A Biofacies of Woodbine Age in Southeastern Gulf Coast Region

By ESTHER R. APPLIN

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

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Description and illustrations of a unique microfauna (including 23 species of Foraminifera, of which 4 are new) and stratigraphic and areal distribution of the microfauna

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ABSTRACT

A unique microfauna occurs in subsurface Cretaceous rocks of Woodbine age in the southeastern Gulf Coast region. The fauna of Foraminifera and Ostracoda is a mixture of forms of Comanche age, long ranging forms of Gulf age and species restricted to the Woodbine and its subsurface equivalents. Twenty-three species of Foraminifera, four of which are new, are described and twenty species are figured. The common lithofacies and the microfaunal biofacies of the Woodbine formation of Texas and its subsurface correlatives in other parts of the Gulf Coast are discussed and the known areal distribution of the fauna is given.

INTRODUCTION

Many writers have discussed the stratigraphy, lithology and, to a lesser degree, the paleontology of the outcropping Woodbine formation in the Gulf Coastal Plain. A few recent publications (Loeblich, 1946, p. 132–133; Bergquist, 1949; Stephenson, 1953, p. 57–58) have demonstrated the value of microfaunal studies in the regional mapping of this formation on the outcrop in Texas; and a few other publications (Conant, 1946, p. 713; Cushman and Applin, 1946; 1947; Applin and Applin, 1947) have shown the similarity between the microfaunas of the Woodbine and of approximately contemporaneous subsurface formations in the southeastern states. In current subsurface investigations by geologists of the U. S. Geological Survey over an area extending from Texas into Florida microfaunal studies suggest the correlation of rocks in the lower part of the Gulf series across the Gulf Coast. The Woodbine formation on the outcrops in Texas, and beds of Woodbine age in the subsurface contain microfaunal assemblages of wide geographic distribution and narrow stratigraphic range. These are helpful in correlating the different intraformational facies. The present report describes the faunal aspects and stratigraphic and areal distribution of a unique microfauna that occurs in subsurface beds of Woodbine age in the southeastern Gulf Coast.

The name Atkinson formation (Applin and Applin, 1947) was introduced with three unnamed members (upper, middle, and lower) for the subsurface rocks of pre-Austin age in southern Alabama and Georgia, and northern Florida. Subsequently, the stratigraphic equivalent of the Atkinson formation has been traced through series of wells as far south as the Florida Keys. In general, the upper member of the Atkinson formation contains a microfauna of Eagle Ford age; the middle and lower members contain a microfauna of Woodbine age. The middle and lower members of the Atkinson formation in Alabama and Georgia were differentiated on a lithologic basis. In that area, the middle member of the Atkinson is predominantly a shale of marine origin, correlated with the so-called "marine shale zone" of the Tuscaloosa. The unfossiliferous littoral or nonmarine sandstone and red shale, which comprise the lower member of the Atkinson in the northern part of the Alabama and Georgia Coastal Plain, merge laterally southward into a fossiliferous marine facies. In the Florida peninsula, the distinguishing lithologic characteristics of the middle and lower members of the Atkinson formation are indistinct. To clarify the correlation of the Atkinson formation of the subsurface in the southeastern Gulf region with the Eagle Ford and Woodbine formations of Texas, the Atkinson formation is here redefined to consist of two members, an upper member of Eagle Ford age as formerly used, and a lower member of Woodbine age consisting of the former lower and middle members. The new biofacies described in the present report occurs in the lower member of the Atkinson formation as here defined.

Acknowledgments—The writer is indebted to Donald J. Munroe, Sun Oil Co., Tallahassee, Fla., for the privilege of selecting and cutting core samples from the Barlow well, Clinch County, Ga., at the time it was drilled. Mr. Munroe and E. A. Murchison and Albert C. Raasch, Humble Oil & Refining Co., Tallahassee, kindly furnished sets of cores and washed concentrates of cores and cutting samples from the other wells in Table 1. Mrs. A. R. Loeblich, Jr. critically compared specimens from the new biofacies with types and paratypes of species she had earlier described. Miss Ruth Todd selected sets of type and paratype specimens for comparison and gave constructive criticism on deter-

minations during the progress of the faunal studies. Frederick M. Swain's careful study and report on the ostracodes was very helpful.

WOODBINE MICROFAUNA

The paucity of published data on the microfauna of the outcropping Woodbine formation of Texas and its subsurface correlatives in other parts of the Gulf Coast emphasizes the need for a brief discussion of the typical widely distributed Woodbine fauna before describing a relatively restricted biofacies.

