form is identical with G. plummerae Loetterle, except for the initial portion, which is acute and compressed with small, broad chambers, flush sutures and entire periphery. It may be a new species, but, in view of its general similarity in the adult portion to G. plummerae Loetterle, it seems unwise to assign it a new name. However, it is illustrated separately on the range chart in order to establish its stratigraphic position, in the event that it should be established as a new species.

GÜMBELINA PSEUDOTESSERA Cushman

Plate 8, figure 6

Gümbelina tessera (Ehrenberg). Cushman (not G. tessera Cushman, 1946, nor Grammostomum tessera Ehrenberg), Jour. Paleontology, vol. 6, p. 338, pl. 51, figs. 4, 5, 1932.
Kikoine, Soc. géol. France, 5th ser., C. R., p. 20, pl. 1, fig. 9, 1948.
Gümbelina pseudotessera Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 14, pl. 2, figs. 19-21, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 106, pl. 45, figs. 16-20, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 258, pl. 24, fig. 10, 1949.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 38, pl. 7, fig. 9, 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 234, pl. 30, fig. 14, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 109, pl. 15, figs. 33, 34, 1954.

The highly compressed, asymmetric, curved chambers of G. pseudotessera Cushman establish it as the most distinctive and readily recognized Gümbelina Egger in the American Upper Cretaceous. It has been reported from the basal Midway of Arkansas (Harris and Jobe, 1951, p. 38), but all other records are confined to Austin and Taylor strata, suggesting that Midway specimens may be reworked.

GÜMBELINA STRIATA (Ehrenberg)

Plate 8, figure 8

Textularia striata Ehrenberg, K. preuss. Akad. Wiss. Berlin, Physik.-Math. Kl., Abh., p. 135, pl. 4, figs. 1-3, 1838.
Gümbelina striata (Ehrenberg). Egger (in part), K. bayer. Akad. Wiss. München., Math.-Physik. Kl., Abh., vol. 21, p. 33, pl. 14, figs. 37-39 (not figs. 5-7, 10, 11), 1899.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 104, pl. 45, figs. 4, 5, 1946 (see this reference for synonymy to 1946).
Kikoine, Soc. géol. France, 5th ser., C. R., p. 20, pl. 1, fig. 7, 1948.
Cushman, U. S. Geol. Survey, Prof. Paper 221-A, p. 7, pl. 3, fig. 24, 1949; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 258, pl. 24, fig. 3, 1949.
Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 39, pl. 7, fig. 8, 1951.
Bandy, Jour. Paleontology, vol. 25, p. 510, pl. 75, figs. 8, 9, 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 235, pl. 30, fig. 13, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 110, pl. 15, figs. 39, 40, 1954.

This species is difficult to recognize in the Austin chalk because of the poor state of preservation of costae, but it occurs rather frequently in the Bonham clay. However, it does appear to be uncommon in comparison with most species of Gümbelina Egger.

Genus RECTOGÜMBELINA Cushman, 1932

RECTOGÜMBELINA HISPIDULA Cushman

Plate 8, figure 14

Rectogümbelina hispidula Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 21, pl. 3, figs. 20-22, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 109, pl. 46, figs. 22-24, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 110, pl. 16, fig. 1, 1954.

This species occurs in the lower Austin, where it is uncommon.

RECTOGÜMBELINA TEXANA Cushman

Plate 8, figure 15

Rectogümbelina texana Cushman, Cushman Lab. Foram. Research, Contr., vol. 8, p. 6, pl. 1, figs. 8-10, 1932; U. S. Geol. Survey, Prof. Paper 206, p. 109, pl. 46, figs. 19-21, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 110, pl. 16, figs. 3, 4, 1954.

This species is a contemporary of *R. hispidula* Cushman in lower Austin strata, where it is uncommon. It has also been recorded from one locality in the upper Eagle Ford.

Genus VENTILABRELLA Cushman, 1928

VENTILABRELLA AUSTINANA Cushman

Plate 8, figure 9

Ventilabrella eggeri Cushman. Carman (not of Cushman), Jour. Paleontology, vol. 3, p. 314, pl. 34, fig. 7, 1929.
Ventilabrella austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 26, pl. 4, fig. 19, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 111, pl. 47, fig. 16, 1946 (see this reference for synonymy to 1946).
Kikoine, Soc. géol. France, C. R., vol. 18, 5th ser., p. 25, pl. 2, fig. 6, 1948.
Hamilton, Jour. Paleontology, vol. 27, p. 235, pl. 30, fig. 7, 1953.
Ventilabrella austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 111, pl. 16, figs. 9a,b, 1954.

Records indicate that this species occurs uncommonly in strata ranging from upper Eagle Ford to lower Taylor in age. It is uncommon in the Austin.

VENTILABRELLA EGGERI Cushman

Plate 8, figure 10

<u>Gümbelina</u> <u>acervulinoides</u> Egger (in part), K. bayer. Akad. Wiss. München., Math.-Physik. Kl., Abh., vol. 21, p. 36, pl. 14, fig. 20 (not figs. 17, 18, 21, 22), 1899.
<u>Ventilabrella</u> <u>eggeri</u> Cushman, Cushman Lab. Foram. Research, Contr., vol. 4, p. 2, pl. 1, figs. 10-12, 1928; U. S. Geol. Survey, Prof. Paper 206, p. 111, pl. 47, figs. 17-19, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 259, pl. 25, fig. 13, 1949.
<u>Ventilabrella</u> <u>eggeri</u> Cushman var. <u>eggeri</u> Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 111, pl. 16, fig. 10, 1954.

This species was described originally from Europe and has been recorded from Austin and Taylor equivalents of Texas, Mississippi, and Alabama. It is uncommon in in Austin strata.

Genus BOLIVINOIDES Cushman, 1927

BOLIVINOIDES DECORATUS (Jones)

Plate 8, figure 16

<u>Bolivina</u> <u>decorata</u> Jones, in J. Wright, Belfast Nat. Field Club, Proc., App. 9, p. 330, pl. 27, figs. 7, 8, 1886.
<u>Bolivinoides</u> <u>decorata</u> (Jones). Cushman, Cushman Lab. Foram. Research, Contr., vol. 2, p. 89, pl. 12, fig. 9, 1927; U. S. Geol. Survey, Prof. Paper 206, p. 113, pl. 48, figs. 8, 9, 1946 (see this reference for synonymy to 1946).
Kikoine, Soc. géol. France, 5th ser., C. R., vol. 18, p. 21, pl. 1, fig. 10, 1948.
Cushman, Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 259, pl. 24, fig. 14, 1949.
<u>Bolivinoides</u> <u>decoratus</u> (Jones) var. <u>decoratus</u> (Jones). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 111, pl. 16, figs. 17a,b, 1954.

This species has been recorded throughout the Taylor and Navarro of the Gulf Coastal Plain. It is uncommon in Austin samples.

Austin specimens exhibit variation in prominence of the chamber lobes to the extent that some specimens appear superficially to be _B_. _austinana_ Cushman. However, it appears to the writer that the smoothness is a result of erosion.

Genus EOUVIGERINA Cushman, 1926

EOUVIGERINA AMERICANA Cushman

Plate 8, figure 11

Eouvigerina americana Cushman, Cushman Lab. Foram. Research, Contr., vol. 2, p. 4, pl. 1, figs. 1a-c, 1926; U. S. Geol. Survey, Prof. Paper 206, p. 115, pl. 49, figs. 4, 5, 1946; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 260, pl. 24, fig. 18, 1949.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 112, pl. 16, figs. 15a,b, 1954.

Eouvigerina cretacea (Heron-Allen and Earland). White (not of Heron-Allen and Earland), Jour. Paleontology, vol. 3, p. 42, pl. 4, fig. 18, 1929.

Eouvigerina aculeata Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 62, pl. 7, figs. 8a,b, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 116, pl. 49, fig. 13, 1946.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 112, pl. 16, figs. 13, 14, 1954.

This form in Austin samples displays all gradations from _E_. _americana_ Cushman in the Bonham to the form that Cushman described as _E_. _aculeata_ Cushman in the chalk facies. It appears certain to the writer that _E_. _aculeata_ Cushman is only a poorly preserved _E_. _americana_ Cushman with chalk-filled sutures and eroded and flattened chamber edges, features considered by Cushman as characteristic of _E_.

aculeata Cushman. The latter is accordingly placed in synonymy with *E. americana* Cushman.

This species has been recorded from numerous localities in Taylor and Austin strata of Texas and from strata of Navarro age at a locality in Tennessee. It is fairly common in the Austin, occurring throughout the unit.

EOUVIGERINA AUSTINANA Cushman

Plate 8, figure 12

Eouvigerina austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 61, pl. 7, figs. 5a,b, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 116, pl. 49, fig. 9, 1946 (see this reference for synonymy to 1946).

Eouvigerina austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 112, pl. 16, figs. 24a,b, 1954.

This species has been reported from Austin and lower Taylor strata. It is uncommon in the Austin.

EOUVIGERINA PLUMMERAE Cushman

Plate 8, figure 13

Eouvigerina plummerae Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 62, pl. 7, figs. 6, 7, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 116, pl. 49, figs. 10, 11, 1946 (see this reference for synonymy to 1946).

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 113, pl. 16, fig. 28, 1954.

The record of this species confines it to Austin strata. It occurs most frequently in middle Austin strata of Collin and Dallas Counties.

Family BULIMINIDAE

Genus BULIMINELLA Cushman, 1911

BULIMINELLA CARSEYAE Plummer

Plate 8, figures 17a,b

Bulimina compressa Bailey. Carsey (not of Bailey), Univ. Texas, Bull. 2612, p. 29, pl. 4, fig. 14, 1926.
Buliminella carseyae Plummer, Univ. Texas, Bull. 3101, p. 179, pl. 8, fig. 7, 1931.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 119, pl. 50, figs. 17-20, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 261, pl. 24, fig. 22, 1949.
Buliminella carseyae Plummer var. carseyae Plummer. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 114, pl. 16, figs. 37, 38, 1954.

The records of this species demonstrate that it is common in Senonian strata of the Gulf Coastal Plain. It occurs rather frequently in the Gober of Fannin County, but is uncommon elsewhere in the Austin group.

Genus BULIMINA d'Orbigny, 1826

BULIMINA REUSSI Morrow

Plate 8, figure 18

Bulimina ovulum Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 37, pl. 8, fig. 57, pl. 13, fig. 73, 1845.
Bulimina murchisoniana d'Orbigny. Cushman (not of d'Orbigny), Jour. Paleontology, vol. 5, p. 308, pl. 35, figs. 14a,b, 1931.
Bulimina brevis d'Orbigny. Cushman (not of d'Orbigny), Cushman Lab. Foram. Research, Contr., vol. 7, p. 40, pl. 5, figs. 9a-c, 1931.
Bulimina reussi Morrow, Jour. Paleontology, vol. 8, p. 195, pl. 29, fig. 12, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 120, pl. 51, figs. 1-5, 1946 (see this reference for synonymy to 1946).
Bulimina ovulum Reuss var. ovulum Reuss. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 115, pl. 17, fig. 2, 1954.

The writer may have included a few specimens of <u>B</u>. <u>exigua</u> Cushman and Parker among those identified as <u>B</u>. <u>reussi</u> Morrow because the former so closely resemble nepionic specimens of the latter species. The two species are so similar in size and in taper that confusion is altogether likely.

This species has been widely recorded from Austin, Taylor, and Navarro strata of the Gulf Coastal Plain and the mid-continent area. It is common in the Austin.

Genus NEOBULIMINA Cushman and Wickenden, 1928

NEOBULIMINA CANADENSIS Cushman and Wickenden

Plate 8, figure 19

<u>Neobulimina</u> <u>canadensis</u> Cushman and Wickenden, Cushman Lab. Foram. Research, Contr., vol. 4, p. 13, pl. 1, figs. 1, 2, 1928.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 125, pl. 52, figs. 11, 12, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 116, pl. 17, figs. 11a,b, 1954.

This species has been widely and frequently recorded from strata ranging from upper Eagle Ford to Navarro in age, but it was found only in the lower Austin in this study.

NEOBULIMINA IRREGULARIS Cushman and Parker

Plate 8, figures 20, 21

<u>Neobulimina</u> <u>irregularis</u> Cushman and Parker, Cushman Lab. Foram. Research, Contr., vol. 12, p. 9, pl. 2, figs. 8a,b, 1936.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 125, pl. 52, fig. 13, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 261, pl. 25, fig. 1, 1949.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 116, pl. 17, figs. 12a,b, 1954.

This species was found only in lower Austin samples, but it is reported to range from upper Eagle Ford to lower Taylor.

Genus VIRGULINA d'Orbigny, 1826

VIRGULINA TEGULATA Reuss

Plate 8, figure 22

Virgulina tegulata Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 40, pl. 13, fig. 81, 1845.
Bandy, Jour. Paleontology, vol. 25, p. 512, pl. 75, figs. 7a-c, 1951 (see this reference for synonymy to 1951).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 117, pl. 17, figs. 20, 21, 1954.

This form occurs frequently but sparsely in Austin strata. It has a long range in the Gulf Coastal Plain, extending from the Eagle Ford through the Navarro. In Austin samples it varies considerably in size.

Genus LOXOSTOMUM Ehrenberg, 1854

LOXOSTOMUM CLAVATUM (Cushman)

Plate 8, figures 23, 24

Bolivina clavata Cushman, Cushman Lab. Foram. Research, Contr., vol. 2, p. 87, pl. 12, figs. 5a,b, 1927.
Loxostoma clavatum (Cushman). Cushman, Jour. Paleontology, vol. 6, p. 340, pl. 51, figs. 8a,b, 1932; U. S. Geol. Survey, Prof. Paper 206, p. 130, pl. 54, figs. 4-9, 1946 (see this reference for synonymy to 1946).
Loxostomum cushmani Wickenden, Royal Soc. Canada, Trans., 3rd ser., vol. 26, sec. 4, p. 91, pl. 1, figs. 6a,b, 1932.
Loxostoma cushmani Wickenden. Cushman and Deaderick, Cushman Lab. Foram. Research, Contr., vol. 18, p. 63, pl. 15, figs. 11-13, 1942.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 129,

pl. 53, figs. 24-31, 1946 (see this reference for synonymy to 1946).
Loxostomum clavatum (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 118, pl. 17, figs. 28-31, 1954.
Loxostomum cushmani Wickenden. Frizzell, Univ. Texas, Bureau Econ. Geol. Rept. Inv. no. 22, p. 118, pl. 17, figs. 32-34, 1954.

According to Cushman (1946, p. 130), Loxostomum cushmani Wickenden is distinguished from L. clavatum (Cushman) by "difference in shape, the greater tendency for the former to become uniserial, and the greater development of crenulations in the latter." These distinctions afford separation of the two forms only with much difficulty. Cushman has also stated (ibid.) that the two forms seldom occur together. In Austin samples they not only occur together, but L. clavatum (Cushman) was found only in samples that also contained L. cushmani Wickenden. In these samples it is evident that L. clavatum (Cushman) is derived from L. cushmani Wickenden, and it appears to be merely a slightly more clavate form which does not attain the uniserial stage of a normal L. cushmani Wickenden. Crenulation development is not necessarily greater in L. clavatum (Cushman).

In the writer's opinion, typical L. cushmani Wickenden and L. clavatum (Cushman) cannot be separated properly as two distinct species, and, accordingly, they should be conspecific. The name clavatum has priority, but it should be noted that L. clavatum (Cushman), as originally defined, is the atypical form.

Loxostomum clavatum (Cushman) has been recorded throughout the Gulf Coastal Plain from strata ranging in age from upper Austin through Navarro. It occurs in samples from the Bonham and Gober formations of Fannin County, especially in the latter, but is lacking in those of Collin and Dallas Counties. However, it has been recorded from the uppermost Austin of Collin County. The report from the "Ector" of Grayson County is questionable, as previously noted (see footnote 1, p. 30).

LOXOSTOMUM FANNINENSIS n. sp.

Plate 8, figure 25

Test elongate and very slender, five or more times longer than broad, very slightly tapering, straight, curved, or irregular and twisted, initially oval in transverse section, becoming circular, periphery rounded, initially regularly biserial, becoming irregularly biserial and ultimately tending to uniserial; chambers numerous, initially approximately equal in height and breadth, gradually increasing in height, more so than in breadth, initially uninflated, becoming strongly inflated and globular, extending farther across test as uniserial tendency develops; sutures initially flush, faintly limbate and essentially horizontal, becoming much depressed and curved, occasionally displaying a few faint, slight crenulations at base of an adult chamber; surface smooth and vitreous;

aperture oval, subterminal, tending to become terminal; length .69 mm., breadth .12 mm.

This new species is similar to L. plaitum (Carsey), which occurs throughout the Taylor and Navarro of the Gulf Coastal Plain. However, L. fanninensis n. sp. is definitely more slender than L. plaitum (Carsey), has horizontal rather than oblique early sutures, has high rather than broad chambers, has more globular terminal chambers, and has a stronger uniserial tendency.

Bonham and Gober samples reveal that L. fanninensis n. sp. grades into L. clavatum (Cushman) (i.e., L. cushmani Wickenden type) by increase in sutural crenulations and in robustness of test as the lithology changes from dominantly argillaceous to calcareous.

This new species is known only from the upper Bonham clay of Fannin County.

Family ELLIPSOIDINIDAE

Genus PLEUROSTOMELLA Reuss, 1860

PLEUROSTOMELLA AUSTINANA Cushman

Plate 9, figures 1a,b

Pleurostomella austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 64, pl. 7, fig. 13, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 131, pl. 54, figs. 19-21, 1946 (see this reference for synonymy to 1946).

Pleurostomella austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 120, pl. 18, fig. 4, 1954.

The previous record of this species confines it to the Austin chalk. It occurs frequently in samples from the lower and middle Austin of Dallas and Collin Counties, but is confined to the Ector chalk and basalmost Bonham of Fannin County.

PLEUROSTOMELLA NITIDA Morrow

Pleurostomella nitida Morrow, Jour. Paleontology, vol. 8, p. 196, pl. 30, figs. 22a,b, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 132, pl. 54, figs. 24a,b, (holotype redrawn), 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 120, pl. 18, figs. 5a,b, 1954.

A single but well preserved specimen of this species, identical to the holotype, was found in Sample 1, station F-14, from the middle Gober chalk of Fannin County.

PLEUROSTOMELLA WATERSI Cushman

Plate 9, figures 2a,b

Pleurostomella watersi Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 63, pl. 7, figs. 11, 12, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 132, pl. 54, figs. 22, 23, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 120, pl. 18, figs. 7, 8, 1954.

This species has been recorded from only four localities, all in the Austin chalk. The record from the "Bonham marl" (Cushman, 1946, p. 132, sample no. 328) is from the middle marl of the calcareous facies of the Austin and is several miles from the nearest outcrop of identifiable and normal Bonham lithology. Like P. austinana Cushman, this species occurs frequently in the lower and middle Austin of Dallas and Collin Counties, but is confined to the Ector and basalmost Bonham in Fannin County.

Genus NODOSARELLA Rzehak, 1895

NODOSARELLA TEXANA Cushman

Plate 9, figure 4

Nodosarella texana Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 46, pl. 8, fig. 1, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 133, pl. 55, fig. 18, 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 121, pl. 18, fig. 12, 1954.

The record of this species confines it to upper Austin and lowermost Taylor strata. It is uncommon in Austin strata. It occurs in only the uppermost Austin in Dallas and Collin Counties, but occurs in the lower Gober in Fannin County, more than 200 feet below the top of the Austin group.

Genus ELLIPSOIDELLA Heron-Allen and Earland, 1910

ELLIPSOIDELLA GRACILLIMA (Cushman)

Plate 9, figure 3

Nodosarella gracillima Cushman, Cushman Lab. Foram. Research, Contr., vol. 9, p. 64, pl. 7, figs. 14a,b, 1933; U. S. Geol. Survey, Prof. Paper 206, p. 134, p. 55, figs. 19-21, 1946 (see this reference for synonymy to 1946).
Ellipsoidella gracillima (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, pp. 120, 151, pl. 18, figs. 11a,b, 1954.

The record of this species is similar to that of Nodosarella texana Cushman: the species is confined to upper Austin and lower Taylor strata. However, E. gracillima (Cushman) occurs much more frequently and ranges lower in the Austin.

Genus STILOSTOMELLA Guppy, 1894

STILOSTOMELLA PSEUDOSCRIPTA (Cushman)

Plate 9, figure 5

Ellipsonodosaria pseudoscripta Cushman, Cushman Lab. Foram. Research, Contr., vol. 13, p. 103, pl. 15, fig. 14, 1937; U. S. Geol. Survey, Prof. Paper 206, p. 135, pl. 56, fig. 9, 1946.
Stilostomella pseudoscripta (Cushman). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, pp. 121, 151, pl. 18, fig. 12, 1954.

This species has a modest record of occurrence throughout the Gulf Coastal Plain in strata ranging from upper Austin through Navarro in age. It occurs rather frequently in the Bonham clay of Fannin County, but is uncommon elsewhere.

Family ROTALIIDAE

Genus DISCORBIS Lamarck, 1804

DISCORBIS MORROWI nom. nov.

Plate 9, figures 7a-c

Valvulineria infrequens Morrow, Jour. Paleontology, vol. 8, p. 197, pl. 30, figs. 3a-c, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 138, pl. 57, figs. 5a-c (holotype refigured), 1946 (see this reference for synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 123, pl. 18, figs. 35a-c, 1954.

The holotype of this species is sufficiently biconvex to render reasonable the original identification as *Valvulineria* Cushman, although the dorsal face is described as moderately convex and the ventral as concave. However, this species, which is rather common in Austin samples, is variably, but usually strongly, plano-convex, as illustrated in Plate 9, figures 7a-c. Specimens similar to the holotype are rare. Because of a majority of specimens with highly convex dorsal and flat to concave ventral surfaces, it is necessary to remove this species from the genus *Valvulineria* Cushman and assign it to the genus *Discorbis* Lamarck.

Since the name *Discorbis infrequens* Plummer is preoccupied (Plummer, 1927, p. 138), the new name *morrowi* is suggested.

Discorbis morrowi nom. nov. has been recorded from Austin and lowermost Taylor strata in Texas. It was originally described from the Niobrara chalk. It is rather common in Austin strata and is one of the few species found frequently in samples from Travis County.

Genus VALVULINERIA Cushman, 1926

VALVULINERIA CRETACEA (Carsey)

Plate 9, figures 8a-c

Rotalia cretacea Carsey, Univ. Texas, Bull. 2612, p. 48, pl. 5, figs. 1a,b, 1926.

Gyroidina depressa (Alth). Cushman and Church (not of Alth), California Acad. Sci., Proc., 4th ser., vol. 18, p. 515, pl. 41, figs. 4-6, 1929.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 139, pl. 58, figs. 1-4 (see this reference for synonymy to 1946).

Valvulineria plummerae Loetterle. Cushman (in part) (not of Loetterle), U. S. Geol. Survey, Prof. Paper 206, pl. 57, figs. 3a-c (not fig. 4; editorial error; see Loetterle, 1937, pl. 6, figs. 7a-c), 1946.

The confusion of this species and *V. cushmani* nom. nov. will be discussed in the remarks concerning the latter species, which immediately follows _V. cretacea_ (Carsey).

This species has been recorded throughout the Senonian of North and South America. It is rather common in the Austin.

VALVULINERIA CUSHMANI nom. nov.

Plate 9, figures 9a-c

Rotalia cretacea Carsey. Sandidge (not of Carsey), Am. Mid. Nat., vol. 13, p. 364, pl. 33, figs. 7, 8, 1932.
Valvulineria cretacea (Carsey). Cushman and Todd (not of Carsey), Cushman Lab. Foram. Research, Contr., vol. 19, p. 67, pl. 12, fig. 1, 1943.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 138, pl. 57, figs. 8a-c, 1946.
Gyroidina depressa (Alth). Frizzell (not of Alth), Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 123, pl. 18, figs. 36a-c, 1954.

The confusion of _V. cretacea_ (Carsey) and _V. cushmani_ nom. nov. is discussed in detail by Harris and McNulty (Jour. Paleontology, in print). Briefly, the history of the two forms is as follows: _Rotalia cretacea_ Carsey was described by Carsey as a new species. Cushman and Church incorrectly identified this species as _R. depressa_ Alth and erroneously changed the genus to _Gyroidina_ d'Orbigny. Cushman and Todd later described _Valvulineria cretacea_ Cushman and Todd, which was considered identical with Carsey's species and, consequently, was assigned that specific name. It is presumed that Cushman intended for Carsey's species to be removed from the synonymy of _Gyroidina depressa_ (Alth) Cushman and Church, but this was not done.

Harris and McNulty maintain that Carsey's species is not the same as that of Alth and that, therefore, the original name of Carsey has priority and should be used. They also present evidence that this species should be assigned to the genus Valvulineria Cushman instead of to Gyroidina d'Orbigny. Such change leaves V. cretacea (Carsey) Cushman and Todd (not of Carsey) a separate and distinct species with a homonymous name. Accordingly, they assign the name Valvulineria cushmani nom. nov.

Valvulineria cushmani nom. nov. has been reported from Taylor and Navarro strata of the Gulf Coastal Plain. It occurs rather frequently throughout middle and upper Austin strata.

VALVULINERIA PLUMMERAE Loetterle

Plate 9, figures 10a-c

Gyroidina nitida Reuss. Plummer (not of Reuss), Univ. Texas, Bull. 3101, p. 191, pl. 14, fig. 5, 1931.

Valvulineria plummerae Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 41, pl. 6, figs. 5, 6, 1937.

Cushman (in part), U. S. Geol. Survey, Prof. Paper 206, p. 137, pl. 56, figs. 4,(not figs. 3a-c), 1946 (see this reference for synonymy to 1946).

Frizzell (in part), Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 123, pl. 18, fig. 33 (not figs. 32a-c), 1954.

This species has been recorded from Austin, Taylor, and Navarro strata throughout the Gulf Coastal Plain. It occurs rather frequently in the Austin of Dallas County and sporadically elsewhere.

Genus QUADRIMORPHINA Finlay, 1939

QUADRIMORPHINA ALLOMORPHINOIDES (Reuss)

Plate 9, figure 12

Valvulina allomorphinoides Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, p. 223, pl. 11, figs. 6a-c, 1860.

Discorbina allomorphinoides (Reuss). Franke, Greifswald Univ., Geolog.-Pal. Inst., Abh., vol. 6, p. 91, pl. 8, figs. 11a,b, 1925.

Discorbis allomorphinoides (Reuss). Cushman, Am. Assoc. Petr. Geol., Bull., vol. 10, p. 606, pl. 20, figs. 18, 19; pl. 21, fig. 5, 1926.

Valvulineria allomorphinoides (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 7, p. 43, pl. 6, figs. 2a-c, 1931.

Kline, Mississippi State Geol. Survey, Bull. 53, p. 52, pl. 5, figs. 11, 12, 1943.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 138, pl. 57, figs. 6, 7, 1946 (see this reference for additional synonymy to 1946).

Cushman and Todd, Cushman Lab. Foram. Research, Contr., vol. 22, p. 62, pl. 11, fig. 1, 1946.

Cushman, Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 263, pl. 25, fig. 12, 1949; U. S. Geol. Survey, Prof. Paper 232, p. 50, pl. 14, figs. 8, 9, 1951.

Harris and Jobe, Microfauna of Basal Midway Outcrops near Hope, Arkansas, p. 46, pl. 8, figs. 14, 15, 1951.

Bandy, Jour. Paleontology, vol. 25, p. 503, pl. 74, figs. 4a-c, 1951.

Quadrimorphina allomorphinoides (Reuss). Finlay, Trans. Roy. Soc. New Zealand, vol. 69, p. 325, 1939.

"*Valvulineria*" *allomorphinoides* (Reuss). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 122, pl. 18, figs. 31a-c, 1954.

According to Glaessner (1945, p. 146) this species and its allies have been separated from *Valvulineria* Cushman and assigned to the genus *Quadrimorphina* Finlay.

Harris and Jobe (1951, p. 47) have suggested the possibility that the smaller Cretaceous forms assigned to ~~this species may be a different species. However, both~~

large and small specimens occur contemporaneously in Austin samples, and the writer observes no discernible specific difference between the two sizes.

This species has been found in Senonian strata of Europe and the western hemisphere. It occurs in small numbers throughout the Austin.

Genus GYROIDINA d'Orbigny, 1826

GYROIDINA GLOBOSA (Hagenow)

Plate 9, figures 11a,b

Nonionina globosa Hagenow, Neues Jahrb., p. 574, 1842.
Rotalia globosa (Hagenow). Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 44, pt. 1, p. 330, pl. 7, figs. 2a,b, 1862.
Gyroidina globosa (Hagenow). Cushman, Jour. Paleontology, vol. 5, p. 310, pl. 35, figs. 19a-c, 1931; U. S. Geol. Survey, Prof. Paper 206, p. 140, pl. 58, figs. 6-8, 1946 (see this reference for synonymy to 1946); Cushman Lab. Foram. Research, Contr., vol. 23, p. 13, pl. 4, fig. 23, 1947; Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 264, pl. 25, figs. 15, 16, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 124, pl. 18, figs. 40a-c, 1954.

This species occurs throughout the Senonian of North America. Although present in small numbers, it occurs throughout Austin strata.

Family CHILOSTOMELLIDAE

Genus ALLOMORPHINA Reuss, 1850

ALLOMORPHINA TROCHOIDES (Reuss)

Plate 9, figures 13a,b

Globigerina trochoides Reuss, Verstein. böhm. Kreideformation, pt. 1, p. 36, pl. 12, fig. 22, 1845.
Valvulina trochoides (Reuss). Franke, Preuss. geol. Lande

sanstalt, Abh., new ser., vol. 111, p. 162, pl. 15, figs. 2a-c, 1928.

Allomorphina trochoides (Reuss). Cushman and Jarvis, U. S. Nat. Mus., Proc., vol. 80, art. 14, p. 49, pl. 15, figs. 3a-c, 1932.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 145, pl. 60, fig. 7, 1946 (see this reference for additional synonymy to 1946).

This species was described from the Upper Cretaceous of Europe and has been recorded from Trinidad and Mexico but not from Texas. It occurs in uppermost Austin strata, where it is very uncommon.

Family GLOBIGERINIDAE

Genus GLOBIGERINA d'Orbigny, 1826

GLOBIGERINA sp. cf. G. CRETACEA d'Orbigny

Plate 9, figures 14a-c

Globigerina cretacea d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 34, pl. 3, figs. 12-14, 1840.

This very abundant Austin species is coiled in a definite but very low helix. It displays five to seven chambers in the final whorl. In general the chambers increase regularly but gradually in size, although individual specimens occasionally display aberration of some chamber, such as decrease in size or twisting of the terminal chamber. The chambers are set rather well apart, and the periphery of the test is lobulate. The umbilicus is extremely large on specimens with seven chambers in the final whorl, but it is reduced with decrease in number of chambers in the final whorl. It is presumed that each chamber opens into the umbilicus, although this was not substantiated because of calcareous deposits in the umbilicus.

This species displays the characteristics generally accepted for _G_. _cretacea_ d'Orbigny, but it is accompanied by abundant specimens that appear identical except for the presence of two weak peripheral carinae. These carinae usually decrease in strength aperturally and are often lacking in the final and penultimate chambers. The carinate forms are most abundant in the lower Austin.

Such weakly carinate globigerinids have usually been assigned to _Globotruncana_ _globigerinoides_ Brotzen (e.g., Hamilton, 1953, p. 233; Bolli, 1951, p. 198), and they are so grouped in this report. However, such separation certainly seems unnatural, and the identification of both _Globigerina_ sp. cf. _G_. _cretacea_ d'Orbigny and _Globotruncana_ sp. cf. _G_. _globigerinoides_ Brotzen is, consequently, in doubt.

Genus RUGOGLOBIGERINA Bronniman, 1952

RUGOGLOBIGERINA RUGOSA RUGOSA (Plummer)

Plate 9, figures 15a-c

Globigerina _cretacea_ d'Orbigny. Carsey (not of d'Orbigny), Univ. Texas, Bull. 2612, p. 43, pl. 5, fig. 5, 1926.
Cushman (not of d'Orbigny), Tenn. Div. Geol., Bull. 41, p. 53, pl. 10, figs. 6, 7, 1931.
Schell (not of d'Orbigny), Southern Methodist Univ., Master's Thesis, p. 80, 1952.
Globigerina _rugosa_ Plummer, Univ. Texas, Bull. 2644, p. 38, pl. 2, figs. 10a-d, 1927; Univ. Texas, Bull. 3101, p. 194, 1931.
Rugoglobigerina _rugosa_ _rugosa_ (Plummer). Bronniman, Bull. ~~Amer. Paleontology, vol. 34, no. 140, p. 28,~~

text figs. 11-13, 1952.
Hamilton, Jour. Paleontology, vol. 27, p. 227, pl. 30, figs. 1-3, 1953.

Although no umbilical cover plate was observed on Austin specimens, all possess along the umbilical margin of the final chamber some degree of flange, which appears to be the basal remnant of a cover plate. In addition, well preserved specimens display the diagnostic radial alignment of cancellate spines. The form has been recorded from the Eagle Ford, Navarro, Ripley, and Upper Cretaceous of Trinidad. It is very abundant in Austin strata.

Genus GLOBIGERINELLA Cushman, 1927

GLOBIGERINELLA ASPERA (Ehrenberg)

Plate 10, figures 1a,b

Rotalia aspera Ehrenberg, Mikrogeologie, pl. 27, figs. 57, 58; pl. 28, figs. 42, 42a, 1854.
Globigerinella aspera (Ehrenberg). Carman, Jour. Paleontology, vol. 3, p. 59, pl. 34, fig. 6, 1929.
Bandy, Jour. Paleontology, vol. 25, p. 508, pl. 75, figs. 3a-c, 1951 (see this reference for synonymy to 1951).
Hamilton, Jour. Paleontology, vol. 27, p. 226, pl. 30, fig. 5, 1953.

Since the original designation of this species lacked any description, and since illustrated specimens were viewed in transmitted light of a Canada balsam mount, the definition of the species must be a product of later workers' consensus.

Some workers have emphasized exceptionally rapid expansion of the final two or three chambers; others apparently consider forms with chambers of regularly increasing size to be acceptable. Consequently, this common Austin species, with chambers of regularly increasing size, is assigned to G. aspera (Ehrenberg), with the note that later analysis of the species may cause it and other similar forms to be separated.

Genus HASTIGERINELLA Cushman, 1927

HASTIGERINELLA ALEXANDERI Cushman

Plate 10, figures 2a,b

Hastigerinella alexanderi Cushman, Cushman Lab. Foram. Research, Contr., vol. 7, p. 87, pl. 11, figs. 6-9, 1931; U. S. Geol. Survey, Prof. Paper 206, p. 148, pl. 61, figs. 4-7, 1946.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 127, pl. 20, figs. 15, 16, 1954.

With its planispirally coiled chambers varying from subglobular to extremely elongate conical, H. alexanderi Cushman is a most distinctive species. It has been recorded from only two localities in the lower and middle Austin of Grayson County. However, it is actually rather common in the lower and middle Austin of the calcareous facies of Collin and Dallas Counties, although it was not found above lowermost Bonham clay strata in the argillaceous facies of Fannin County.

The species is evidently confined to the Austin and will serve as an index fossil for the unit.

HASTIGERINELLA SIMPLEX Morrow

Plate 10, figures 3a,b

Hastigerinella simplex Morrow, Jour. Paleontology, vol. 8,

p. 198, pl. 30, figs. 6a,b, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 148, pl. 61, fig. 10, 1946 (see this reference for additional synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 127, pl. 20, figs. 13a,b, 1954.

This species was described originally from the Greenhorn formation of Kansas and has been reported from the Niobrara and Austin chalks. It is similar to the rapidly expanding type of *Globigerinella aspera* (Ehrenberg), and slightly atypical specimens are difficult to distinguish from the latter species. Although not abundant, the species occurs throughout Austin strata.

HASTIGERINELLA WATERSI Cushman

Plate 10, figures 4a,b

Hastigerinella watersi Cushman, Cushman Lab. Foram. Research, Contr., vol. 7, p. 86, pl. 11, figs. 4, 5, 1931; U. S. Geol. Survey, Prof. Paper 206, p. 148, pl. 61, figs. 8, 9, 1946 (see this reference for additional synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 128, pl. 20, figs. 17a,b, 1954.

This species has been recorded from the Niobrara chalk and the lower and middle Austin. It occurs rather frequently in the lower and middle Austin of the calcareous facies of Dallas and Collin Counties, but is lacking in samples from Fannin County. Like *H. alexanderi* Cushman, it is restricted to Austin strata and may serve as an index fossil for the unit.

Family GLOBOROTALIIDAE

Genus GLOBOTRUNCANA Cushman, 1927

"GLOBOTRUNCANA CANALICULATA (Reuss)"

Plate 10, figures 5a-c

?Rosalina canaliculata Reuss, Akad. Wiss. Wien., Math.-naturwiss. Kl., Mem., vol. 7, pt. 1, p. 70, pl. 26, fig. 4, 1854.

Globotruncana canaliculata (Reuss). Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 149, pl. 61, figs. 17, 18, 1946 (see this reference for partial synonymy to 1946).

Bandy, Jour. Paleontology, vol. 25, p. 509, pl. 75, figs. 2a-c, 1951.

Hamilton, Jour. Paleontology, vol. 27, p. 232, pl. 29, figs. 9, 10, 1953.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 128, pl. 20, figs. 21a-c, 1954.

Globotruncana lapparenti lapparenti Bolli, Eclogae geol. Helvetiae, vol. 37, p. 230, fig. 1, nos. 15, 16; pl. 9, fig. 11, 1944.

This species is recognized essentially by its parallel sides. The ventral sutures are curved in the G. lapparenti Bolli fashion, and the umbilicus is relatively large. The peripheral carinae are well developed and well separated, producing a blunt, conspicuously truncate periphery.

This is the common Upper Cretaceous species that has been consistently identified as G. canaliculata (Reuss) by American workers, although it differs notably in ventral aspect from the original illustration of Reuss, as European workers have noted. According to Bolli (1951, pp. 191, 192, 194), it should be placed in synonymy with G. lapparenti lapparenti Bolli. However, Bolli (1951, p. 191) called attention to the possibility that the original illustrations of Reuss' species may be inaccurate and that _G_. _canaliculata_ (Reuss) may actually possess the identical ventral character of _G_. _lapparenti lapparenti_ Bolli. In such event, _G_. _canaliculata_ (Reuss), _G_. _canaliculata_ of Cushman and other American workers, and _G_. _lapparenti lapparenti_ Bolli would be synonymous, and the species would be _G_. _canaliculata_ (Reuss). Consequently, and until the problem is clarified, the writer employs the earlier name for the Austin form, although it is apparently synonymous with Bolli's species.

This Austin species is common and occurs throughout the unit.

GLOBOTRUNCANA FORNICATA Plummer

Plate 10, figures 6a,b

Globotruncana fornicata Plummer, Univ. Texas, Bull. 3101, p. 198, pl. 13, figs. 4-6, 1931.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 149, pl. 61, figs. 19a-c, 1946 (see this reference for synonymy to 1946).
Cita, Riv. ital. paleon., anno. 54, p. 153, pl. 3, figs. 8a-c, 1948.
Bolli, Jour. Paleontology, vol. 25, p. 194 (no illustration), 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 232, pl. 29, fig. 21, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 129, pl. 20, figs. 26a-c, 1954.

This distinctive species of _Globotruncana_ Cushman is common in Austin strata. It frequently occurs with _G_. _rosetta_ (Carsey), and it appears that _G_. _fornicata_ Plummer is derived from _G_. _rosetta_ (Carsey) by reduction in number and increase in curvature of chambers.

GLOBOTRUNCANA sp. aff. G. GLOBIGERINOIDES Brotzen

Plate 10, figures 7a,b

Globotruncana globigerinoides Brotzen, Sveriges geol. Undersökning, ser. C, no. 396, Arsbok 30, pl. 12, figs. 3a-c; pl. 13, fig. 3, 1936.

Except for two rather weak peripheral carinae, which often disappear on terminal chambers, this species is identical with Globigerina sp. cf. G. cretacea d'Orbigny, as noted in the discussion of that species. In recent years such weakly carinate globigerinids have been assigned to Brotzen's species (Bolli, 1944, p. 233; 1951, p. 198, Hamilton, 1953, p. 233), and that procedure is followed here.

This species appears to grade almost imperceptibly into Globotruncana marginata (Reuss) by increase in strength and separation of carinae and by increase in curvature of dorsal sutures.

This species is abundant throughout Austin strata.

GLOBOTRUNCANA MARGINATA (Reuss)

Plate 10, figures 8a,b

Rosalina marginata Reuss, Verstein, böhm. Kreideformation, pt. 1, p. 36, pl. 8, figs. 54, 74; pl. 13, fig. 68, 1845.

Globotruncana marginata (Reuss). Thalmann, Eclogae geol. Helvetiae, vol. 27, p. 414, 1934.

Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 150, pl. 62, figs. 1, 2, 1946 (see this reference for synonymy to 1946).

Hamilton, Jour. Paleontology, vol. 27, p. 233, pl. 29, figs. 23-25, 1953.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 129, pl. 20, figs. 24a-c, 1954.

Globotruncana lapparenti bulloides (Vogler). Bolli, Eclogae geol. Helvetiae, vol. 37, p. 231, fig. 1, nos. 17, 18; pl. 9, fig. 12, 1944.

As in the case of "*Globotruncana canaliculata* (Reuss)", there is here a question of the specific name to be employed for this species. It has generally been identified as *G. marginata* (Reuss) by American workers, but Bolli has placed it in synonymy with *G. lapparenti bulloides* (Vogler).

Specimens from Austin samples suggest that this species may be related to "*G. canaliculata* (Reuss)," and that the latter may have been derived from a form such as *G. marginata* (Reuss).

GLOBOTRUNCANA ROSETTA (Carsey)

Plate 10, figures 9a-c

Globigerina rosetta Carsey, Univ. Texas, Bull. 2612, p. 44, pl. 5, figs. 3a-c, 1926.
?*Pulvinulina arca* Cushman, Cushman Lab. Foram. Research, Contr., vol. 2, p. 23, pl. 3, figs. 1a-c, 1926.
Globotruncana rosetta (Carsey). White, Jour. Paleontology, vol. 2, p. 286, pl. 39, fig. 1, 1928.
Bandy, Jour. Paleontology, vol. 25, p. 509, pl. 75, figs. 4a-c, 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 233, pl. 29, figs. 26-28, 1953.
?*Globotruncana arca* (Cushman). Cushman, Cushman Lab. Foram. Research, Contr., vol. 3, p. 91, pl. 19, fig. 11, 1927.

The status and relations of *G. rosetta* (Carsey) have been the subject of controversy since the publication of Cushman's Professional Paper 206 (1946). In this and many previous reports Cushman assigned *G. rosetta* (Carsey) to synonymy with *G. arca* (Cushman). However, illustrations of *G. arca* (Cushman) in U. S. Geological Survey Professional

Paper 206 (pl. 62, figs. 4, 5) depict two apparently unrelated and quite dissimilar specimens. One of these is the holotype of G. arca (Cushman), illustrated by reproduction of the original illustration. The second is a form that closely resembles G. rosetta (Carsey). The accompanying description and remarks do not explain the apparent anomaly. Consequently, several workers understandably questioned or rejected inclusion of the rosetta-like form in G. arca (Cushman).

The evidence for combining these two forms was discussed in detail by Plummer (1931, pp. 195-198). According to Mrs. Plummer, G. arca (Cushman) and G. rosetta (Carsey) are end members of variants within a single species. The characteristics which vary are the number and strength of peripheral keels and the relative convexity of ventral and dorsal faces. Immature forms, from which the holotype of G. arca (Cushman) was chosen, possess two definite peripheral keels throughout the final whorl and are biconvex and bluntly truncate on the periphery. Variation within the species allows the ventral keel to become obscure, (by decrease in its relief and simultaneous crowding against the dorsal keel) and ultimately to disappear completely. These changes appear first on final chambers of the final whorl of a test and extend progressively toward the initial chambers of the final whorl, producing in extremes of variation a uni-carinate specimen. Disappearance of the ventral keel is usually accompanied by increase in convexity of the ventral face. Extremes of variation, from which G. rosetta (Carsey) was described, are essentially plano-convex and single keeled.

It is possible that Mrs. Plummer's views may be erroneous despite evidently extensive study of the problem. Present American workers appear to regard G. arca (Cushman) as a biconvex, almost discoid, bluntly truncated form with widely separated peripheral keels, as has been well illustrated by Bandy (1951, p. 75, figs. 1a-c). Such characteristics may be inferred from the original illustrations, although these illustrations are vague and indistinct. The original description is uninformative as to these properties, and it contains no information concerning the curvature of ventral sutures.

Specimens examined for this report support Mrs. Plummer's observations. They vary in development of peripheral keels from forms with a distinct ventral keel, which becomes indistinct on terminal chambers, to forms which are virtually single keeled throughout. They vary in shape from sub-biconvex to plano-convex. However, typical G. arca (Cushman) types with distinct and strong development of both keels throughout are uncommon.