The microfauna of the outcropping Woodbine formation generally occurs in shales of the Lewisville (Hill, 1901, p. 114–115, 297), Templeton (Bergquist, 1949), and Pepper shale members (Adkins, 1932, p. 417–420; Stephenson, 1953, p. 58–59). The shales are mostly dark gray to brownish gray, and characteristically contain fine shreds of carbonaceous plant remains, pyrite, and various amounts of comminuted mica. The fauna is composed almost entirely of arenaceous Foraminifera, among which the genus *Ammobaculites* strongly predominates. Most of the species have been described (Cushman and Applin, 1946; 1947; Loeblich, 1946). Ostracodes are rare in outcrop samples and the species are undescribed. The species of ostracodes recorded from the Woodbine by C. I. Alexander (1929, p. 36) are now known to have been collected from Comanche deposits (personal communication from C. I. Alexander). Algal fragments are found in some outcrop samples and in some cuttings and cores from oil-test wells.

In the subsurface, the typical Woodbine fauna was found by the writer in east Texas; the "marine shale" zone of the Tuscaloosa in Mississippi; in the lower member of the Atkinson formation in southern Alabama and Georgia, and in Florida as far south as Hardee County. Subsurface beds of Woodbine age in the southeastern Gulf region, especially in the northern part of the Florida peninsula, contain lenses of the so-called "speckled" shales that are closely similar in character and faunal content to the "speckled" shales of the basal part of the Eagle Ford of Texas. The "speckled" shales of Woodbine age are waxy, thinly laminated, and dark gray to dark brownish gray, the "speckled" appearance being due largely to abundant specimens of *Globigerina* and *Gümbelina*. Generally, the fossils are crushed but sufficiently well preserved for generic identification. In addition, arenaceous species typical of the Woodbine occur frequently in the "speckled" shales. Some beds of black shale in the lower member of the Atkinson formation in Florida contain a dwarf foraminiferal fauna composed of numerous minute specimens of *Globigerina*, *Gümbelina*, *Neobulimina*, and *Eponides*? sp. This dwarf fauna occurs, also, in an outcrop of the Woodbine formation in Denton County, Tex.

DEPOSITIONAL ENVIRONMENT OF THE WOODBINE

The predominating arenaceous microfauna of the Woodbine and the lithologic character of the containing sediments indicate conditions of deposition ranging from very shallow-water marine to estuarine and brackish to weakly saline and possibly poorly aerated waters. Investigations by Ladd (1936), Crickmay, Ladd, and Hoffmeister (1941), and others show that *Globigerina* deposits do not necessarily imply outer marine or bathyal depths. Accordingly, moderately shallow-water deposition is postulated for the "speckled" shale units, although currents and wave action probably contributed to the wide distribution and thick accumulation of the planktonic genera. A further indication of shallow water is the dwarf calcareous foraminiferal fauna herein recorded from some facies of the lower member of the Atkinson formation in Florida, and from an outcrop of the Woodbine formation in Texas. Dwarf faunas develop in environments unfavorable to the normal growth of the organisms; in Florida, adverse factors induced by shallow water apparently depauperized the fauna.

NEW BIOFACIES OF THE LOWER MEMBER OF THE ATKINSON FORMATION

The new biofacies of the lower member of the Atkinson formation is usually called the "Barlow fauna" by geologists engaged in subsurface studies in the southeastern Gulf Coast. The fauna was discovered in the Sun Oil Company Barlow well 1, drilled in 1948 in Clinch County, Georgia. Subsequently, it has been found in 12 additional scattered wells (fig. 41) situated in the area extending northward from Levy and Putnam Counties, Florida, to Clinch County in southern Georgia, and westward to Crenshaw County in south-central Alabama.

Unlike the typical microfauna of the Woodbine and the lower member of the Atkinson, about 50 percent of the species in the new biofacies are calcareous forms. The most striking feature of the fauna, however, is that about one-third of the species were previously known only from rocks in the Comanche series. Most of these species had been recorded as ranging throughout the Washita group of the Comanche series, and a few were considered key microfossils for the recognition of the top of the Washita group. Although in the typical Woodbine fauna specimens of Ostracoda are relatively rare; in the new biofacies they may constitute as much as a third to a half of the faunal bulk. F. M. Swain studied representative specimens of ostracodes from this biofacies and identified 9 species that occur in the