Most of the Austin specimens are intermediate to both G. arca (Cushman) and G. rosetta (Carsey) as defined originally. However, they more closely resemble G. rosetta

(Carsey) than G. arca (Cushman). Moreover, Carsey's species was published in March, 1926, whereas Cushman's was published in April, 1926. Therefore, G. rosetta (Carsey) has priority and is employed here.

This species occurs throughout the Austin, but is particularly abundant in the lower Austin.

GLOBOTRUNCANA sp.

Plate 10, figures 10a-c

This Austin species is characterized by a flat to somewhat convex dorsal face with raised, beaded sutures that vary from strong curvature in initial stages to slight and tangential curvature in terminal stage. The ventral face is convex initially and increases in convexity and inflation of chambers terminally. The ventral sutures are raised, beaded, and very slightly curved aperturally, but they appear radial because of their depression between the much inflated chambers. Superficially there appears to be but a single keel, but actually there are two: the lower keel is usually distinct on the early chambers, but is weak and crowded against the stronger dorsal keel on final chambers. Typically the ventral keel is obscure on final chambers, but may be distinct.

This Austin species displays the characteristics of G. cretacea Cushman, with the possible exception of ventral sutures, which may be curved anteriorly on the latter species. However, Globotruncana sp. is confined to lowermost Austin strata, whereas G. cretacea Cushman has been recorded throughout the Austin, Taylor, and Navarro and was originally described from the Ripley (Navarro) formation of Tennessee. This discrepancy suggests that this Austin form may not be conspecific with Cushman's species, and that variants of some third species, probably G. rosetta (Carsey), have been identified as G. cretacea Cushman in Austin strata.

This species is also generally similar to Globorotalia cushmani Morrow, but possesses a large, open, uncovered umbilicus and double carinae. It is possible that the forms identified as G. cushmani Morrow from the lower Austin of Dallas and Collin Counties (Cushman, 1946, p. 152) actually are of this species, since it is similar to G. cushmani Morrow and the latter was not found in the samples of this study.

Some specimens of this species become sufficiently inflated ventrally and flattened dorsally to suggest affinity to G. ventricosa White. However, typical specimens of White's species display somewhat different curvature of sutures and less rapidly expanding chambers; hence, this relationship is questionable and is mentioned only to note the possibility for other observers.

GLOBOTRUNCANA VENTRICOSA White

Plate 10, figures 11a-c

Globotruncana canaliculata (Reuss) var. ventricosa White,

Jour. Paleontology, vol. 2, p. 284, pl. 38, fig. 5, 1928.
Globotruncana ventricosa White. Brotzen, Sveriges geol. Undersökning, ser. C, Arsbok 30, p. 171, pl. 13, figs. 4a-c, text fig. 63, 1936.
Cushman, Cushman Lab. Foram. Research, Contr., vol. 20, p. 96, 1944; U. S. Geol. Survey, Prof. Paper 206, p. 150, pl. 62, fig. 3, 1946.
Bolli, Jour. Paleontology, vol. 25, pp. 192, 194, (no illustration), 1951.
Hamilton, Jour. Paleontology, vol. 27, p. 233, pl. 29, figs. 29-31, 1953.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 129 (no illustration), 1954.

This species and G. fornicata Plummer are the two most distinctive of Globotruncana Cushman in Austin strata. Globotruncana ventricosa White is common throughout the Austin group.

Genus GLOBOROTALITES Brotzen, 1942

GLOBOROTALITES MICHELINIANA (d'Orbigny)?

Plate 10, figures 12, 13

Rotalina micheliniana d'Orbigny, Soc. géol. France, Mém., 1st ser., vol. 4, p. 31, pl. 3, figs. 1-3, 1840.
Truncatulina refulgens (Montfort). var. conica Carsey, Univ. Texas, Bull. 2612, p. 46, pl. 4, fig. 15, 1926.
Eponides micheliniana (d'Orbigny). Plummer, Univ. Texas, Bull. 3101, p. 192, pl. 14, fig. 11, 1931.
Globorotalia micheliniana (d'Orbigny). Cushman, Cushman Lab. Foram. Research, Contr., vol. 7, p. 45, pl. 6, figs. 8a-c, 1931; U. S. Geol. Survey, Prof. Paper 206, p. 152, pl. 63, figs. 2, 3, 1946 (see this reference for additional synonymy to 1946).
Gyroidina micheliniana (d'Orbigny). Cushman, Jour. Paleontology, vol. 6, p. 342, pl. 51, figs. 12a-c, 1932.
Globorotalites micheliana (d'Orbigny). Cushman, Foraminifera, ed. 4, Key, pl. 35, figs. 13a-c, 1948.
Gyroidina alabamensis Sandidge, Jour. Paleontology, vol. 6, p. 283, pl. 43, figs. 13-15, 1932.
Globorotalites conicus (Carsey). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 130, pl. 20, figs. 31a-c, 1954.

This species has been recorded widely from Taylor and Austin strata and has been assigned to d'Orbigny's species by many workers. Recently Frizzell (1954, p. 130) has removed it from that designation without stating reasons. Since Cushman had available topotype material for comparison with this American form, it seems judicious to maintain his assignment until valid reasons for change are presented.

The majority of the Austin specimens are small to medium in size, making difficult their distinction from G. subconicus (Morrow). Large specimens do occur in uppermost Austin strata, particularly in the upper part of the Gober chalk of Fannin County, and they appear identical with the smaller forms. Some medium-sized to large specimens were also found in lowermost Austin strata of Dallas and Fannin Counties. No specific difference could be observed between these large and small specimens.

The species occurs in modest numbers throughout Austin strata.

GLOBOROTALITES SUBCONICUS (Morrow)?

Plate 10, figures 14a-c

Globorotalia subconica Morrow, Jour. Paleontology, vol. 8 p. 200, pl. 30, figs. 11, 18, 1934.
Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 43, pl. 6, figs. 10a-c, 1937.
Globorotalites subconicus (Morrow). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 130, pl. 20, figs. 32a-c, 1954 (see this reference for additional synonymy to 1954).

The occasional forms assigned to this species in this report are small, are depressed, and have definitely concavely conical outline. They appear to the writer no more than somewhat crushed specimens of G. micheliniana (d'Orbigny)? and doubtfully separable from the latter.

This form is uncommon in Austin strata.

GLOBOROTALITES UMBILICATUS (Loetterle)

Plate 10, figures 15a-c

Globorotalia umbilicata Loetterle, Nebraska Geol. Survey, Bull. 12, 2nd ser., p. 43, pl. 6, figs. 9a-c, 1937.
Globorotalites umbilicatus (Loetterle). Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 130, pl. 20, figs. 33a-c, 1954 (see this reference for additional synonymy to 1946).

This species has been recorded from a number of localities in lower Taylor and Austin strata. Although present in limited numbers, it occurs throughout Austin strata.

Family ANOMALINIDAE

Genus ANOMALINA d'Orbigny, 1826

ANOMALINA AMMONOIDES (Reuss)

Plate 10, figures 16a-c

Rosalina ammonides Reuss, Geognostische Skizzen Böhmen, vol. 2, pt. 1, p. 214, 1844.
Anomalina ammonides (Reuss). Chapman, Quart. Jour. Geol. Soc., vol. 50, p. 722, 1894.
Anomalina ammonoides (Reuss). Cushman, Cushman Lab. Foram. Research, Contr., vol. 16, p. 28, pl. 5, figs. 4, 5, 1940; U. S. Geol. Survey, Prof. Paper 206, p. 154, pl. 63, figs. 10, 11, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 266, pl. 26, figs. 7a,b, 1949.
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 130, pl. 21, figs. 1a-c, 1954.

This species occurs in Taylor and Austin strata in Texas. It is very uncommon in Austin strata, occurring well down in the Gober chalk of Fannin County, but confined to uppermost Austin strata in Collin and Dallas Counties.

Genus PLANULINA d'Orbigny, 1826

PLANULINA AUSTINANA Cushman

Plate 10, figure 17

Planulina austinana Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 68, pl. 12, figs. 2a-c, 1938; Cushman Lab. Foram. Research, Contr., vol. 16, p. 33, pl. 6, figs. 6a-c, 1940; U. S. Geol. Survey, Prof. Paper 206, p. 156, pl. 64, figs. 10a-c, 1946.
Planulina austiniana Cushman. Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 132, pl. 21, figs. 9a-c, 1954.

The record of this species confines it to lower and middle Austin strata of Texas. It occurs in samples from the lower and middle Austin of Dallas and Collin Counties, but is restricted to Ector and basalmost Bonham beds in Fannin County. Evidently the form may serve as an Austin guide fossil; however, it is uncommon in faunules.

PLANULINA KANSASENSIS Morrow

Plate 10, figure 18

Planulina kansasensis Morrow, Jour. Paleontology, vol. 8, p. 201, pl. 30, figs. 2, 12, 15, 1934.
Cushman, U. S. Geol. Survey, Prof. Paper 206, p. 157, pl. 64, figs 12a-c, 1946 (see this reference for additional synonymy to 1946).
Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 132, pl. 21, figs. 16a-c, 1954.

This species was described from the Niobrara chalk of Kansas. It has been recorded from strata of Austin age in Texas and Arkansas. Like P. austinana Cushman, it occurs in samples of the lower and middle Austin of Dallas and Collin Counties, but it is greatly restricted in Fannin County, occurring in only the Ector chalk. This distribution reflects doubt upon the records of occurrence much higher in the section in Lamar County, Texas, and Sevier County, Arkansas (Cushman, 1946, p. 157).

PLANULINA TEXANA Cushman

Plate 10, figures 19a-c

Planulina texana Cushman, Cushman Lab. Foram. Research, Contr., vol. 14, p. 69, pl. 12, figs. 3a-c, 1938; U. S. Geol. Survey, Prof. Paper 206, p. 157, pl. 64, figs. 11a-c, 1946 (see this reference for synonymy to 1946); Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, p. 266, pl. 26, figs. 9a,b, 1949.

Frizzell, Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, p. 132, pl. 21, figs. 15a-c, 1954.

This species displays a tendency to become more fragile in the Bonham clay of Fannin County, suggesting that it may develop into P. dumblei (Applin) (formerly P. taylorensis (Carsey)) in the Taylor, due to changed environment.

Planulina texana Cushman is common in Austin and Taylor strata of the Gulf Coastal Plain. It is very abundant in Austin strata, constituting one of the most dominant species.

CONCLUSION

FAUNA

The Foraminifera of the Austin strata will be presented by noting: (1) the number of species present, (2) the proportions of species present, and (3) the characteristic species of the Austin group.

In the samples of this study, 148 species have been identified, including eleven new species and eight possibly new species. Of the 129 previously described species, the following thirty-eight have not been reported hitherto from Austin strata of Texas:

"*Proteonina difflugiformis* (H. B. Brady)"

Reophax constricta (Reuss)

Haplophragmoides fraseri Wickenden

Haplophragmoides irregularis (White)

Frankeina rugosissima (Alexander and Smith)

Gaudryina ellisorae Cushman

Gaudryina faujasi (Reuss)

Gaudryina nebrascensis Loetterle

Lenticulina kansasensis Morrow?

Astacolus taylorensis Plummer

Planularia planotrochiformis Hussey and McNulty

Planularia umbonata Loetterle

Marginulina bullata Reuss

Marginulina cretacea Cushman

Marginulina curvatura Cushman?

Marginulina inconstantia Cushman

Marginulina pseudomarcki Cushman

Marginulina texasensis Cushman

"*Dentalina aculeata* d'Orbigny"

Dentalina delicatula Cushman

Dentalina niobrarensis Loetterle?

Dentalina stephensoni (Cushman)

Nodosaria alternistriata Morrow

Pseudoglandulina lagenoides (Olszewski)

Lingulina taylorana Cushman?

Vaginulina sp. cf. *V. cretacea* Plummer

Vaginulina sp. cf. *V. silicula* (Plummer)

Frondicularia archiaciana d'Orbigny

Pyrulina cylindroides (Roemer)

Ramulina laevis Rupert Jones

Gümbelina planata Cushman

Valvulineria cushmani nom. nov.

Allomorphina trochoides (Reuss)

Globigerina sp. cf. *G. cretacea* d'Orbigny

Rugoglobigerina globosa globosa (Plummer)

Globigerinella aspera (Ehrenberg)

Globotruncana sp. aff. *G. globigerinoides* Brotzen

Globotruncana rosetta (Carsey)

In Cushman's (1946) monographic report concerning Foraminifera of the Gulf Coastal Plain there were listed 143 species from Austin strata of Texas. In the present study, four of these species have been placed in synonymy; four (*Marginulina austinana* Cushman var. *acescens* Cushman, *Dentalina legumen* Reuss, *Nodosaria distans* Reuss, and *Frondicularia linearis* Franke) have been omitted purposely because of questionable identification with fragmental or immature specimens of other species; and the following eighty-nine have been recognized in the samples of this study:

Ammodiscus cretaceus (Reuss)

Flabellammina clava Alexander and Smith

"*Spiroplectammina*" *laevis* (Roemer) var. *cretosa* Cushman

Gaudryina austinana Cushman

Gaudryina faujasi (Reuss)

Gaudryinella bentonensis (Carman)

Pseudoclavulina clavata (Cushman)

Pseudogaudryinella capitosa (Cushman)

Heterostomella austinana Cushman

Arenobulimina americana Cushman

Marssonella oxycona (Reuss)

Dorothia? alexanderi Cushman

Dorothia stephensoni Cushman

Polyphragma sp.

Lenticulina münsteri (Roemer)

"*Lenticulina rotulata* (Lamarck)"

Saracenaria triangularis (d'Orbigny)

Marginulinopsis stephensoni (Cushman)

Marginulina austinana Cushman

Marginulina directa (Cushman)

Dentalina alternata (Jones)

Dentalina gracilis d'Orbigny

Nodosaria septemcostata Geinitz

Nodosaria fusula Reuss

Chrysalogonium texanum Cushman

Pseudoglandulina manifesta (Reuss)

Citharina texana (Cushman)

Palmula cushmani (Morrow)?

Palmula pilulata Cushman

Palmula rugosa (d'Orbigny)

Palmula suturalis (Cushman)

Kyphopyxa christneri (Carsey)

Frondicularia austinana Cushman

Frondicularia cordata Roemer

Frondicularia goldfussi Reuss?

Frondicularia inversa Reuss?

Frondicularia lanceola Reuss

Frondicularia lanceola Reuss var. *bidentata* Cushman

Frondicularia mucronata Reuss

Frondicularia undulosa Cushman

Frondicularia verneuiliana d'Orbigny

Lagena sp. cf. *L. acuticosta* Reuss

Lagena sp. cf. *L. hispida* Reuss

Globulina lacrima Reuss

Vitriwebbina biosculata Frizzell

Nonionella austinana Cushman

Spiroplectoides rosula (Ehrenberg)

Gümbelina globulosa (Ehrenberg)

Gümbelina plummerae Loetterle

Gümbelina pseudotessera Cushman

Gümbelina striata (Ehrenberg)

Rectogümbelina hispidula Cushman

Rectogümbelina texana Cushman

Ventilabrella austinana Cushman

Ventilabrella eggeri Cushman

Bolivinoides decoratus (Jones)

Eouvigerina americana Cushman

Eouvigerina austinana Cushman

Eouvigerina plummerae Cushman

Buliminella carseyae Plummer

Bulimina reussi Morrow

Neobulimina canadensis Cushman and Wickenden

Neobulimina irregularis Cushman and Parker

Virgulina tegulata Reuss

Loxostomum clavatum (Cushman)

Pleurostomella austinana Cushman

Pleurostomella nitida Morrow

Pleurostomella watersi Cushman

Ellipsoidella gracillima Cushman

Nodosarella texana Cushman

Stilostomella pseudoscripta (Cushman)

Discorbis morrowi nom. nov.

Valvulineria cretacea (Carsey)

Valvulineria plummerae Loetterle

Quadrimorphina allomorphinoides (Reuss)

Gyroidina globosa (Hagenow)

Hastigerinella alexanderi Cushman

Hastigerinella simplex Morrow

Hastigerinella watersi Cushman

"Globotruncana canaliculata (Reuss)"

Globotruncana fornicata Plummer

Globotruncana marginata (Reuss)

Globotruncana ventricosa White

Globorotalites micheliniana (d'Orbigny)

Globorotalites subconicus (Morrow)

Globorotalites umbilicatus (Loetterle)

Planulina austinana Cushman

Planulina kansasensis Morrow

Planulina texana Cushman

Forty-five of the species reported by Cushman from Austin strata of Texas were not recognized in the samples of this study:

Bathysiphon _taurinensis_ Sacco

Bathysiphon _alexanderi_ Cushman

Pelosina _complanata_ Franke

Glomospira _gordialis_ (Jones and Parker)

Haplophragmoides _calcula_ Cushman and Waters

Ammobaculites _coprolithiformis_ (Schwager)

Ammobaculites _fragmentarius_ Cushman

Flabellammina _rugosa_ Alexander and Smith

Haphlophragmium _taylorense_ Cushman and Waters

Lituola _taylorensis_ Cushman and Waters

Spiroplectammina _lalickeri_ Albritton and Phleger

Textularia _subconica_ Franke

Verneuilina _cretosa_ Cushman

Gaudryina _rudita_ Sandige

Gaudryina _stephensoni_ Cushman

Clavulinoides _aspera_ (Cushman)

Pseudogaudryinella _mollis_ (Cushman)

Dorothia _bulletta_ (Carsey)

Dentalina _involvens_ Cushman

Dentalina _lorneiana_ d'Orbigny

Dentalina _solvata_ Cushman

Frondicularia _dunbari_ Morrow

Frondicularia _aclis_ Morrow

Frondicularia _verneuiliana_ d'Orbigny var. _fossata_ Cushman

Frondicularia _striatula_ Reuss

Lagena amorpha Reuss var. *paucicosta* Franke

Lagena cf. *L. globosa* Montagu

Globulina lacrima Reuss var. *horrida* Reuss

Ramulina globo-tubulosa Cushman

Gümbelina moremani Cushman

Gümbelina globocarinata Cushman

Ventilabrella eggeri Cushman var. *glabrata* Cushman

Bolivinoides austinana Cushman

Bolivinita eleyi Cushman

Pseudovigerina plummerae Cushman

Pseudovigerina cretacea Cushman

Buliminella cushmani Sandidge

Buliminella fablis Cushman and Parker

Buliminella vitrea Cushman and Parker

Bulimina exigua Cushman and Parker

Bulimina rudita Cushman and Parker

Gyroidina girardina (Reuss)

Allomorphina minuta Cushman

Schackoina multispinata (Cushman and Wickenden)

Globotruncana cretacea Cushman

The writer is of the opinion that several species of the aforementioned list will eventually be abandoned or placed in synonymy because of erroneous identification. Nevertheless, it is necessary to expand the total number of established species in the Austin strata of Texas from 143 to approximately 175.

Although Austin strata contain a large number of different species, the majority of them are uncommon. With very few exceptions, more than 75 per cent of all Austin faunules are composed in varying proportions of the following nineteen species:

Gaudryina austinana Cushman

Dorothia? alexanderi Cushman

Dorothia stephensoni Cushman

Lenticulina münsteri (Roemer)

"Lenticulina rotulata (Lamarck)"

Nodosaria septemcostata Geinitz

Frondicularia lanceola Reuss var. bidentata Cushman

Gümbelina globulosa (Ehrenberg)

Gümbelina plummerae Loetterle

Gümbelina pseudotessera (Cushman)

Globigerina sp. cf. G. cretacea d'Orbigny

Rugoglobigerina rugosa rugosa (Plummer)

Globigerinella aspera (Ehrenberg)

"Globotruncana canaliculata (Reuss)"

Globotruncana fornicata Plummer

Globotruncana sp. aff. G. globigerinoides Brotzen

Globotruncana rosetta (Carsey)

Globotruncana ventricosa White

Planulina texana Cushman

The following fourteen species display sufficiently frequent occurrence and relatively restricted range to be considered characteristic of Texas Austin strata:

Gaudryina austinana Cushman
Dorothia? *alexanderi* Cushman
Planularia umbonata Loetterle
Marginulina austinana Cushman
Marginulina directa (Cushman)
Citharina texana (Cushman)
Eouvigerina plummerae Cushman
Pleurostomella austinana Cushman
Pleurostomella watersi Cushman
Ellipsoidella gracillima Cushman
Discorbis morrowi nom. nov.
Hastigerinella alexanderi Cushman
Hastigerinella simplex Morrow
Hastigerinella watersi Cushman

Of the fourteen aforementioned species, *Gaudryina austinana* Cushman, *Dorothia*? *alexanderi* Cushman, *Ellipsoidella gracillima* (Cushman), and *Discorbis morrowi* nom. nov. also occur uncommonly in strata presently considered lowermost Taylor. However, the writer will present evidence indicating that these beds should be assigned to the Austin group, thus permitting the use of these four species as guide fossils for the Austin group.

In addition to the fourteen aforementioned species, there are some half-dozen species known only from the Austin which occur too uncommonly to merit listing (e.g., *Dentalina* *involvens* Cushman).

The relations of the Austin fauna to that of the underlying Eagle Ford group and the overlying Taylor group are strikingly and significantly dissimilar.

From seventeen samples, Cushman (1946) lists fifteen Eagle Ford species that occur also in Austin strata. From 116 samples, Schell (1952) lists fourteen additional Eagle Ford species which occur in the Austin group. Approximately one-half of these species occur rarely in Austin strata. In contrast, at least 140 Austin species occur in Taylor or younger strata, and approximately a dozen continue into the Tertiary. Consequently, it appears that the Gulf Series of Texas may be divided naturally on the basis of foraminiferal evidence into two series, the lower including the Eagle Ford and Woodbine groups, the equivalent of the European Turonian and Upper Cenomanian, and the upper including the Austin, Taylor, and Navarro groups, essentially the equivalent of the Senonian of Europe.

There is a well defined vertical variation in the Austin fauna. However, as would be expected from a widespread and uniform Cretaceous sea, there is little lateral variation in the fauna.

Vertical faunal variation is typically and well depicted by the samples of the Dallas County traverse in the varying proportions of the aforementioned dominant species. In these samples from the basal 250 feet, species of Globigerina d'Orbigny, Globotruncana Cushman, Gümbelina Egger, and Lenticulina Lamarck are overwhelmingly dominant, composing from 75 per cent to 90 per cent of the faunal population. In the succeeding 200 feet of strata, these species decrease to approximately 40 per cent, while Planulina texana Cushman, accompanied by a score of common, but numerically minor members of the population, becomes the dominant form, composing up to 40 per cent of the faunal population. In the uppermost 200 feet, the aforementioned pelagic species continue to decrease to approximately 25 per cent of the fauna, with the remainder of the population dominated by Gaudryina austinana Cushman, Dorothia? alexanderi Cushman, Dorothia stephensoni Cushman, and Planulina texana Cushman. This trend is broken abruptly, but temporarily, at approximately 600 feet above the base of the chalk by resurgence of the pelagic species to approximately 75 per cent of the fauna. However, the typical upper Austin fauna is resumed within 30 feet. Thus the dominating constituents of the Dallas County faunal population reveal a gradual transition from pelagic to benthonic species, with an abrupt, but temporary, reversal near the top of the sequence.

This faunal transition is accompanied by a marked increase in organic debris, primarily calcite prisms from pelecypod shells, which may compose as much as one-half the sample volume in the upper beds.

Generally the aforementioned vertical trend characterizes faunal changes along the entire strike. However, the typical upper Austin fauna extends through much more of the section (Bonham clay and Gober chalk) in Fannin County than in Collin and Dallas Counties. In addition, there is, in the silty and micaceous phase of the Bonham clay, a reduction in the abundance of all species, due perhaps to the influence of a more or less fresh water environment. The sparse fauna in the samples of the Travis County traverse, far to the south, is due presumably to the extreme induration of the rock, which permits only the most robust forms to be recovered by washing.

Zonation and Correlation

Information obtained from this study does not justify unequivocal correlation of the calcareous and argillaceous facies of the Austin group, but a reasonable solution to this problem is suggested.

Upper Bonham and Gober strata of Fannin County contain a number of species which are not present in, or are uncommon, in Collin and Dallas Counties to the south. Some of these species are rare even in Fannin County; others are rather common. Their combined total is not sufficient to obscure the aforementioned typical upper Austin fauna, dominated by _Gaudryina austinana_ Cushman, _Dorothia_? _alexanderi_ Cushman, _Dorothia stephensoni_ Cushman, and Planulina texana Cushman. This specific assemblage constitutes a distinctly modified typical upper Austin fauna that ranges through several hundred feet of strata in Fannin County, although it occurs only in the uppermost Austin strata of Collin and Dallas Counties. This modified upper Austin fauna is herein named the Gober Fauna, because it is best developed in the Gober chalk of the Austin group. The following list presents the definitive species of the Gober Fauna discovered in this study:

Pseudoclavulina clavata (Cushman)
Pseudogaudryinella capitosa (Cushman)
"Rimalina" goberana n. sp.
Astacolus taylorensis Plummer
Marginulinopsis stephensoni (Cushman)
Marginulina bullata Reuss
Marginulina cretacea Cushman
Marginulina curvatura Cushman?
Marginulina inconstantia Cushman
Marginulina texasensis Cushman
Dentalina alternata (Jones)
Dentalina delicatula Cushman
Palmula rugosa (d'Orbigny)
Frondicularia archiaciana d'Orbigny
Loxostomum clavatum (Cushman)
Nodosarella texana Cushman
Allomorphina trochoides (Reuss)

Anomalina ammonoides (Reuss)

Because of their rarity some species of the Gober Fauna were probably overlooked in this study. From Cushman's data (1946) this list may be expanded by at least five species:

Haplophragmium taylorense Cushman and Waters

Dorothia bulletta (Carsey)

Dentalina lorneiana d'Orbigny

Dentalina solvata Cushman

Frondicularia aclis Morrow

The fauna underlying the Gober Fauna is herein termed the Normal Austin Fauna. The following species characterize and define strata of the Normal Austin Fauna:

Planularia umbonata Loetterle

Rectogümbelina hispidula Cushman

Rectogümbelina texana Cushman

Pleurostomella austinana Cushman

Pleurostomella watersi Cushman

Hastigerinella alexanderi Cushman

Hastigerinella watersi Cushman

Correlated on the basis of the Gober Fauna, the upper three-fourths or more of the Austin clay-chalk section in Fannin County is equivalent to less than the upper one-fourth of the Austin chalk section in Collin and Dallas Counties. Inversely, the same applies for the Normal Austin Fauna; that is to say, the lower zone is three or more times thicker to the south than in the more northern Fannin County.

Field work in Collin and Dallas Counties has revealed an obscure one-foot zone of _Exogyra ponderosa_ Roemer?, which appears to mark the precise stratigraphic base of the Gober Fauna. This _E. ponderosa_ Roemer? zone was crossed by the Dallas County traverse at the west side of the Hudson Airport, where it is approximately 590 feet above the base of the chalk and approximately 50 feet below the top. In Collin County the traverse encountered the zone in a quarry on the north side of State Highway 24, approximately two and one-quarter miles east of McKinney. Here the zone is approximately 610 feet above the base of the chalk and 150 feet below the top. Thus, above the _E. ponderosa_ Roemer? zone, the section of chalk which contains the Gober Fauna increases approximately 100 feet in thickness from Dallas to Collin Counties, whereas the underlying section remains essentially constant. Further thickening of strata of the Gober Fauna is suggested by samples from Whitewright, Grayson County (Cushman 1946, p. 7, samples nos. 289-291), which have been reported to contain Gober Fauna species. Since Whitewright is located in the center of the belt of Austin outcrop, strata of the Gober Fauna would appear to be 300 or more feet in thickness. Conversely, the Whitewright samples imply that the Normal Austin Faunal section has thinned to 350 or 400 feet. The

E. ponderosa Roemer? zone was not found in Fannin County. However, if its relation to the Gober Fauna persists, it would occur in the lower Bonham clay, which is so heavily mantled on the outcrop that the zone could be very difficult to locate.

The *E. ponderosa* Roemer? zone at the base of the Gober Fauna may mark an hiatus. This inference is supported by the abrupt, but temporary, resurgence of pelagic species in chalk samples immediately overlying this zone in Dallas County. Unfortunately, the strata immediately above this zone in Collin County were covered and the aforementioned resurgence could not be verified in Collin County. Maintenance of relations between the *E. ponderosa* Roemer? zone and the Gober Fauna implies, in addition, that the former truncates strata of the underlying Normal Austin Faunal zone in eastern Grayson and Fannin Counties.

There is evidence that the upper part of the southward thinning wedge of chalk strata of the Gober Fauna changes facies to marl in Collin and Dallas Counties, where these marl beds have been included quite understandably in the Taylor group. Samples from the marl immediately overlying the top of the Austin chalk along the Collin County traverse and occurrences listed by Cushman (1946) reveal that some Gober Fauna species (e.g., *Marginulina inconstantia* Cushman and *Nodosarella texana* Cushman), which are restricted to the Gober chalk in Fannin County, occur in lowermost

"Taylor" strata of Dallas and Collin County. These samples and records also reveal that several species which are common, though not definitive, members of the Gober Fauna (e.g., Gaudryina austinana Cushman and Dorothia? alexanderi Cushman) continue into lowermost "Taylor" strata. Stephenson (1937) has reported tracing an unconformity at the top of the Gober chalk in Fannin County southward to Dallas County. Austin (1948) and Johnson (1948) have mapped, in the lower Taylor over the southern half of Collin County, an unnamed limestone marker bed, which is separated from the top of the Austin chalk by thirty to forty feet of chalky marl which is intermediate in lithology between Austin chalk and typical Taylor marl. The unnamed marker bed was exposed on the Collin County traverse approximately fifty feet above the top of the chalk, but it was not discovered in the heavily mantled area to the north. The lowermost "Taylor" is also poorly exposed in Dallas County, but its gradational or transitional character is evident (see page 6). The writer is of the opinion that these transitional, lowermost "Taylor" beds, bearing the Gober Fauna, decrease southward in thickness from somewhat more than fifty feet in Collin County to twenty feet or less in Dallas County. Their envisioned relation to the Gober chalk of Fannin County is shown diagrammatically in figure 2.

In comparison with the Normal Austin Fauna, the Gober Fauna superficially reflects a Taylor aspect, since several of its definitive species are much more common in and characteristic of Taylor or Taylor and Navarro strata. However, the Gober Fauna contains, in addition to the definitive species of Taylor character, some species which are restricted to uppermost Austin and lowermost Taylor beds (e.g., Marginulina inconstantia Cushman, Frondicularia aclis Morrow, Nodosarella texana Cushman, and Haplophragmium taylorense Cushman and Waters). In addition, it contains several species which are common and characteristic throughout both the Normal Austin and the Gober Faunas, but which disappear in uppermost Austin or lowermost "Taylor" strata (e.g., Gaudryina austinana Cushman, Dorothia? alexanderi Cushman, Marginulina austinana Cushman, Marginulina directa Cushman, and Citharina texana (Cushman)). Finally, more than forty very common species of the Taylor fauna are not present in the Gober. Thus, the Gober Fauna is demonstrably more closely related to the Normal Austin Fauna than to the Taylor fauna. Consequently, the writer prefers to assign strata of the Gober Fauna to the Austin group. This assignment permits division of the Austin group into two units, the lower characterized by the Normal Austin Fauna and the upper by the Gober Fauna. On this basis the 600 feet of the lower unit in Dallas and Collin Counties would constitute the equivalent of no more than 250 feet (Ector and lower Bonham formations) in northerly Fannin County. Inversely, the fifty to one hundred feet of Austin chalk and

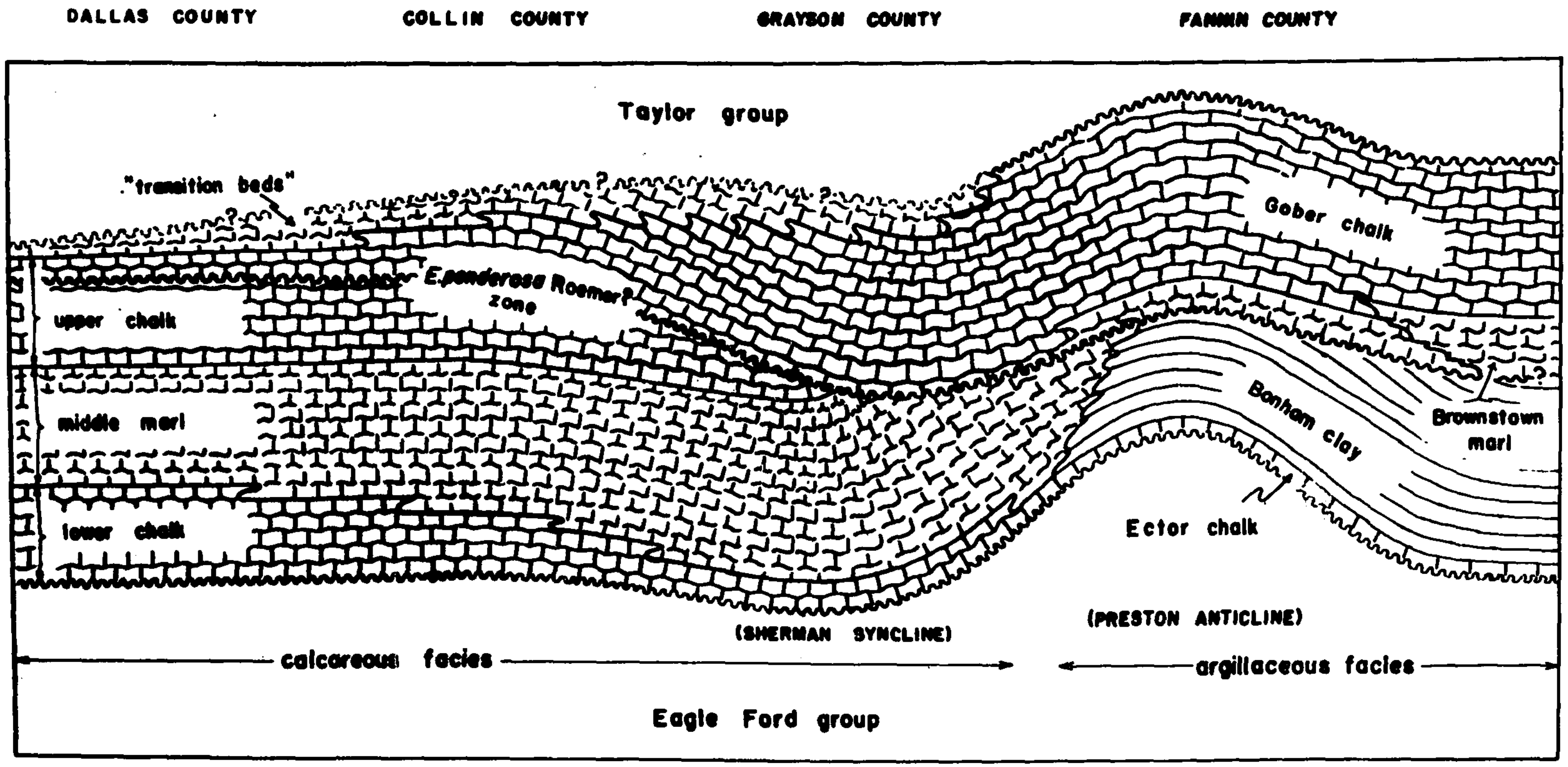


Figure 2.--Generalized reconstructed diagram of stratigraphic relations of calcareous and argillaceous facies of Austin group.

the twenty to approximately fifty feet of basal "Taylor" marl of Dallas and Collin Counties would constitute the equivalent of more than 500 feet (upper Bonham and Gober formations) in Fannin County. These relations are depicted diagrammatically in figure 2.

A few species (e.g., _Frondicularia watersi_ Cushman, _Ramulina laevis_ Rupert Jones, _Eouvigerina americana_ Cushman, and _Planulina texana_ Cushman) appear to be more heavily constructed or more ornate in chalk strata than in clay. However, major faunal changes and trends appear to be unrelated to lithologic units.

Summary

The total number of different species in the foraminiferal fauna of Austin strata of Texas must be increased from the approximately 140 previously listed to 175.

Nineteen species dominate the population of the Austin fauna and, in varying proportions, constitute 75 to 90 percent of a given faunule population.

Fourteen species can be considered characteristic of Austin strata, and, of these, *Citharina texana* (Cushman) is the most useful by reason of its persistence.

The great dissimilarity of Austin-Eagle Ford faunas and the striking similarity of Austin-Taylor faunas strongly suggest that the Upper Cretaceous of Texas should be divided into two series at the Eagle Ford-Austin contact.

Vertical variation in relative abundance among the nineteen dominating species of the Austin fauna reveals a gradual change from pelagic to benthonic species, with a temporary reversal of trend immediately above the *Exogyra ponderosa* Roemer? zone.

At the zone of *Exogyra ponderosa* Roemer?, which appears to mark an hiatus, the fauna of the Austin group is divisible into lower and upper fauna. The lower fauna is herein termed the Normal Austin Fauna and characterizes all except the uppermost strata of the calcareous facies. The upper fauna is termed the Gober Fauna and characterizes all except the lowermost strata of the argillaceous facies. Each fauna can be traced along strike and defines a faunal zone. The unconformity of the E. ponderosa Roemer? zone gradually truncates strata of the Normal Austin Faunal zone, with the result that the Normal Austin Faunal zone thins northward in the area of this report. The Gober sequence is thickest in the northerly Fannin County and thins southward. Uppermost strata of the Gober Faunal zone change facies southward from chalk to marl and, consequently, have been included in the Taylor group in Collin and Dallas Counties. It is recommended that these lowermost strata, which have been demonstrated to be a mapable unit (Austin, 1948; Johnson, 1948), be removed from the Taylor group and included in the Austin group.

APPENDIX

LIST OF SAMPLES

Fannin County

Ector formation

Station A: located in dry stream bed, 3 miles due south of Ravenna in northwestern part of county, George W. King Survey, A-600

Sample	#	EC-	7A -	base of Ector				
"	"	"	- 8A -	2'	above	base	of	Ector
"	"	"	- 9A -	4'	"	"	"	"
"	"	"	-10A -	5'	"	"	"	"
"	"	"	-11A -	9'	"	"	"	"
"	"	"	-12A -	13'	"	"	"	"
"	"	"	-13A -	17'	"	"	"	"
"	"	"	-14A -	20'	"	"	"	"
"	"	"	-15A -	22'	"	"	"	"

Station B: located in abandoned quarry on H. V. Done farm, 1½ miles southeast of Ravenna, near boundary of George W. King Survey, A-600, and B. S. Craft Survey, A-250

Sample # EC- 8B - base of Ector

Sample # EC- 9B - 2' above base of Ector

" " " -10B - 6' " " " "

" " " -11B - 12' " " " "

" " " -12B - 18' " " " "

" " " -13B - 22' " " " "

" " " -14B - 27' " " " "

Station C: located at dam of Lake Crockett, northeastern part of county

Sample # EC-10C - 5' above base of Ector

" " " -11C - 11' " " " "

" " " -12C - 17' " " " "

" " " -13C - 22' " " " "

" " " -14C - 28' " " " "

" " " -15C - 33' " " " "

Bonham formation

U. S. Highway 82 Traverse: from a point ½ mile east of Ector to a point 1 mile west of Dodd City, central part of county

Sample # BC- 2 - 30' above base of Ector; approximate base of Bonham

Sample # BC- 3 - 42' above base of Ector

" " " - 4 - 52' " " " "

" " " - 5 - 59' " " " "

" " " - 6 - 74' " " " "

" " " - 7 - 82' " " " "

" " " - 8 - 97' " " " "

Sample	#	BC- 9	- 110'	above	base	of	Ector
"	" "	-10	- 136'	"	"	"	"
"	" "	-11	- 144'	"	"	"	"
"	" "	-12	- 162'	"	"	"	"
"	" "	-13	- 193'	"	"	"	"
"	" "	-14	- 218'	"	"	"	"
"	" "	-15	- 261'	"	"	"	"
"	" "	-16	- 289'	"	"	"	"
"	" "	-17	- 300'	"	"	"	"
"	" "	-18	- 311'	"	"	"	"
"	" "	-19	- 321'	"	"	"	"
"	" "	-20	- 333'	"	"	"	"
"	" "	-21	- 345'	"	"	"	"
"	" "	-22	- 355'	"	"	"	"
"	" "	-23	- 379'	"	"	"	"
"	" "	-24a	- 393'	"	"	"	"
"	" "	-24b	- 402'	"	"	"	"
"	" "	-25	- 414'	"	"	"	"
"	" "	-26	- 436'	"	"	"	"
"	" "	-27	- 448'	"	"	"	"
"	" "	-28	- 460'	"	"	"	"
"	" "	-29	- 472'	"	"	"	"
"	" "	-30	- 482'	"	"	"	"
"	" "	-31	- 496'	"	"	"	"
"	" "	-32	- 508'	"	"	"	"

Station FC-2: 3.5 miles southwest of Bonham; basal 1/5 of Bonham

Station FC-3a & 3b: 4 miles south southwest of Bonham; Blossom sand?

Station FC-4: 4.5 miles south and southwest of Bonham on Randolph road; Blossom sand?

Station FC-6: 3 miles west of Bonham; basal 1/5 of Bonham

Station FC-7: 3.8 miles west southwest of Bonham; basal 1/5 of Bonham

Station FC-9: 3 miles north of Bonham, west side State Highway 78; lower Bonham

Station FC-11: 3.2 miles northeast of Bonham; basal ¼ of Bonham

Station FC-12: .5 mile west of entrance to Bonham State Park and 2.5 miles southeast of Bonham; upper 1/5 of Bonham

Station FC-15: .5 mile south of Selfs, east side of Farm to Market road 100, northeastern part of county; middle Bonham

Station FC-16: .5 mile northwest of Selfs; middle Bonham

Station FC-17: .3 mile southwest of Lannius; east central part of county; upper Bonham (Blossom sand?)

Station FC-18: 2.7 miles south of Bonham; lower middle part of Bonham

Station FC-19: 4 miles south of Bonham; lower middle part of Bonham

Station FC-20: .5 mile west of FC-19; lower middle part of Bonham

Gober formation

Farm to Market Road 271 Traverse: from Bonham State Park to Gober (this profile run with plane table and alidade)

Sample # 1, F- 5 - 510' above base of Ector; base of Gober

Sample	# 2,	F- 5	- 511'	above	base	of	Ector
"	" 6,	"	- 520'	"	"	"	"
"	" 3,	"	- 537'	"	"	"	"
"	" 4,	"	- 546'	"	"	"	"
"	" 5,	"	- 552'	"	"	"	"
"	" 1,	F- 6	- 561'	"	"	"	"
"	" 1,	F- 8	- 569'	"	"	"	"
"	" 2,	G- 6	- 579'	"	"	"	"
"	" 2,	F- 9	- 566'	"	"	"	"
"	" 3,	"	- 581'	"	"	"	"
"	" 4,	"	- 592'	"	"	"	"
"	" 5,	"	- 600'	"	"	"	"
"	" 1,	F-10	- 609'	"	"	"	"
"	" 1,	F-11	- 618'	"	"	"	"
"	" 2,	"	- 625'	"	"	"	"
"	" 3,	"	- 633'	"	"	"	"
"	" 1,	F-12	- 640'	"	"	"	"
"	" 2,	"	- 655'	"	"	"	"

Sample	#	1,	F-13	- 690'	above	base	of	Ector	
"	"	2,	"	- 706'	"	"	"	"	
"	"	1,	F-14	- 711'	"	"	"	"	
"	"	2,	"	- 697'	"	"	"	"	
"	"	3,	"	- 730'	"	"	"	"	
"	"	4,	"	- 720'	"	"	"	"	
"	"	2,	F-15	- 746'	"	"	"	"	
"	"	3,	"	- 755'	"	"	"	"	
"	"	1,	F-16	- 773'	"	"	"	"	
"	"	7,	F- 2	- 791'	"	"	"	"	
"	"	6,	"	- 795'	"	"	"	"	
"	"	5,	"	- 798'	"	"	"	"	
"	"	4,	"	- 801'	"	"	"	"	
"	"	3,	"	- 811'	"	"	"	"	
"	"	2,	"	- 817'	"	"	"	"	
"	"	1,	"	- 818'	"	"	"	"	
"	"	3,	F- 3	- 828'	"	"	"	"	
"	"	2,	"	- 830'	"	"	"	"	
"	"	1,	"	- 840'	"	"	"	"	
"	"	5,	"	- 850'	"	"	"	"	: top of Gober

Collin County

Austin undifferentiated

State Highway 24 Traverse: from a point .5 mile east of junction with State Highway 289 to a point 5 miles east of McKinney, central part of county.