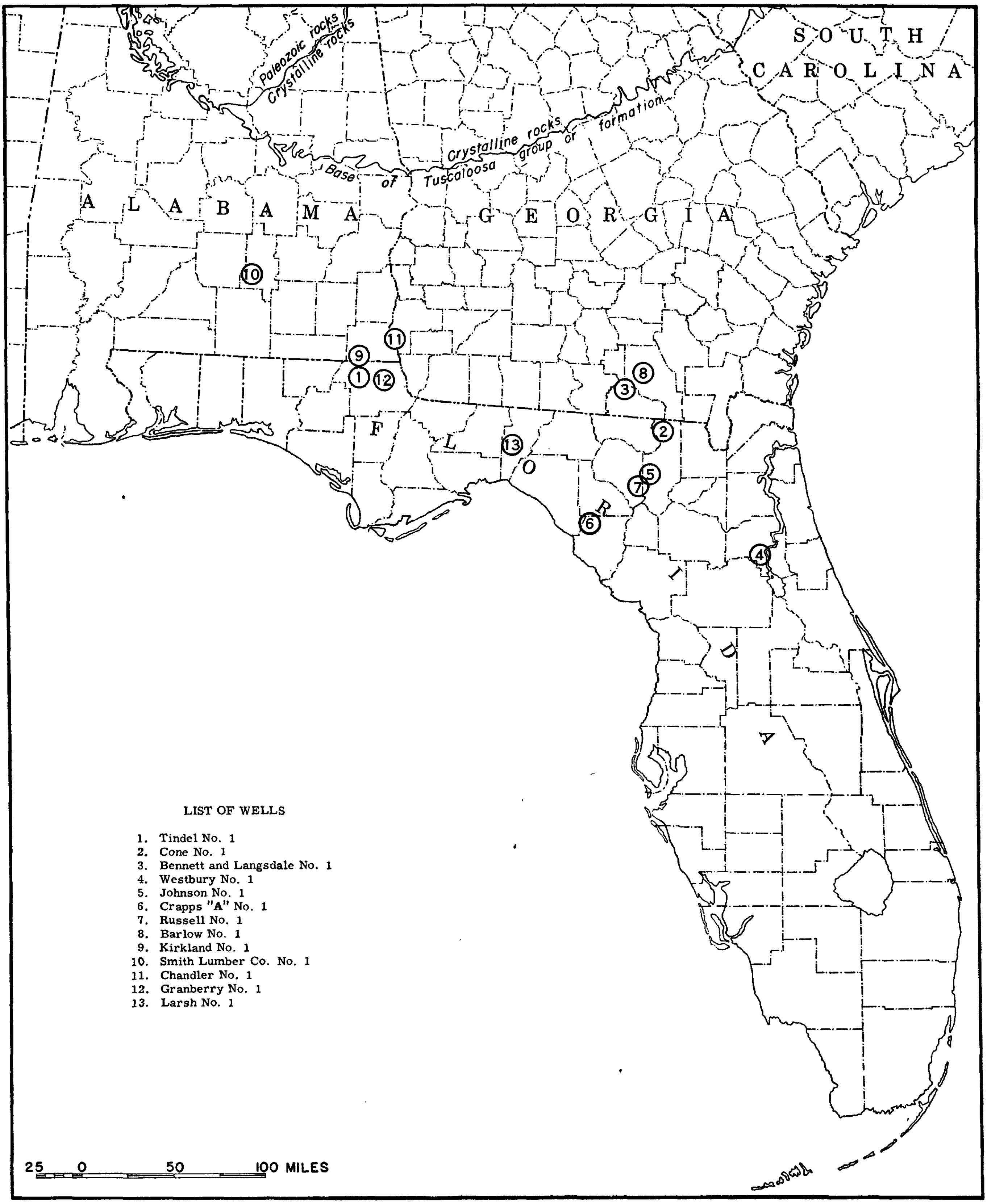

FIGURE 41.—Map of Florida and Georgia showing location of wells.

Washita group of the Comanche series; 3 that occur in the Taylor, Austin and Eagle Ford formations of the Gulf series; and 7, probably new species, that were only generically identified. Swain wrote (personal communication May 15, 1951).

The identifiable species of this fauna mostly suggest a pre-Senonian age, but it is too mixed to provide a definite comparison with any one of the American Cretaceous stratigraphic units. Relationships both to the Eagle Ford formation and to the Washita group of Texas are present. An assignment to a basal Upper Cretaceous age seems reasonable on the basis of the ostracodes.

Like the Ostracoda, the Foraminifera of the new biofacies of the Atkinson formation includes specimens of species characteristic of the Washita group in addition to a few species that range from the lower to the middle part of the Gulf series and some species that were described from and presumably restricted to beds of Woodbine age. The Foraminifera and Ostracoda that comprise the new microfaunal assemblage suggest a migration of the fauna from an area in which deposition was practically continuous from late Comanche into early Gulf time.

Mixed faunas such as this one suggest secondary deposition but in the new biofacies of the lower member of the Atkinson, three factors prohibit such an origin. First, in the area in which the fauna has been found, and for several hundred miles beyond its known depositional limits, Comanche age deposits consist of nonmarine red beds and sandstone. Second, the preservation of the three faunal constituents, the Comanche age forms, the long ranging Gulf age forms, and the restricted Woodbine age forms, is the same in character and quality. Third, except for minor variation in dominance, the fauna is unusually uniform throughout its known geographic range.