Sample	# CA-	1	-	5'	above	base	of	Austin
"	" "	- 1a	-	10'	"	"	"	"
"	" "	- 2	-	12'	"	"	"	"
"	" "	- 3	-	17'	"	"	"	"
"	" "	- 4	-	30'	"	"	"	"
"	" "	- 5	-	35'	"	"	"	"
"	" "	- 6	-	40'	"	"	"	"
"	" "	- 6a	-	67'	"	"	"	"
"	" "	- 6b	-	80'	"	"	"	"
"	" "	- 6c	-	93'	"	"	"	"
"	" "	- 6d	-	107'	"	"	"	"
"	" "	- 8	-	120'	"	"	"	"
"	" "	- 9	-	133'	"	"	"	"
"	" "	-10	-	147'	"	"	"	"
"	" "	-12	-	160'	"	"	"	"
"	" "	-19	-	172'	"	"	"	"
"	" "	-13	-	178'	"	"	"	"
"	" "	-18	-	190'	"	"	"	"
"	" "	-17	-	200'	"	"	"	"
"	" "	-15	-	213'	"	"	"	"
"	" "	-14	-	224'	"	"	"	"
"	" "	-16	-	240'	"	"	"	"
"	" "	-20	-	253'	"	"	"	"
"	" "	-21	-	266'	"	"	"	"
"	" "	-22	-	293'	"	"	"	"
"	" "	-23	-	400'	"	"	"	"

Sample # CA-24	- 412'	above	base	of	Austin			
"	" " -25	- 453'	"	"	"	"		
"	" " -26	- 466'	"	"	"	"		
"	" " -27	- 480'	"	"	"	"		
"	" " -28	- 513'	"	"	"	"		
"	" " -29	- 520'	"	"	"	"		
"	" " -30	- 538'	"	"	"	"		
"	" " -31	- 547'	"	"	"	"		
"	" " -32	- 560'	"	"	"	"		
"	" " -33	- 574'	"	"	"	"		
"	" " -34	- 587'	"	"	"	"		
"	" " -35	- 600'	"	"	"	"		
"	" " -36	- 608'	"	"	"	"		
"	" " -37	- 654'	"	"	"	"		
"	" " -38	- 666'	"	"	"	"		
"	" " -39	- 700'	"	"	"	"		
"	" " -40	- 726'	"	"	"	"		
"	" " -41	- 720'	"	"	"	"		
"	" " -42	- 727'	"	"	"	"		
"	" " -43	- 740'	"	"	"	"		
"	" " -44	- 754'	"	"	"	"	:	top of Austin chalk
Sample # CA-45	- 758'	above	base	of	Austin			
"	" " -46	- 768'	"	"	"	"		
"	" " -47	- 785'	"	"	"	"		
"	" " -48	- 810'	"	"	"	"		

Dallas County

Austin undifferentiated

Sample DA-1: roadside ditch 5 miles east of U. S. Highway 75 overpass on Loop 12

Loop 12 Highway Traverse: from Bluff View, which is about ½ mile east of the junction of Loop 12 and Lemmon Avenue, to a point .5 mile east of the junction of Loop 12 and U. S. Highway 67 (Garland road), central part of county

Sample	#	L12-	1b -	2'	above	base	of	Austin	
"	"	"	- 1c -	4'	"	"	"	"	
"	"	"	- 1d -	9'	"	"	"	"	
"	"	"	- 1e -	16'	"	"	"	"	
"	"	"	- 1f -	20'	"	"	"	"	
"	"	"	- 1g -	30'	"	"	"	"	
"	"	"	- 1h -	40'	"	"	"	"	
"	"	"	- 1i -	50'	"	"	"	"	
"	"	"	- 2a -	70'	"	"	"	"	
"	"	"	- 2b -	80'	"	"	"	"	
"	"	"	- 2c -	90'	"	"	"	"	
"	"	"	- 2d -	100'	"	"	"	"	
"	"	"	- 2e -	110'	"	"	"	"	
"	"	"	- 3 -	120'	"	"	"	"	
"	"	"	- 4 -	130'	"	"	"	"	
"	"	"	- 5 -	139'	"	"	"	"	
"	"	"	- 7 -	150'	"	"	"	"	

Sample # L12- 8a - 158' above base of Austin

" " " - 8b - 160' " " " "

" " " - 9 - 170' " " " "

" " " -10 - 180' " " " "

" " " -15a - 183' " " " "

" " " -15b - 187' " " " "

" " " -11 - 190' " " " "

" " " -15c - 198' " " " "

" " " -16 - 218' " " " "

" " " -18 - 238' " " " "

" " " -19 - 250' " " " "

" " " -14a - 259' " " " "

" " " -14b - 264' " " " "

" " " -14c - 269' " " " "

" " " -41a - 270' " " " "

" " " -14d - 274' " " " "

" " " -41b - 280' " " " "

" " " -14e - 284' " " " "

" " " -12a - 288' " " " "

" " " -41c - 290' " " " "

" " " -12b - 293' " " " "

" " " -21 - 300' " " " "

" " " -20a - 310' " " " "

" " " -20b - 320' " " " "

" " " -35a - 330' " " " "

" " " -26a - 340' " " " "

Sample # L12-26b - 350' above base of Austin
" " " -35b - 360' " " " "
" " " -22a - 365' " " " "
" " " -22b - 370' " " " "
" " " -22c - 380' " " " "
" " " -22d - 390' " " " "
" " " -22e - 400' " " " "
" " " -27a - 418' " " " "
" " " -27b - 425' " " " "
" " " -27c - 435' " " " "
" " " -27d - 445' " " " "
" " " -23a - 445' " " " "
" " " -23b - 460' " " " "
" " " -23c - 470' " " " "
" " " -23d - 480' " " " "
" " " -23e - 490' " " " "
" " " -24a - 525' " " " "
" " " -24b - 530' " " " "
" " " -24c - 540' " " " "
" " " -24d - 550' " " " "
" " " -29a - 550' " " " "
" " " -29b - 560' " " " "
" " " -30a - 570' " " " "
" " " -30b - 580' " " " "
" " " -30c - 590' " " " "
" " " -30d - 592' " " " "

Sample #	L12-30e	- 600'	above	base	of	Austin		
"	" " -31	- 610'	"	"	"	"		
"	" " -39a	- 625'	"	"	"	"		
"	" " -39b	- 635'	"	"	"	"		
"	" " -40	- 645'	"	"	"	"		
"	" " -32a	- 646'	"	"	"	"		
"	" " -32b	- 655'	"	"	"	"		
"	" " -36	- 655'	"	"	"	"		
"	" " -32c	- 665'	"	"	"	"	:	from

4 to 10 feet below top of Austin

Travis County

Austin undifferentiated

Brushy Creek Traverse: from base of Austin, .4 mile downstream from U. S. Highway 79 & 81 bridge over Brushy Creek and on south bank of creek, along Brushy Creek to a point .7 mile east of Pflugerville, thence .3 mile south up hill to church

Sample #	TA- 1	- 2'	above	base	of	Austin
"	" " - 2	- 7'	"	"	"	"
"	" TB- 4	- 11'	"	"	"	"
"	" " - 3	- 20'	"	"	"	"
"	" " - 3a	- 25'	"	"	"	"
"	" TE- 7	- 32'	"	"	"	"
"	" " - 8	- 40'	"	"	"	"
"	" TF-12	- 65'	"	"	"	"
"	" TG-14	- 73'	"	"	"	"

Sample	#	TG-13	-	82'	above	base	of	Austin
"	"	TF-15	-	86'	"	"	"	"
"	"	TG-17	-	97'	"	"	"	"
"	"	" -18	-	106'	"	"	"	"
"	"	" -20	-	110'	"	"	"	"
"	"	TH-21	-	110'	"	"	"	"
"	"	" -22	-	116'	"	"	"	"
"	"	TI-24	-	126'	"	"	"	"
"	"	" -25	-	140'	"	"	"	"
"	"	" -26	-	158'	"	"	"	"
"	"	TJ-27	-	161'	"	"	"	"
"	"	" -28	-	173'	"	"	"	"
"	"	" -29a	-	179'	"	"	"	"
"	"	" -29b	-	183'	"	"	"	"
"	"	" -29c	-	191'	"	"	"	"
"	"	" -29d	-	200'	"	"	"	"
"	"	TL-30a	-	205'	"	"	"	"
"	"	" -30b	-	211'	"	"	"	"
"	"	" -31	-	222'	"	"	"	"
"	"	TM-32	-	232'	"	"	"	"
"	"	TN-34	-	240'	"	"	"	"
"	"	" -36	-	250'	"	"	"	"
"	"	TO-AC	-	256'	"	"	"	"
"	"	TW-56	-	265'	"	"	"	"
"	"	TO-38	-	271'	"	"	"	"
"	"	TQ-40a	-	281'	"	"	"	"

Sample # TQ-40b - 282' above base of Austin

"	"	TR-43	- 290'	"	"	"	"		
"	"	TS-45	- 300'	"	"	"	"		
"	"	TT-50a	- 310'	"	"	"	"		
"	"	" -50b	- 317'	"	"	"	"		
"	"	TV-55	- 329'	"	"	"	"		
"	"	TT-49a	- 336'	"	"	"	"		
"	"	" -49b	- 337'	"	"	"	"	:	sandy
"	"	" -49c	- 340'	"	"	"	"		
"	"	" -52	- 349'	"	"	"	"		
"	"	TU-53b	- 372'	"	"	"	"	:	glau-conitic

Sample # TU-53c - 378' above base of Austin: glauconitic

Sample # TU-53d - 380' above base of Austin: glauconitic

Sample # TU-54 - 388' above base of Austin: top of Austin chalk

BIBLIOGRAPHY

Adkins, W. S., 1932. "The Mesozoic Systems in Texas, Geology of Texas, Vol. 1, Stratigraphy." Univ. Texas, Bull. 3232, pp. 239-513.

Albritton, C. C., Jr., and Phleger, F. B., Jr., 1937. "Foraminiferal zonation of certain Upper Cretaceous clays of Texas." Jour. Paleontology, vol. 11, no. 4, pp. 347-354, 3 text figs.

Alexander, C. I., and Smith, J. P., 1932. "Foraminifera of the genera Flabellammina and Frankeina from the Cretaceous of Texas." Jour. Paleontology, vol. 6, no. 4, pp. 299-311, pls. 45-47, 2 text figs.

Applin, E. R., 1933. "A microfossiliferous Upper Cretaceous section from South Dakota." Jour. Paleontology, vol. 7, no. 2, pp. 215-220.

________, and Jordan, L., 1945. "Diagnostic foraminifera from subsurface formations in Florida." Jour. Paleontology, vol. 19, no. 2, pp. 129-148, pls. 18-21.

Austin, E. B., Jr., 1948. Geology of the Rylie Area, Collin County, Texas. Master's thesis, Southern Methodist University, 29 pp., 4 pls., 9 text figs.

Bandy, O. L., 1951. "Upper Cretaceous foraminifera from the Carlsbad area, San Diego, California." Jour. Paleontology, vol. 25, no. 4, pp. 488-513, pls. 72-75, 2 text figs.

Bartenstein, H., 1948. "Entwicklung der Gattung Lenticulina (Lenticulites) Lamarck, 1804, mit ihren UnterGattungen." Senckenbergiana, vol. 29, nos. 1-6, pp. 41-65, pls. 1-5, 1 text fig.

________, and Brand, E., 1950. "Die Foraminiferen-Gattung Tribrachia Schubert, 1912, in der deutschen Kreide." Senckenbergiana, vol. 31, nos. 1-2, p. 125, pl. 1, fig. 11.

Berry, W., and Kelley, L., 1929. "The Foraminifera of the Ripley formation of Coon Creek, Tennessee." U. S. Nat. Mus., Proc., vol. 76, art. 19, 20 pp., 3 pls.

Bolli, H., 1944. "Zur Stratigraphie der Oberen Kreide in den höheren helvetischen Decken." Eclogae geol. Helvetiae, vol. 37, pp. 217-328, pl. 9.

________, 1951. "The genus Globotruncana in Trinidad, B. W. I." Jour. Paleontology, vol. 25, no. 2, pp. 187-199, pls. 34-35, 1 text fig.

Bronniman, P., 1952. "Globigerinidae from the Upper Cretaceous (Cenomanian-Maestrichtian) of Trinidad, B. W. I." Bull. Amer. Paleontology, vol. 34, no. 140, 70 pp., 4 pls., 30 text figs.

Brotzen, F., 1936. "Foraminiferen aus dem schwedischen, untersten Senon von Eriksdal in Schonen." Sver. Geol. Undersök., (ser. C, No. 396), vol. 30, no. 3, pp. 5-206, pls. 1-14, 69 text figs, 4 tables.

Bullard, F. J., 1953. "Polymorphinidae of the Cretaceous (Cenomanian) Del Rio shale." Jour. Paleontology, vol. 27, no. 3, pp. 338-347, pls. 45, 46, 1 text fig.

Campbell, C. B., 1951. "The Campbell Micro-fossil Washer." Iowa Acad. Sci., vol. 58, pp. 275-277.

Carman, K. W., 1929. "Some Foraminifera from the Niobrara and Benton Formations of Wyoming." Jour. Paleontology, vol. 3, pp. 309-315, pl. 34.

Carsey, D. O., 1926. "Foraminifera of the Cretaceous of Central Texas." Univ. Texas, Bull. 2612, 56 pp., 8 pls.

Chapman, F., 1894. "The Bargate Beds of Surrey and their Microscopic Contents." Quart. Jour. Geol. Soc., vol. 50, pp. 677-730, pls. 33, 34.

Cita, M. B., 1948. "Richerche stratigrafiche e micropaleontologiche sul Cretacico e sull'Eocene di Tignale (Lago di Garda)." Riv. Ital. Pal., vol. 54, pp. 49-74, 117-133, 143-168, pls. 2-4.

Cushman, J. A., 1926. "The Foraminifera of the Velasco shale of the Tampico embayment." Amer. Assoc. Petr. Geol., Bull., vol. 10, pp. 581-612, pls. 15-21.

________, 1926. "Eouvigerina, a new genus from the Upper Cretaceous." Cushman Lab. Foram. Research, Contr., vol. 2, no. 1, pp. 3-6, pl. 1.

________, 1926. "Some foraminifera from the Mendez shale of eastern Mexico." Cushman Lab. Foram. Research, Contr., vol. 2, no. 1, pp. 16-26, pls. 2-3.

________, 1927. "American Upper Cretaceous species of Bolivina and related species." Cushman Lab. Foram. Research, Contr., vol. 2, pp. 85-91, pls. 11-12.

________, 1927. "New and interesting foraminifera from Mexico and Texas." Cushman Lab. Foram. Research, Contr., vol. 3, pp. 111-117, pls. 22-23.

________, 1929. "Kyphopyxa, a new genus from the Cretaceous of Texas." Cushman Lab. Foram. Research, Contr., vol. 5, no. 1, pp. 1-4, pl. 1.

________, 1930. "Notes on Upper Cretaceous species of Vaginulina, Flabellina, and Frondicularia from Texas and Arkansas." Cushman Lab. Foram. Research, Contr., vol. 6, no. 2, pp. 25-38, pls. 4-5.

________, 1931. "Cretaceous foraminifera from Antigua, B. W. I." Cushman Lab. Foram. Research, Contr., vol. 7, no. 2, pp. 33-46, pls. 5-6.

________, 1931. "Hastigerinella and other interesting foraminifera from the Upper Cretaceous of Texas." Cushman Lab. Foram. Research, Contr., vol. 7, no. 4, pp. 83-90, pl. 11.

________, 1931. "The foraminifera of the Saratoga chalk." Jour. Paleontology, vol. 5, no. 4, pp. 297-315, pls. 34-36.

________, 1931. "A preliminary report on the foraminifera of Tennessee." Tenn. Div. Geol., Bull., vol. 41, 62 pp., 13 pls.

________, 1932. "Rectogümbelina, a new genus from the Cretaceous." Cushman Lab. Foram. Research, Contr., vol. 8, no. 1, pp. 4-7, pl. 1.

________, 1932. "Textularia and related forms from the Cretaceous." Cushman Lab. Foram. Research, Contr., vol. 8, no. 4, pp. 86-97, pl. 11.

________, 1932. "The foraminifera of the Annona chalk." Jour. Paleontology, vol. 6, no. 4, pp. 330-345, pls. 50-51.

________, 1933. "Some new Foraminiferal genera." Cushman

Lab. Foram. Research, Contr., vol. 9, no. 2, pp. 32-38, pl. 4.

________, 1933. "New American Cretaceous foraminifera." Cushman Lab. Foram. Research, Contr., vol. 9, no. 3, pp. 49-64, pls. 5-7.

________, 1934. "The generic position of '<u>Cornuspira cretacea</u> Reuss.'" Cushman Lab. Foram. Research, Contr., vol. 10, no. 2, pp. 44-47.

________, 1935. "Notes on some American Cretaceous Flabellinas." Cushman Lab. Foram. Research, Contr., vol. 11, no. 4, pp. 83-89, pl. 13.

________, 1936. "Notes on some American Cretaceous Frondicularias." Cushman Lab. Foram. Research, Contr., vol. 12, no. 1, pp. 11-22, pls. 3-4.

________, 1936. "Some American Cretaceous species of <u>Ellipsonodosaria</u> and <u>Chrysalogonium</u>." Cushman Lab. Foram. Research, Contr., vol. 12, no. 3, pp. 51-55, pl. 9.

________, 1936. "New genera and species of the families Verneuilinidae and Valvulinidae and of the subfamily Virgulininae." Cushman Lab. Foram. Research, Spec. Publ. 6, 71 pp., 8 pls.

________, 1936. "Geology and paleontology of the Georges Bank canyons. Pt. IV. Cretaceous and late Tertiary foraminifera." Geol. Soc. Amer., Bull. 47, pp. 413-440, pls. 1-5.

________, 1937. "Some notes on Cretaceous species of <u>Marginulina</u>." Cushman Lab. Foram. Research, Contr., vol. 13, no. 4, pp. 91-99, pls. 13-14.

________, 1937. "A few new species of American Cretaceous foraminifera." Cushman Lab. Foram. Research, Contr., vol. 13, no. 4, pp. 100-105, pl. 15.

________, 1937. "A monograph of the foraminiferal family Verneuilinidae." Cushman Lab. Foram. Research, Spec. Publ. 7, 157 pp., 20 pls.

________, 1937. "A monograph of the foraminiferal family Valvulinidae." Cushman Lab. Foram. Research, Spec. Publ. 8, 210 pp., 24 pls.

________, 1938. "Cretaceous species of <u>Gümbelina</u> and related genera." Cushman Lab. Foram. Research, Contr., vol. 14, no. 1, pp. 2-28, pls. 2-4.

________, 1938. "Additional new species of American Cretaceous foraminifera." Cushman Lab. Foram. Research, Contr., vol. 14, no. 2, pp. 31-50, pls. 5-8.

________, 1938. "Some new species of rotaliform foraminifera from the American Cretaceous." Cushman Lab. Foram. Research, Contr., vol. 14, no. 3, pp. 66-71, pls. 11-12.

________, 1938. "Marginulina texasensis Cushman, a new name." Cushman Lab. Foram. Research, Contr., vol. 14, no. 4, p. 95.

________, 1940. "American Upper Cretaceous foraminifera of the family Anomalinidae." Cushman Lab. Foram. Research, Contr., vol. 16, no. 2, pp. 27-40, pls. 5-7.

________, 1941. "American Upper Cretaceous foraminifera belonging to Robulus and related genera." Cushman Lab. Foram. Research, Contr., vol. 17, no. 3, pp. 55-69, pls. 15-16.

________, 1944. "The foraminiferal fauna of the type locality of the Pecan Gap chalk." Cushman Lab. Foram. Research, Contr., vol. 20, no. 1, pp. 1-17, pls. 1-3.

________, 1944. "Foraminifera of the lower part of the Mooreville chalk of the Selma group of Mississippi." Cushman Lab. Foram. Research, Contr., vol. 20, no. 4, pp. 83-96, pls. 13-14.

________, 1946. "Upper Cretaceous Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas." U. S. Geol. Survey, Prof. Paper 206, 241 pp., 66 pls.

________, 1947. "A foraminiferal fauna from the Santa Anita formation of Venezuela." Cushman Lab. Foram. Research, Contr., vol. 23, no. 1, pp. 1-18, pls. 1-4.

________, 1949. "Cretaceous and Tertiary Subsurface Geology, Foraminifera, Hammond Well; Bethards Well." Maryland Dept. of Geology, Mines and Water Resources, Bull. 2, pp. 213-268, pls. 21-26.

________, 1949. "The Foraminiferal Fauna of the Upper Cretaceous Arkadelphia Marl of Arkansas." U. S. Geol. Survey, Prof. Paper 221-A, 17 pp., 4 pls.

________, 1950. Foraminifera, their Classification and

Economic Use., ed. 4, Harvard University Press, Cambridge, Massachusetts.

________, 1951. "Paleocene Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas." U. S. Geol. Survey, Prof. Paper 232, 69 pp., 24 pls.

________, and Church, C. C., 1929. "Some Upper Cretaceous foraminifera from near Coalinga, California." Calif. Acad. Sci., Proc., 4th ser., vol. 18, pp. 497-530, pls. 36-41.

________, and Deaderick, W. H., 1942. "Cretaceous foraminifera from the Brownstown marl of Arkansas." Cushman Lab. Foram. Research, Contr., vol. 18, no. 3, pp. 50-65, pls. 9-14.

________, and Deaderick, W. H., 1944. "Cretaceous foraminifera from the Marlbrook marl of Arkansas." Jour. Paleontology, vol. 18, no. 4, pp. 328-342, pls. 50-53.

________, and Hedberg, H. D., 1941. "Upper Cretaceous foraminifera from Santander del Norte, Colombia, S. A." Cushman Lab. Foram. Research, Contr., vol. 17, no. 4, pp. 79-100, pls. 21-23.

________, and Jarvis, P. W., 1932. "Upper Cretaceous foraminifera from Trinidad." U. S. Nat. Mus., Proc., vol. 80, art. 14, 60 pp., 16 pls.

________, and Ozawa, Y., 1930. "A monograph of the foraminiferal family Polymorphinidae, Recent and fossil." U. S. Nat. Mus., Proc., vol. 77, art. 6, 185 pp., 40 pls.

________, and Parker, F. L., 1936. "Notes on some Cretaceous species of Buliminella and Neobulimina." Cushman Lab. Foram. Research, Contr., vol. 12, no. 1, pp. 5-10, pl. 11.

________, and Todd, Ruth, 1943. "Foraminifera of the Corsicana marl." Cushman Lab. Foram. Research, Contr., vol. 19, no. 3, pp. 49-72, pls. 9-12.

________, and Wickenden, R. T. D., 1928. "A new foraminiferal genus from the Upper Cretaceous." Cushman Lab. Foram. Research, Contr., vol. 4, no. 1, pp. 12-13, pl. 1.

Dallas Petroleum Geologists, 1941. "Geology of Dallas County." Field and Lab., vol. 10, no. 1, 134 pp., 25 text figs., 4 pls.

Dam, A. Ten, 1948. "Les espèces du genre de foraminifères Globorotalites Brotzen." Inst. France Pétrole, Rev., vol. 3, no. 8, pp. 222-228.

________, 1948. "Middle Neocomian of the Netherlands." Jour. Paleontology, vol. 22, no. 2, pp. 175-192, pl. 32.

Egger, J., 1899. "Foraminiferen und Ostracoden aus den Kreidemergeln der Oberbayerischen Alpen." K. bayer. Akad. Wiss. Münch., Math.-Physik. Kl., Abh., vol. 21, pt. 1, p. 33, pl. 14, figs. 35, 36, 53-55.

Ehrenberg, C. G., 1854. Mikrogeologie. Das Wirken des unsichtbaren kleinen Lebens auf der Erde. 2 vols. fol., Leipzig, 40 pls.

Ellis, B. F., and Messina, A. R., 1940-. Catalogue of Foraminifera. Amer. Mus. Nat. Hist., Spec. Publ.

Finlay, H. J., 1939. "New Zealand Foraminifera: Key Species in Stratigraphy." Trans. Roy. Soc. New Zealand, vol. 69, pp. 89-128, pls. 11-14.

Franke, A., 1925. "Die Foraminiferen der pommerschen Kreide." Abh. Geol. Pal. Instit. Univ. Greifswald, vol. 6, 96 pp., 8 pls.

________, 1928. "Die Foraminiferen der Oberen Kreide Nord- und Mitteldeutschlands." Abh. Preuss. Geol. Landes., vol. 111, 207 pp., 18 pls., 2 text figs.

Frizzell, D. L., 1943. "Upper Cretaceous foraminifera from northwestern Peru." Jour. Paleontology, vol. 17, no. 4, pp. 331-353, pls. 55-57, 2 text figs.

________, 1954. "Handbook of Texas Cretaceous Foraminifera." Univ. Texas, Bureau Econ. Geol., Rept. Inv. no. 22, 231 pp., 21 pls., 2 text figs.

Geinitz, H., 1874. Palaeontographica, Cassel, Stuttgart, vol. 20, pt. 2.

Glaessner, M. F., 1945. Principles of Micropaleontology. Melbourne University Press, Victoria, Australia.

Gordon, C. H., 1909. "The chalk formations of northeast Texas." Amer. Jour. Sci., ser. 4, vol. 27, pp. 369-373.

Grice, C. R., 1948. "Manorella, a new genus of foraminifera from the Austin chalk of Texas." Jour. Paleontology, vol. 22, no. 2, pp. 222-224, figs. 1-5.

Hamilton, E. L., 1953. "Upper Cretaceous, Tertiary and Recent planktonic foraminifera from Mid-Pacific flat-topped seamounts." Jour. Paleontology, vol. 27, no. 2, pp. 204-238, pls. 29-32.

Harris, R. W., and Jobe, B. I., 1951. Microfauna of Basal Midway Outcrops near Hope, Arkansas. Transcript Press, Norman, Oklahoma, 86 pp., 14 pls., 2 text figs.

Heron-Allen, E., and Earland, A., 1910. "The Recent and Fossil Foraminifera of the Shoresands at Selsey Bill, Sussex." Jour. Roy. Micr. Soc., pp. 401-426, pls. 6-11; pp. 693-695.

Hill, R. T., 1901. "Geography and geology of the Black and Grand Prairies, Texas, with detailed descriptions of the Cretaceous formations and special reference to artesian waters." U. S. Geol. Survey, 21st Ann. Rept. (1899-1900), Pt. VII, 666 pp., 71 pls., 80 figs.

Hussey, K. M., and Campbell, C. B., 1951. "A new method of sample preparation." Jour. Paleontology, vol. 25, no. 2, pp. 224-226, 2 text figs.

Hussey, K. M., and McNulty, C. L., Jr., 1950. "Planularia planotrochiformis, a new species showing variation in the genus." Jour. Paleontology, vol. 24, no. 4, pp. 472-473, 9 text figs.

Jennings, P. H., 1936. "A Microfauna from the Monmouth and Basal Rancocas Groups of New Jersey." Bull. Amer. Paleontology, vol. 23, no. 78, 61 pp., 7 pls.

Johnson, W. B., 1948. Geology of the Lucas Area, Collin County, Texas. Master's thesis, Southern Methodist University, 41 pp., 3 pls., 7 text figs.

Kikoine, J., 1948. "Les Hétérohelicidae du Crétace supérior Pyrénéen." Soc. géol. France, 5th ser., C. R., vol. 18, pp. 15-35, pls. 1, 2.

Kline, V. H., 1943. "Midway Foraminifera and Ostracoda." Mississippi State Geol. Survey, Bull. 53, 95 pp., 8 pls.

Lamarck, J., 1804. "Suite des Mémoires sur les Fossiles des Environs de Paris." Mus. Nat. d'Histoire Naturelle, Ann., vol. 5, pp. 179-180, 237-245, 349-357.

_______, 1806. idem, vol. 8, pp. 383-387, pl. 62.

Loeblich, A. R., Jr., and Tappan, H., 1941. "Some palmate Lagenidae from the Lower Cretaceous Washita Group." Bull. Amer. Paleontology, vol. 26, no. 99, 23 pp., 3 pls.

________, 1950. "Foraminifera of the type Kiowa shale, Lower Cretaceous, of Kansas." Univ. Kansas, Pal. Contr., Protozoa, vol. 3, 15 pp., 2 pls.

Loetterle, G. J., 1937. "The Micropaleontology of the Niobrara Formation in Kansas, Nebraska, and South Dakota." Nebraska Geol. Survey, Ser. 2, Bull. 12, 73 pp., 11 pls., 3 text figs.

Macfadyen, W. A., 1933. "A note on the foraminiferal genus Bolivinopsis Yakovlev." Roy. Micr. Soc., Jour., vol. 53, pp. 139-141, 1 text fig.

Moreman, W. L., 1927. "Fossil zones of the Eagle Ford of North Texas." Jour. Paleontology, vol. 1, pp. 89-101, pls. 13-16.

Morrow, A. L., 1934. "Foraminifera and Ostracoda from the Upper Cretaceous of Kansas." Jour. Paleontology, vol. 8, pp. 186-205, pls. 29-31.

Nauss, A. W., 1945. "Cretaceous microfossils of the Vermillion area, Alberta." Jour. Paleontology, vol. 21, no. 4, pp. 329-343, pl. 48, 49, 3 text figs.

d'Orbigny, A. D., 1840. "Mémoire sur les Foraminifères de la Craie blanche du Bassin de Paris." Mém. Soc. Géol. France, vol. 4, 51 pp., 4 pls.

Perebaskine, V., 1946. "Note sur quelques foraminifères nouveaux du Flysch néocrétace pyrénéen." Soc. geol. France, Bull., 5th ser., vol. 15, nos. 7, 8, pp. 359-360, pl. 4.

Plummer, H. J., 1927. "Foraminifera of the Midway Formation in Texas." Univ. Texas, Bull. 2644, 206 pp., 15 pls., 13 text figs., table.

________, 1931. "Some Cretaceous Foraminifera in Texas." Univ. Texas, Bull. 3101, pp. 109-203, pls. 8-15.

Reuss, A. E., 1844. Geognostische Skizzen aus Böhmen. Prague, vol. 2, 304 pp., 3 pls.

________, 1846. Die Versteinerungen der böhmischen Kreideformation. Stuttgart, 148 pp., 51 pls.

________, 1851. "Die Foraminiferen und Entomostraceen des Kreidemergels von Lemburg." Haidinger's Nat. Abhandl., vol. 4, pp. 17-52, pls. 2-6.

________, 1860. "Die Foraminiferen der westphälischen Kreideformation." Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 40, pp. 147-238, pls. 1-13.

________, 1863. "Die Foraminiferen des norddeutschen Hils und Gault." Akad. Wiss. Wien., Math.-naturwiss. Kl., Proc., vol. 46, pp. 5-100, pls. 1-13.

Rhumbler, L., 1904. "Systematische Zusammenstellung der rezenten Retuculosa (Nuda & Foraminifera)." Arch. Prot., vol. 3, pp. 181-294, 142 text figs.

Roemer, F. A., 1839. Die Versteinerungen des norddeutschen Oolithen-Gebirges, Nachtrag. Hanover, 59 pp., 3 pls.

________, 1841. Die Versteinerungen des norddeutschen Kreidegebirges. Hanover, 145 pp., 16 pls.

Sandidge, J. R., 1932. "Significant foraminifera from the Ripley formation of Alabama." Amer. Midl. Nat., vol. 13, no. 4, pp. 190-202, pl. 19.

________, 1932. "Fossil foraminifera from the Cretaceous, Ripley formation of Alabama." Amer. Midl. Nat., vol. 13, no. 5, pp. 312-318, pl. 29.

________, 1932. "Additional foraminifera from the Ripley formation in Alabama." Amer. Midl. Nat., vol. 13, no. 5, pp. 333-337, pls. 31-33.

________, 1932. "Foraminifera from the Ripley formation of western Alabama." Jour. Paleontology, vol. 6, no. 3, pp. 265-287, pls. 41-44.

Schell, W. W., 1952. Foraminifera of the Eagle Ford Shale in the Type Area, Dallas and Tarrant Counties, Texas. Master's thesis, Southern Methodist University, 86 pp., 3 pls., 1 text fig.

Stephenson, L. W., 1918. "A contribution to the geology of northeastern Texas and southern Oklahoma." U. S. Geol. Survey, Prof. Paper 120-H, pp. 129-163.

________, 1927. "Notes on the stratigraphy of the Upper Cretaceous formations of Texas and Arkansas." Amer. Assoc. Petr. Geol., Bull., vol. 11, pp. 1-17.

________, 1929. "Unconformities in Upper Cretaceous series." Amer. Assoc. Petr. Geol., Bull,, vol. 22, pp. 1323-1334.

________, 1937. "Stratigraphic relations of the Austin, Taylor, and equivalent formations in Texas." U. S. Geol. Survey, Prof. Paper 186-G, pp. 133-146.

Thalmann, H. E., 1934. "Die regional-stratigraphische Verbreitung der oberkretazischen Foraminiferen-Gattung Globotruncana Cushman 1927." Eclogae geol. Helvetiae, vol. 27, pp. 413-428, 1 fig.

Toulmin, L. D., 1941. "Eocene smaller Foraminifera from the Salt Mountain limestone of Alabama." Jour Paleontology, vol. 15, pp. 567-611, pls. 78-82, 4 text figs.

White, M. T., 1928. "Some Index Foraminifera of the Tampico Embayment Area of Mexico." Jour. Paleontology, vol. 2, pp. 177-215, pls. 27-29; pp. 280-317, pls. 38-42.

________, 1929. "Some Index Foraminifera of the Tampico Embayment Area of Mexico." Jour. Paleontology, vol. 3, pp. 30-58, pls. 4, 5.

Wickenden, R. T. D., 1932. "New Species of Foraminifera from the Upper Cretaceous of the Prairie Provinces." Trans. Roy. Soc. Canada, 3rd ser., vol. 26, Sec. 4, pp. 85-91, pl. 1.

Wright, J., 1875. "A List of the Cretaceous Microzoa of the North of Ireland." Rep't Proc. Belfast Nat. Field Club, 1873-74, App. 3, pp. 73-99, pls. 2, 3.

________, 1886. "Cretaceous Foraminifera of Kready Hill, Co. Derry." Rep't Proc. Belfast Nat. Field Club, 1885-86, App. 9, pp. 327-332, pl. 27.

INDEX

Page

Plate 1

Plate 1

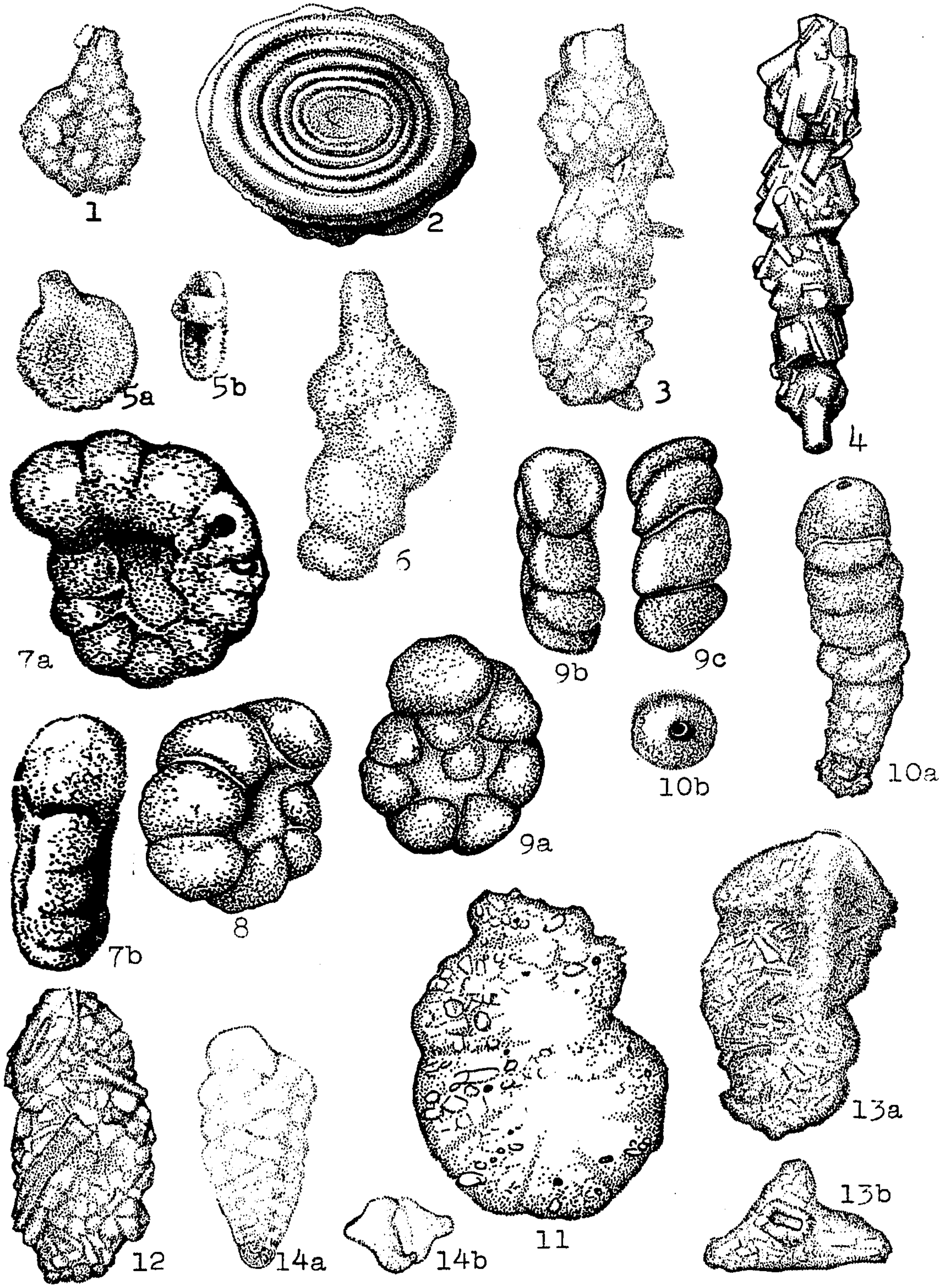


Plate 2

Figures		Pages
1	*Tritaxia* sp., x 30, Sample BC-30. a, Plan view; b, Apertural view	21
2	*Gaudryina austinana* Cushman, x 35, Sample L12-24d. a, Plan view; b, Peripheral view; c, Apertural view	22
3	*Gaudryinella bentonensis* (Carman), x 60, Sample BC-29.	26
4	*Gaudryina dallasensis* n. sp., holotype, x 30, Sample L12-35b. a, Plan view; b, Apertural view	23
5	*Gaudryina ellisorae* Cushman, x 30, Sample CA-39. a, Three-quarter plan view; b, Full plan view of opposite side; c, Apertural view.	24
6	*Gaudryina faujasi* (Reuss), x 30, Sample L12-24a. a, Plan view; b, Apertural view	24
7	*Gaudryina jobeae* n. sp., syntype, x 35, Sample BC-29. a, Plan view; b, Peripheral view; c, Apertural view	25
8	*Gaudryina jobeae* n. sp., syntype, x 30, Sample BC-17.	25
9	*Gaudryina jobeae* n. sp., syntype, x 30, Sample BC-21.	25
10	*Gaudryina jobeae* n. sp., syntype, x 35, Sample BC-23.	25
11	*Gaudryina nebrascensis* Loetterle, x 35, Sample DA-1. a, Plan view; b, Apertural view.	26
12	*Gaudryinella shuleri* n. sp., x 35, Sample BC-17; primitive specimen suggesting relation to *Dorothia*? *alexanderi* Cushman	28
13	*Gaudryinella shuleri* n. sp., syntype, x 35, Sample 2, F-9. a, Plan view; b, Peripheral view; c, Apertural view	28

Plate 2 (continued)

Figures		Pages
14	*Gaudryinella shuleri* n. sp., syntype, x 35, Sample 4, F-9	28
15	*Gaudryinella shuleri* n. sp., syntype, x 30, Sample 4, F-9	28
16	*Gaudryinella fredericksoni* n. sp., x 30, Sample 4, F-9; primitive specimen suggesting relation to *Gaudryinella shuleri* n. sp. a, Plan view; b, Peripheral view; c, Apertural view.	27
17	*Gaudryinella fredericksoni* n. sp., syntype, x 35, Sample 4, F-9	27
18	*Gaudryinella fredericksoni* n. sp., syntype, x 30, Sample 4, F-9	27
19	*Gaudryinella* sp., x 60, Sample EC-13B. a, Plan view; b, Peripheral view; c, Apertural view.	29
20	*Pseudoclavulina clavata* (Cushman), x 30, Sample 2, F-14.	31
21	*Pseudogaudryinella capitosa* (Cushman), x 30, Sample 3, F-15.	31
22	*Arenobulimina americana* Cushman, x 60, Sample L12-30b. a, Plan view; b, Apertural view	33
23	*Marssonella oxycona* (Reuss), x 40, Sample L12-30d	33
24	*Heterostomella austinana* Cushman, x 65, Sample BC-25.	32

Plate 2

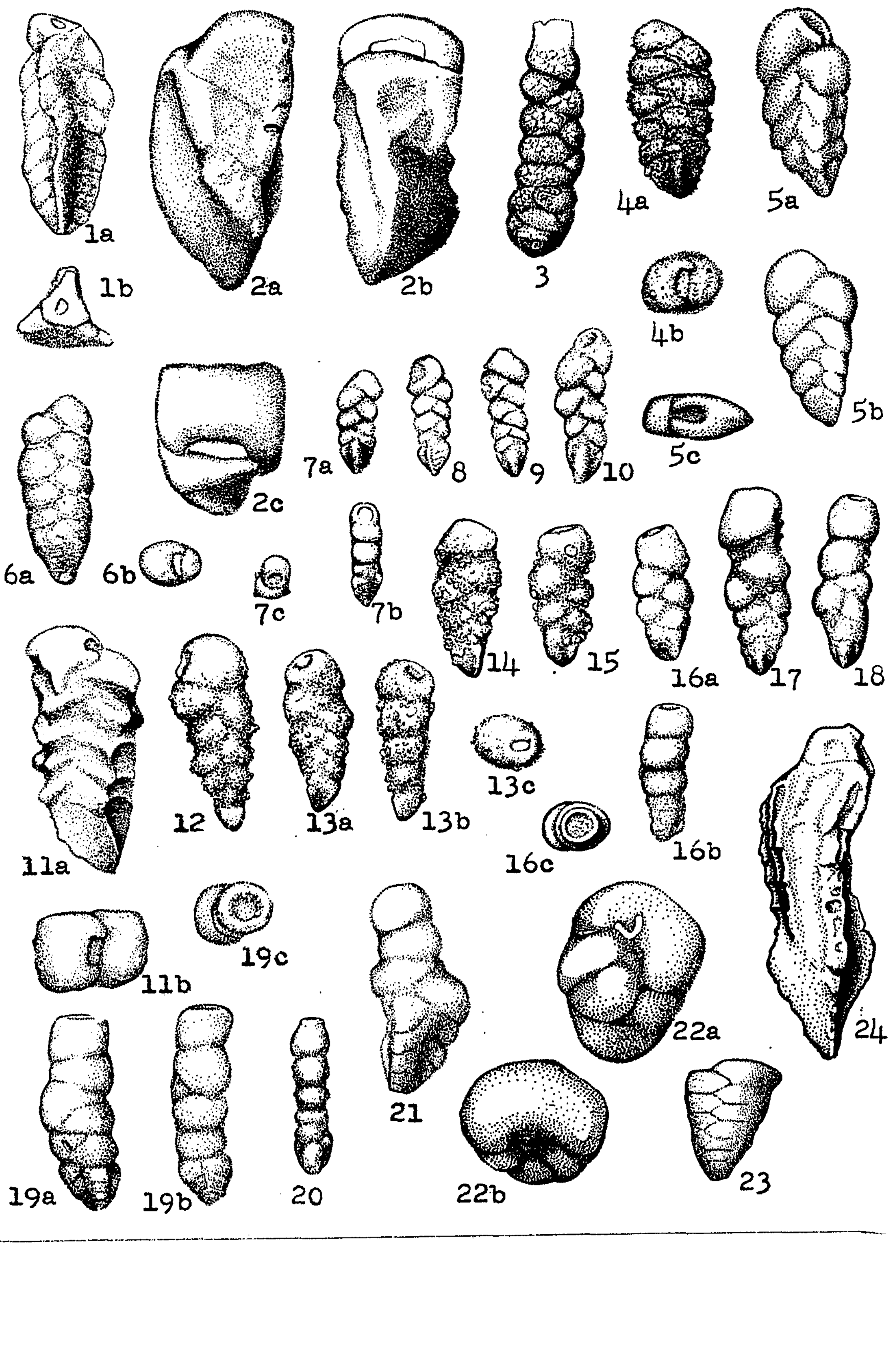

1a
1b
2a
2b
2c
3
4a
4b
5a
5b
5c
6a
6b
7a
7b
7c
8
9
10
11a
11b
12
13a
13b
13c
14
15
16a
16b
16c
17
18
19a
19b
19c
20
21
22a
22b
23
24

Plate 3

Plate 3 (continued)

Plate 3

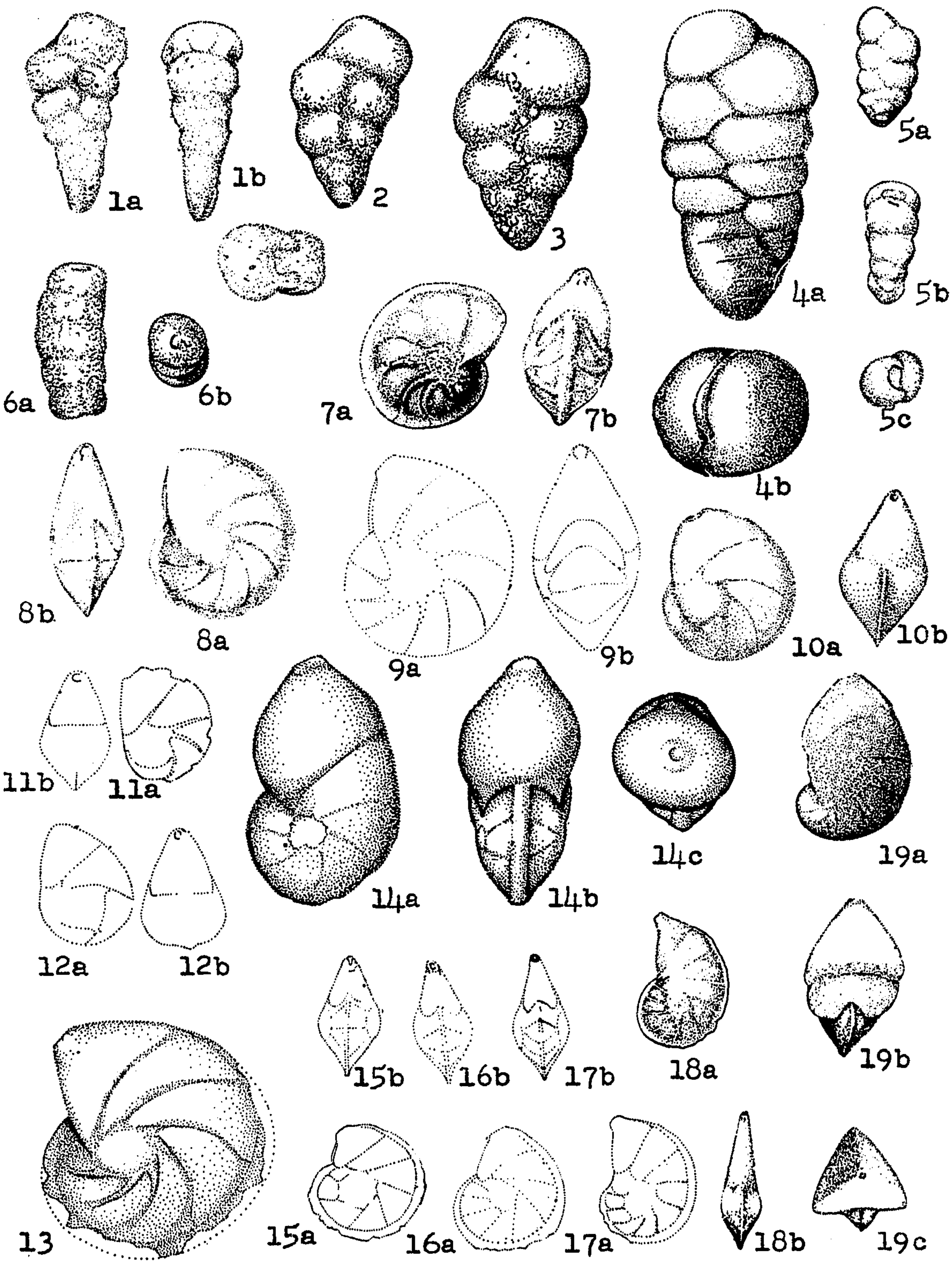

1a
1b
2
3
4a
5a
5b
6a
6b
7a
7b
4b
5c
8b
8a
9a
9b
10a
10b
11b
11a
14a
14b
14c
19a
12a
12b
15b
16b
17b
18a
19b
13
15a
16a
17a
18b
19c

Plate 4

Plate 4 (continued)

Plate 4

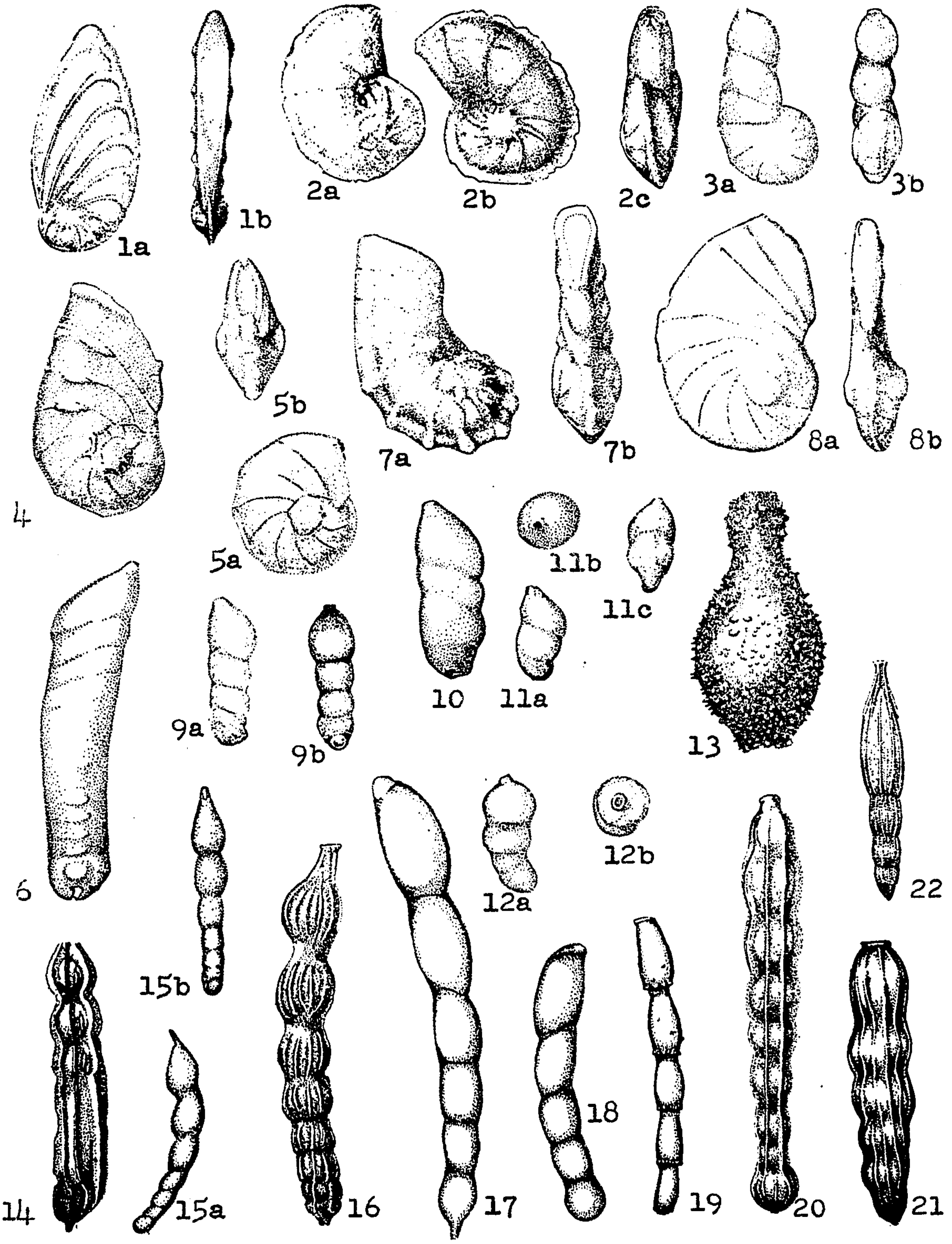

1a
1b
2a
2b
2c
3a
3b
4
5b
7a
7b
8a
8b
5a
11b
11c
10
11a
13
9a
9b
22
6
12a
12b
15b
14
15a
16
17
18
19
20
21

Plate 5

Figures | Pages

Plate 5 (continued)

Plate 5

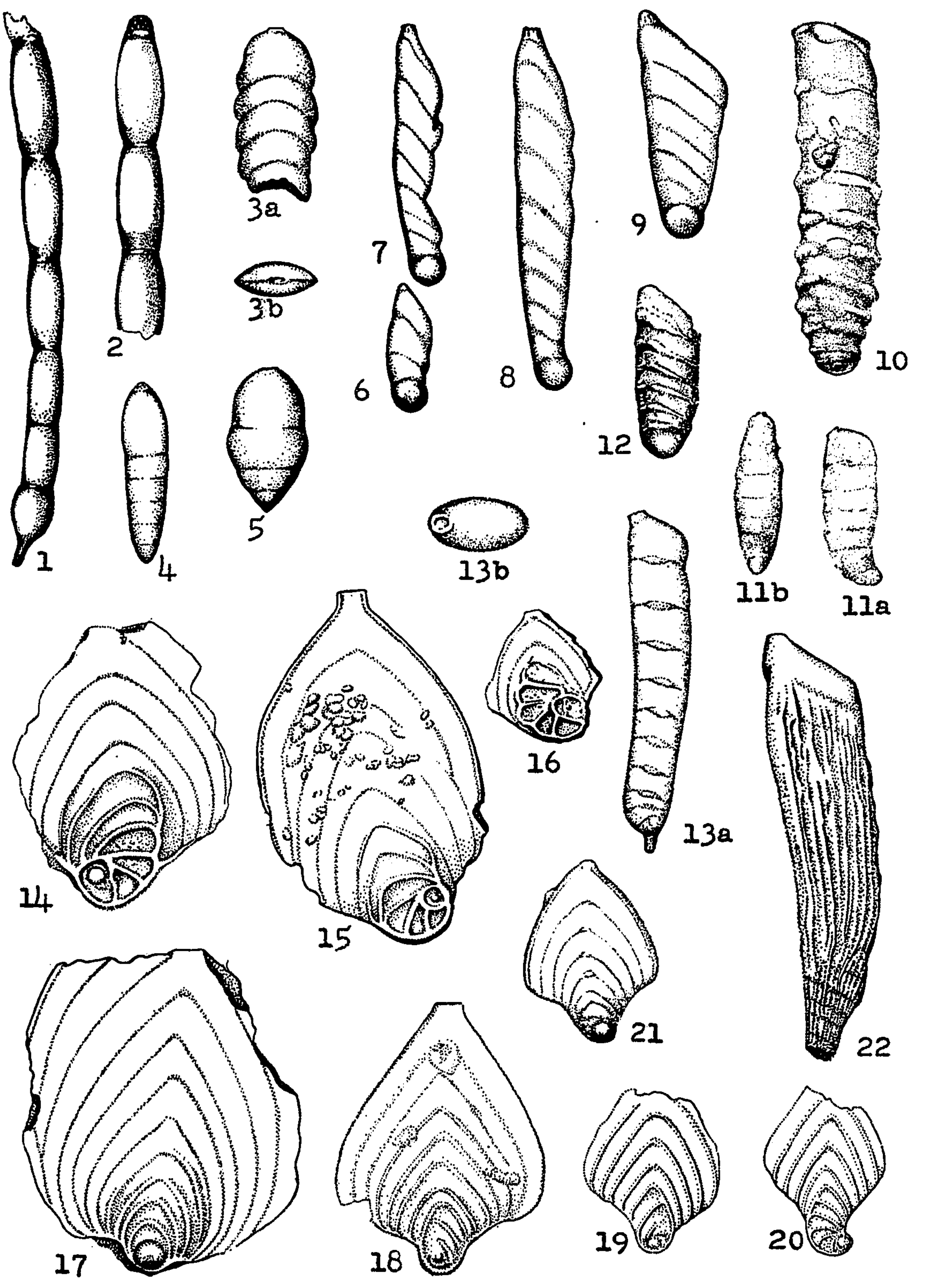


Plate 6

Figures | Pages

Plate 6

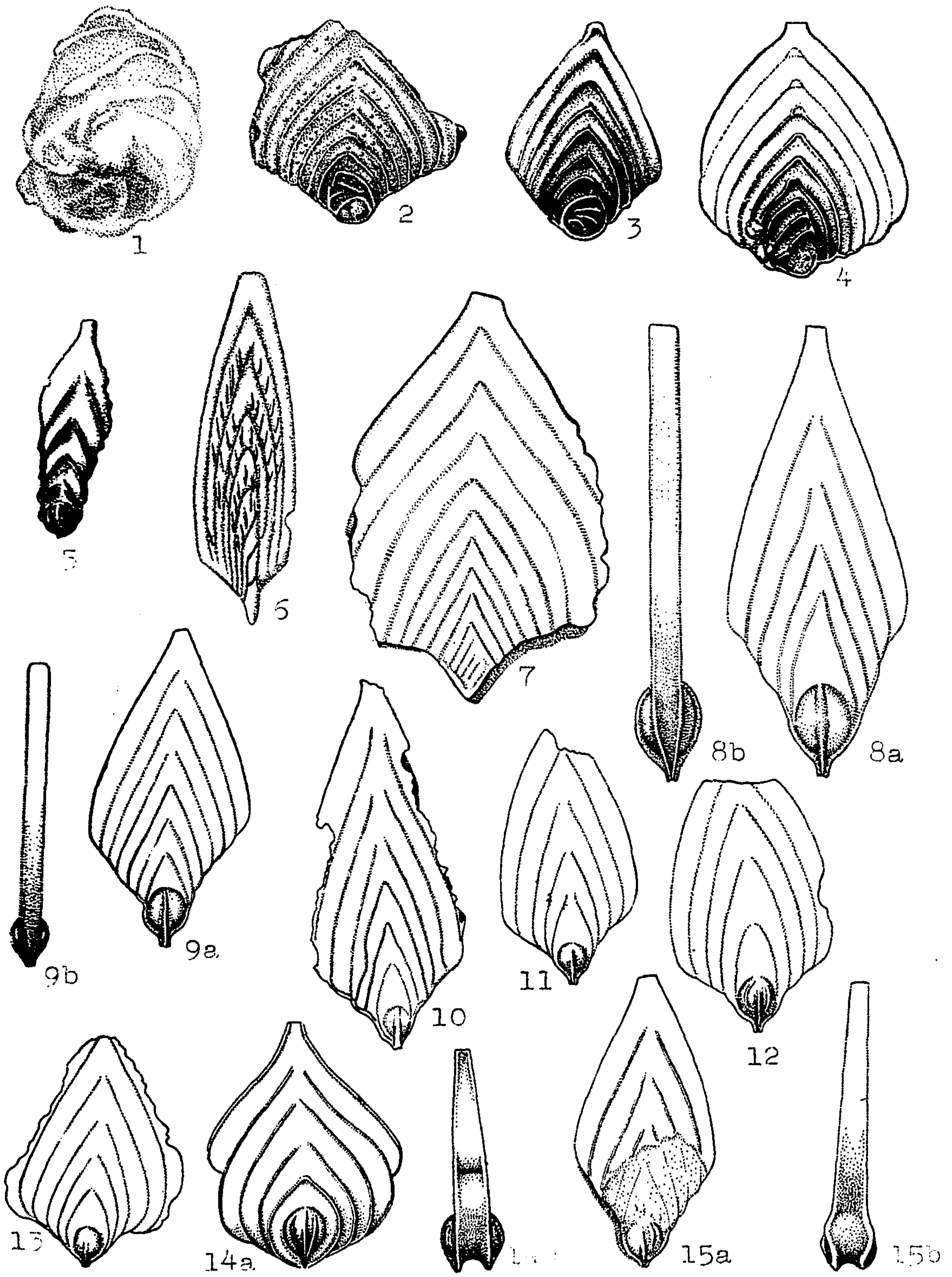


Plate 7

Plate 7 (continued)

Plate 7

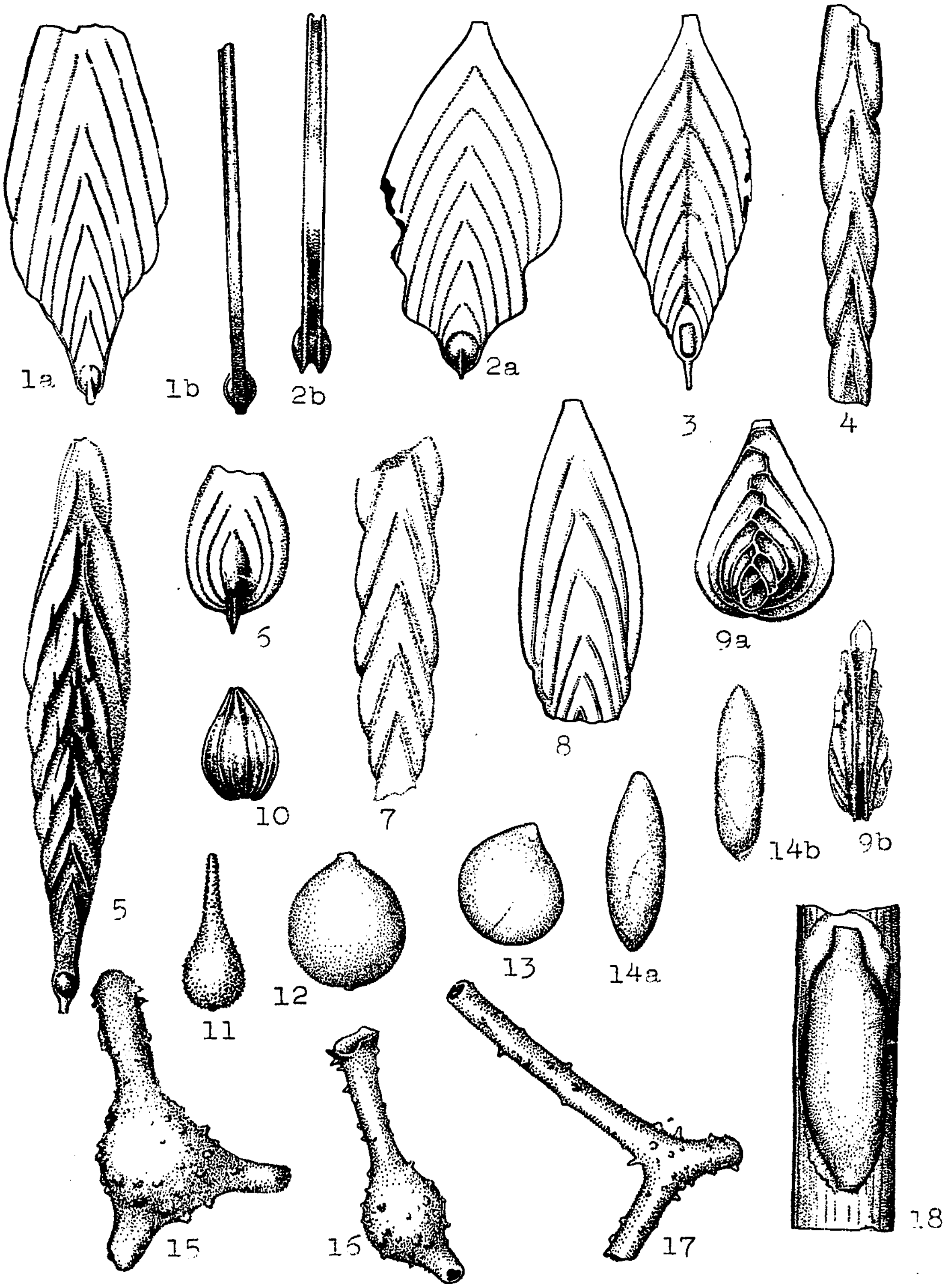


Plate 8

Figures		Pages
1	Tribrachia monnetti n. sp., holotype, x 30, Sample CA-23. a,b, Lateral views	71
2	Nonionella austinana Cushman, x 60, Sample L12-4. a,b, Opposite sides; c, Peripheral view.	78
3	Gümbelina globulosa (Ehrenberg), x 60, Sample L12-1d. a, Plan view; b, Peripheral view.	79
4	Gümbelina planata Cushman, x 55, Sample BC-29. a, Plan view; b, Peripheral view. . . .	81
5	Gümbelina plummerae Loetterle, x 60, Sample BC-16. a, Plan view; b, Peripheral view. . . .	82
6	Gümbelina pseudotessera Cushman, x 55, Sample BC-23.	83
7	Gümbelina sp., x 60, Sample BC-31. a, Plan view; b, Peripheral view.	82
8	Gümbelina striata (Ehrenberg), x 55, Sample 1, F-13	84
9	Ventilabrella austinana Cushman, x 55, Sample EC-12A	85
10	Ventilabrella eggeri Cushman, x 60, Sample 2, F-12	86
11	Eouvigerina americana Cushman, x 60, Sample BC-29	87
12	Eouvigerina austinana Cushman, x 65, Sample 3, F-15	88
13	Eouvigerina plummerae Cushman, x 75, Sample CA-16	88
14	Rectogümbelina hispidula Cushman, x 115, Sample L12-1d	84
15	Rectogümbelina texana Cushman, x 120, Sample L12-5	85

Plate 8 (continued)

Plate 8

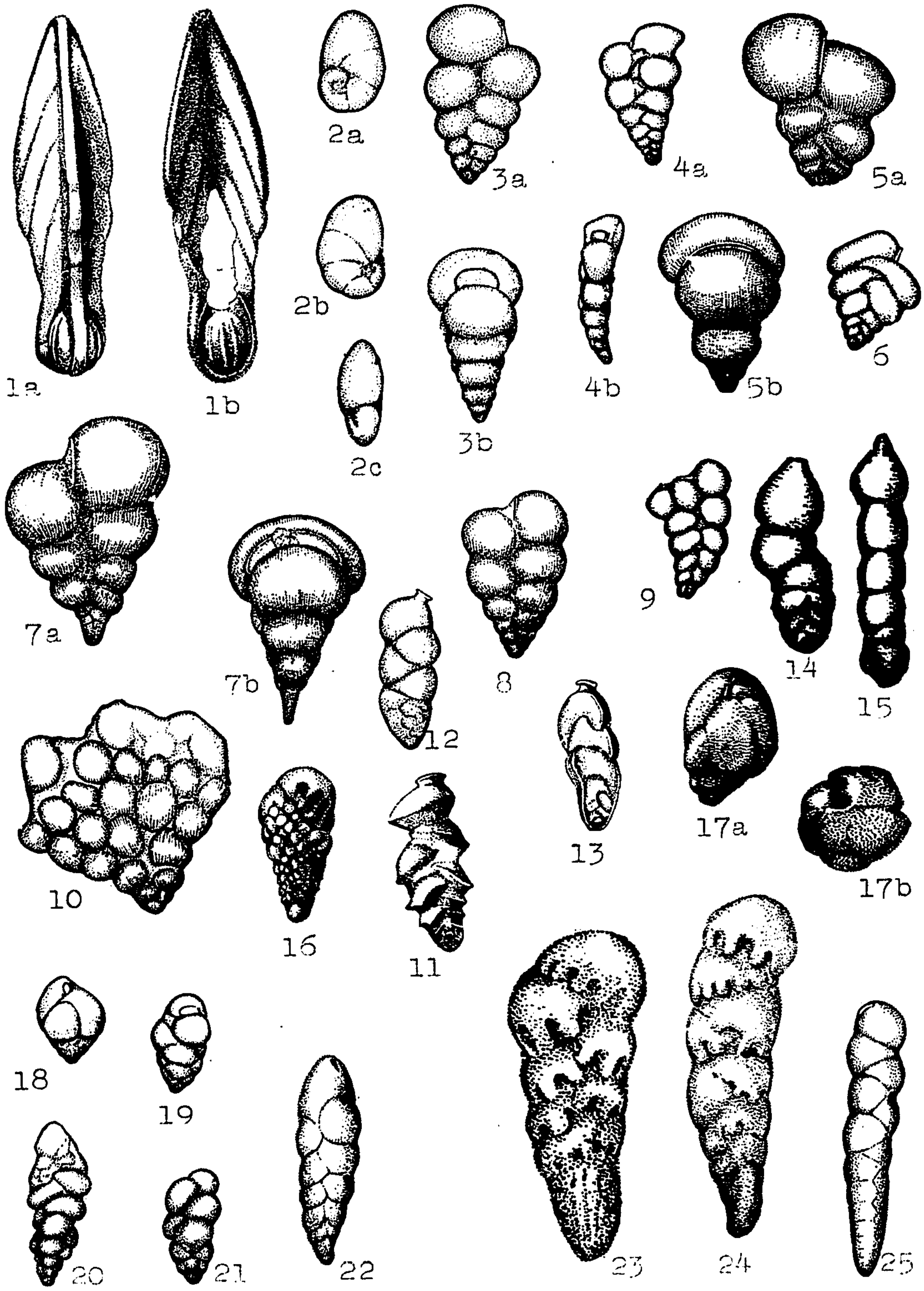

1a
1b
2a
2b
2c
3a
3b
4a
4b
5a
5b
6
7a
7b
8
9
10
11
12
13
14
15
16
17a
17b
18
19
20
21
22
23
24
25

Plate 9

Plate 9 (continued)

Plate 9

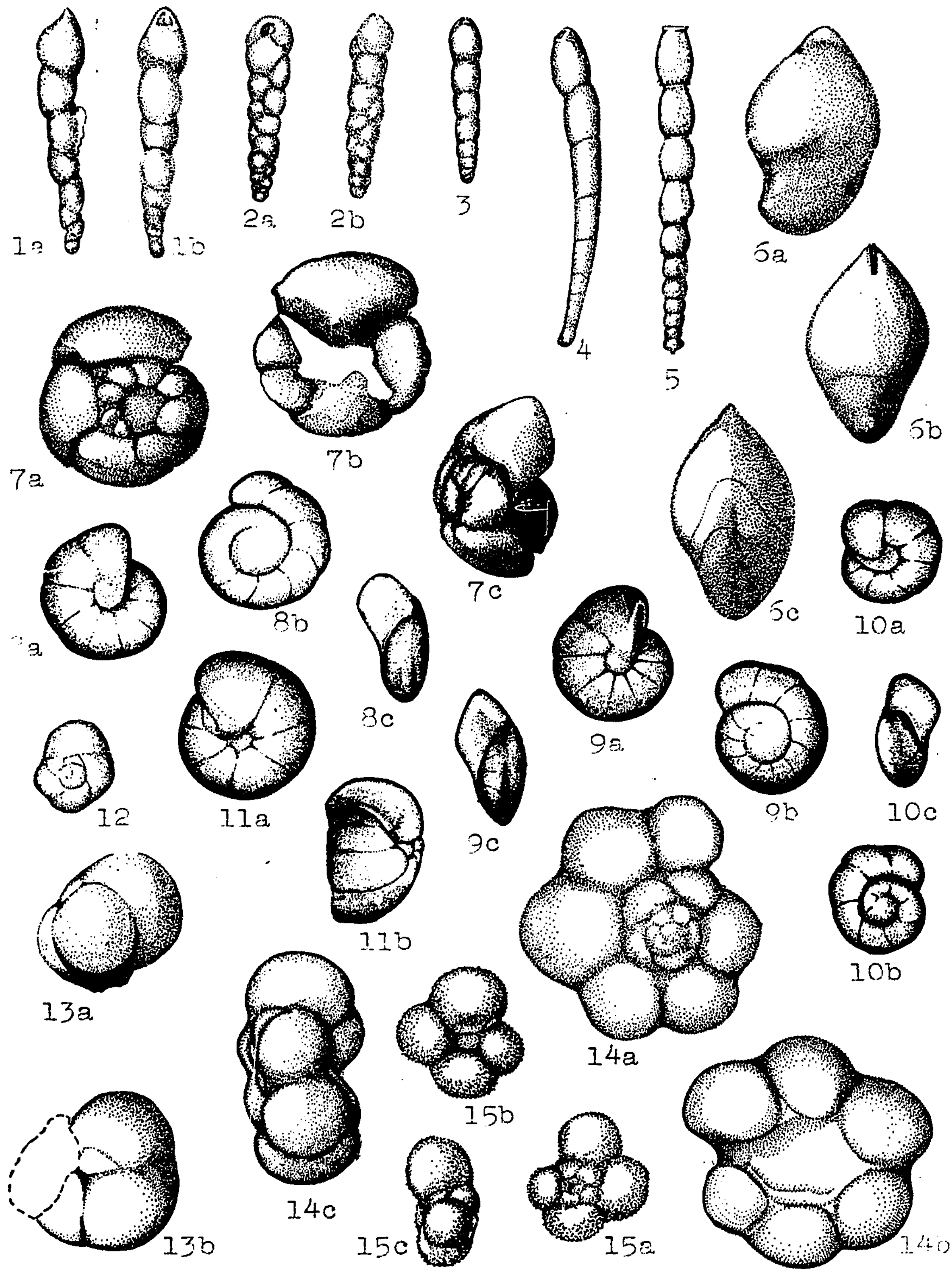
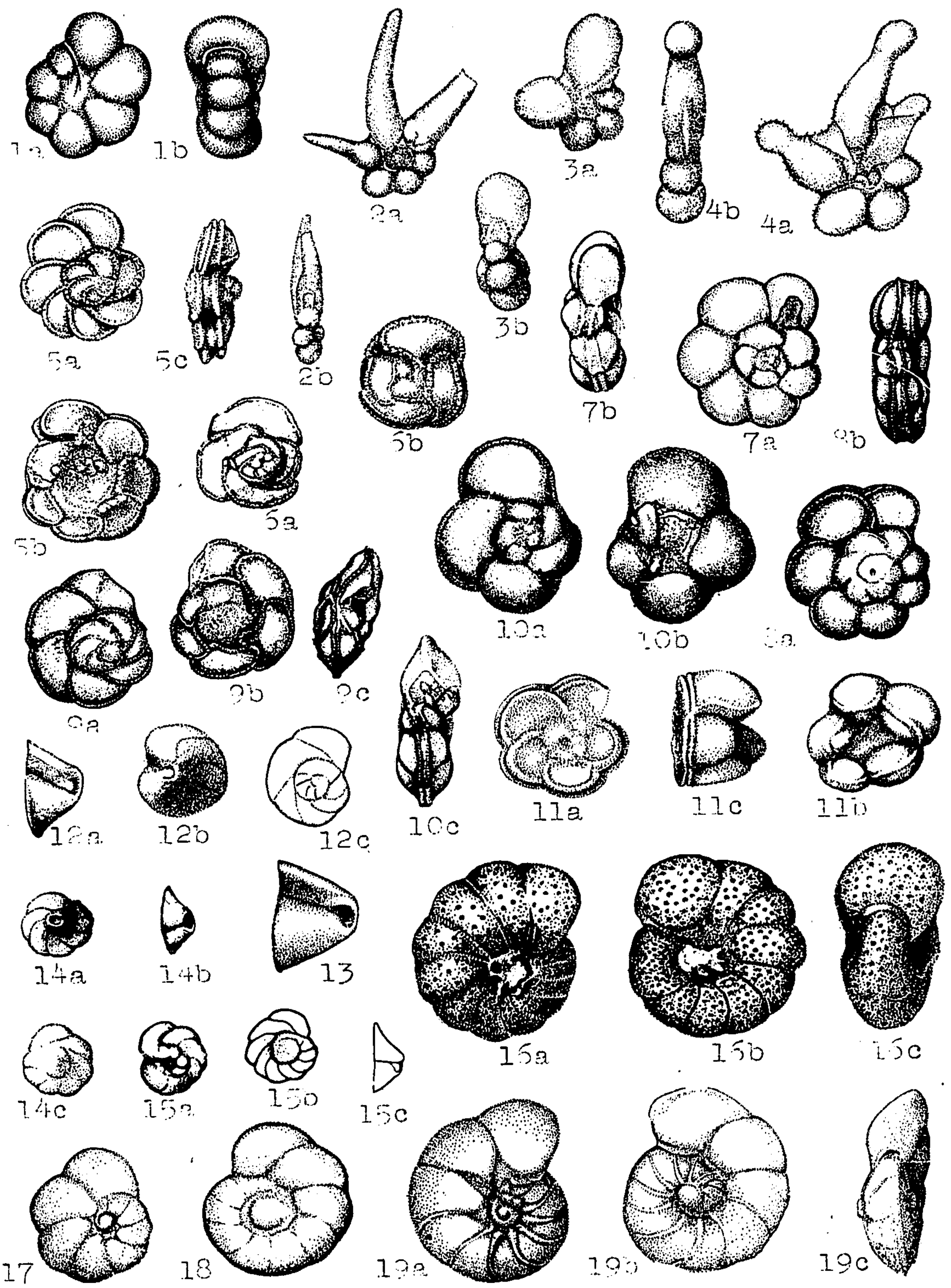
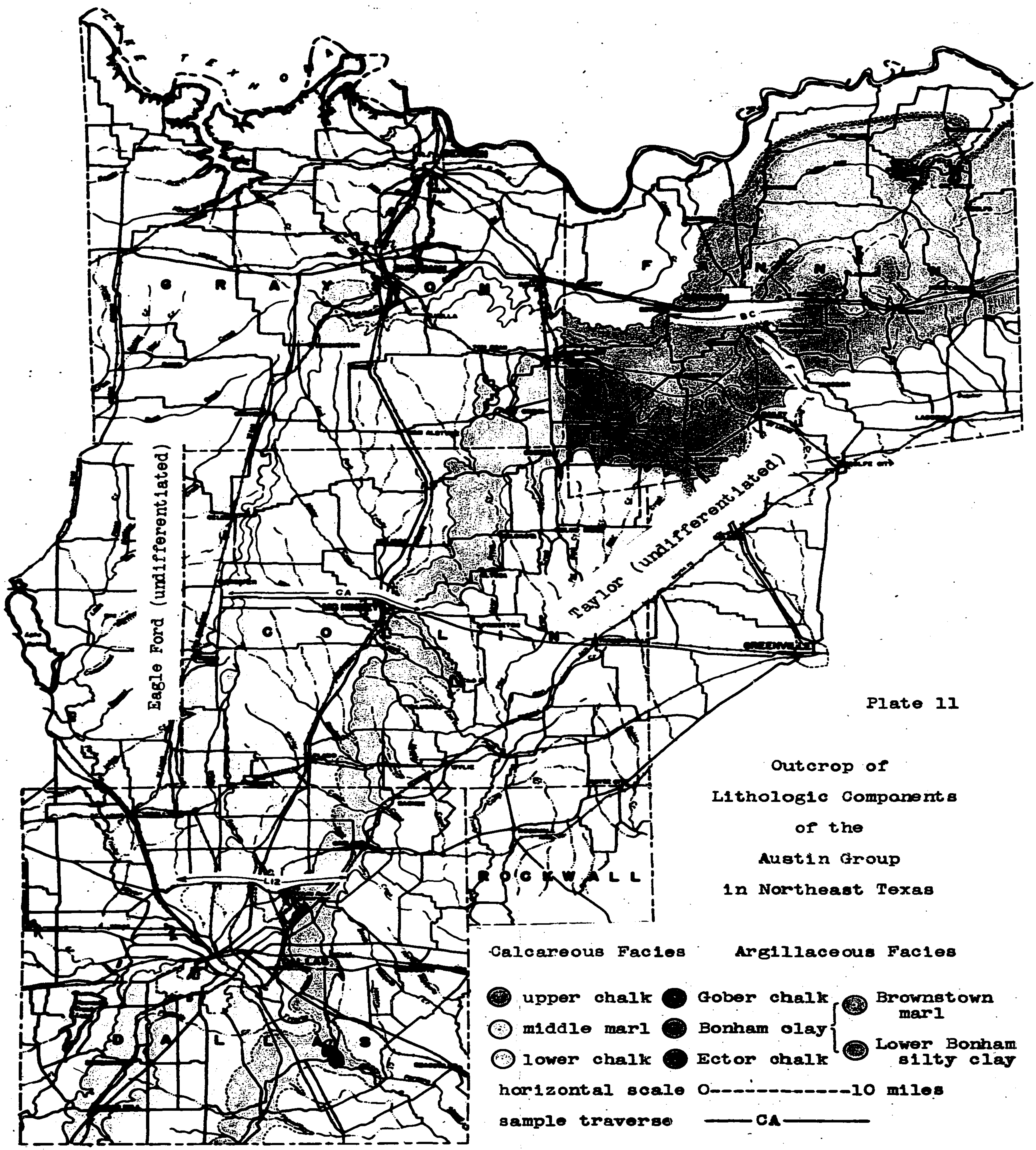

1a
1b
2a
2b
3
4
5
6a
6b
6c
7a
7b
7c
8a
8b
8c
9a
9b
9c
10a
10b
10c
11a
11b
12
13a
13b
14a
14b
14c
15a
15b
15c

Plate 10

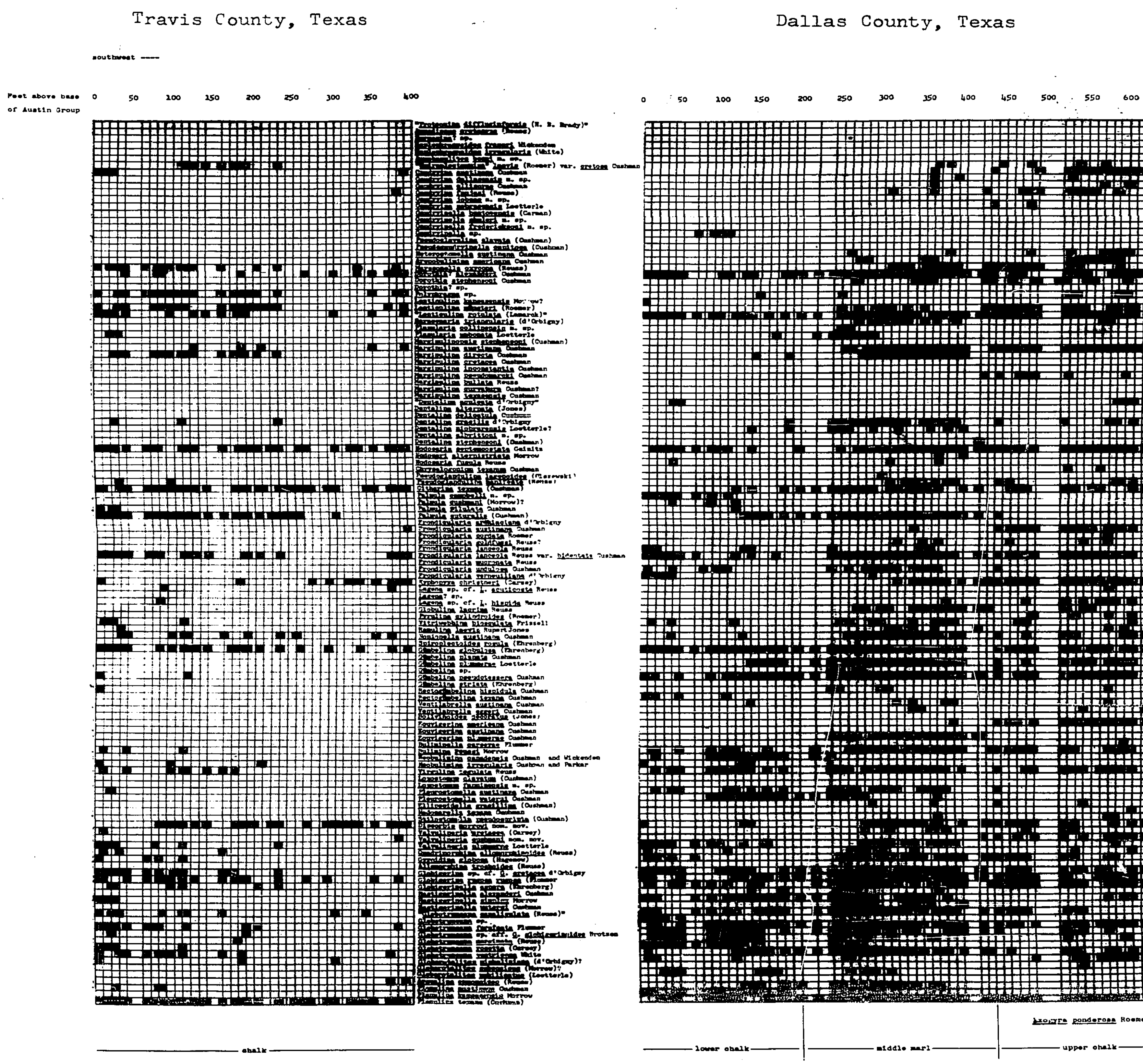
Plate 10 (continued)

Plate 10


1a
1b
2a
3a
4b
4a
5a
5c
2b
3b
6b
7b
7a
8b
5b
6a
10a
10b
8a
9a
9b
9c
10c
11a
11c
11b
12a
12b
12c
14a
14b
13
16a
16b
16c
14c
15a
15b
15c
17
18
19a
19b
19c



Prepared from reconnaissance field work, aided by soil survey maps and previous reports

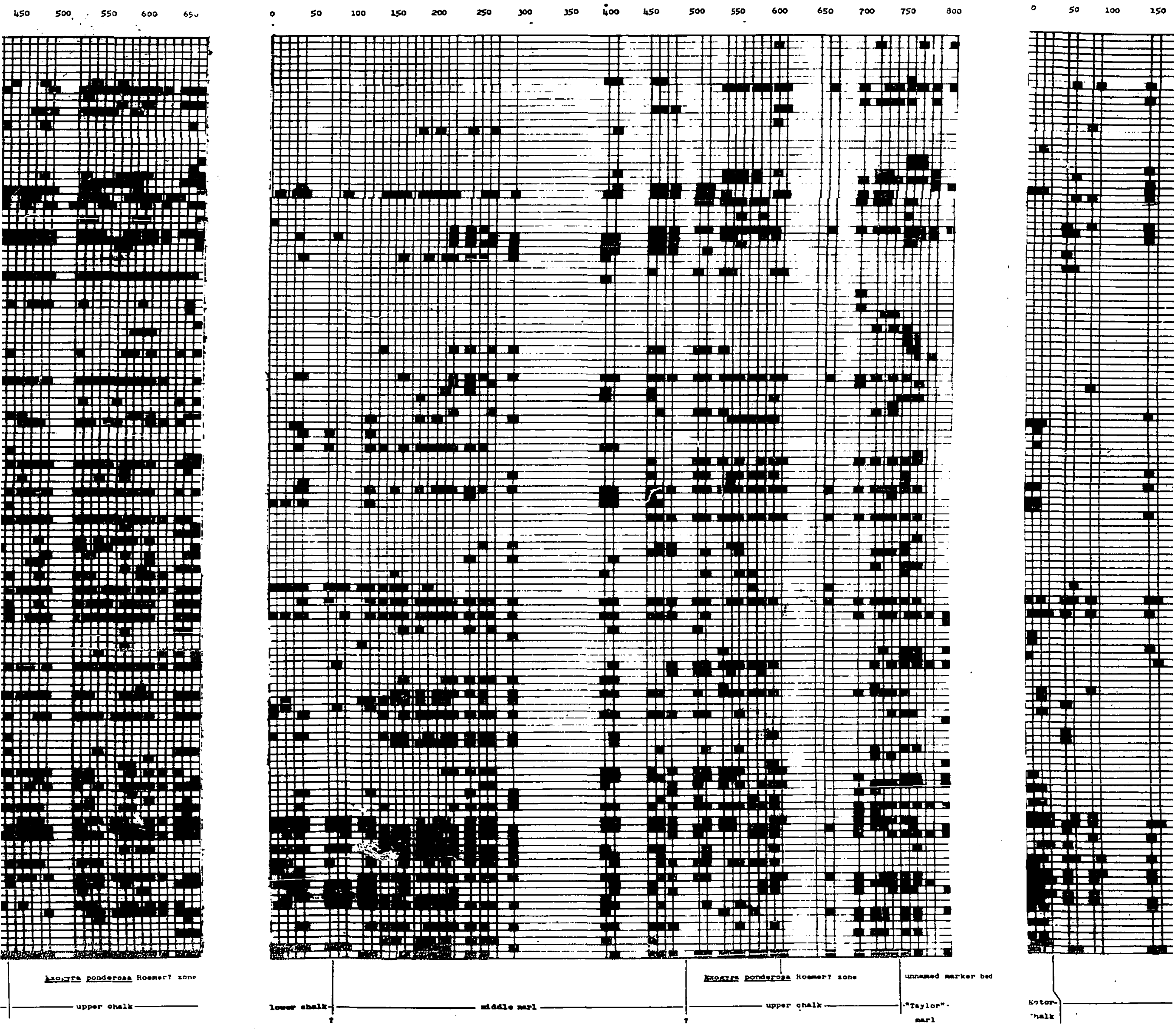

Travis County, Texas
southwest ----
Feet above base of Austin Group
0 50 100 150 200 250 300 350 400
chalk
Dallas County, Texas
0 50 100 150 200 250 300 350 400 450 500 550 600
lower chalk
middle marl
upper chalk

Range Cha

Plate 12

:as

Collin County, Texas



Range Chart of Austin Foraminifera

Fannin County, Texas