Table 1 shows the name and location of the wells (fig. 41) in which the new biofacies of the lower member of the Atkinson formation has been identified and the depths at which it occurs.

TABLE 1. *Names and locations of wells, and depth of samples yielding the new fauna*

No. figure 41	Name and location of well	Depth (feet)
1.	Humble Oil & Refining Co. Tindel well 1, Jackson County, Fla. Cuttings	3,470–3,530
2.	Humble Oil & Refining Co. Cone well 1, Columbia County, Fla. Core	3,328–3,331
3.	Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. Core	3,690–3,710
4.	Sun Oil Co. Westbury well 1, Putman County, Fla. Core	3,838–3,842
5.	Sun Oil Co. Johnson well 1, Columbia County, Fla. Core	2,955–2,973
6.	Sun Oil Co. Crapps "A" well 1, Dixie County, Fla. Core	3,548–3,556
7.	Sun Oil Co. Russell well 1, Suwannee County, Fla. Core	3,070–3,080
8.	Sun Oil Co. Barlow well 1, Clinch County, Ga. Core	3,709–3,719
9.	Union Producing Co. Kirkland well 1, Houston County, Ala. Core	3,280–3,290
10.	Nelson Exploration Co. Smith Lumber Co. well 1, Crenshaw County, Ala. Core	3,021–3,031
11.	Mont Warren Chandler well 1, Early County, Ga. Cuttings	3,007–3,075
12.	Mrs. Mamie Hammonds Granberry well 1, Jackson County, Fla. Cuttings	3,295–3,317
13.	Coastal Petroleum Co. Larsh well 1, Jefferson County, Fla. Cuttings	3,740–3,750

SYSTEMATIC PALEONTOLOGY

Family REOPHACIDAE

Subfamily REOPHACINAE

Genus REOPHAX Montfort, 1808

Reophax deckeri Tappan

Plate 48, figures 1, 2

1940. *Reophax deckeri* Tappan, Jour. Paleontology, v. 14, p.94, pl. 14, figs. 3a–b.
1941. *Reophax eckernex* Vieaux, idem, v. 15, p. 625, pl. 85, fig. 1.
1943. *Reophax deckeri* Tappan, idem, v. 17, no. 5, p. 479–80, pl. 77, fig. 3.
1954. *Reophax deckeri* Frizzell, Texas Bur. Econ. Geology. Rept. Inv. 22, p. 57, pl. 1, figs. 7a–b.

Test free, compressed, tapering toward the initial end; an average of about four chambers on adult specimens, increasing rapidly in size as added, final chamber frequently much larger than those forming remainder of test; sutural areas distinct; periphery lobulate; walls arenaceous, rather coarsely finished, average size of sand grains in the tests varying to some degree in relation to containing sediments, that is, coarser in more coarsely sandy deposits, finer in more silty materials. Color of test also ranges from brown to light gray in relation to the ferruginous quality of the materials in which the specimens are embedded. Aperture a single rounded opening on the phialine terminus of the final chamber. Average length 1 mm., average width of final chamber 0.50 mm.

Types and occurrence.—Hypotype (USNM P2156), finely arenaceous specimens from Humble Oil & Refining Co. Cone well 1, Columbia County, Fla. (Table 1; fig. 41), core 3,328–3,331 ft.

Hypotype (USNM P2157), coarsely arenaceous specimen from another part of same core.

Remarks.—This species was originally described from the Grayson formation of the Washita group, and subsequently was found to range downward through the

Washita group into the Duck Creek formation. It has also been found in a few surface and subsurface samples of Woodbine age, and is generally present but not abundant in the new biofacies of the lower member of the Atkinson.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMOIDINAE

Genus HAPLOPHRAGMOIDES Cushman, 1910

Haplophragmoides langsdalensis n. sp.

Plate 48, figure 3

Test free, large, somewhat compressed, planispirally coiled, partly involute, biumbilicate, depression shallow; walls thick, finely arenaceous, roughly finished; little cement, periphery broad, rounded, lobulate; sutures radiate, depressed, irregularly poorly defined; chambers averaging six to eight in number in final volution; interior simple or non-labyrinthic; aperture generally obscure, an irregular shaped opening at, or close to the base of the final chamber. Average diameter 1.20 mm., average thickness 0.48 mm.

Types and occurrence.—Holotype (USNM P2158), unfigured paratype (USNM P2159), specimens from Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,710 ft.

Remarks.—Specimens are similar to *Ammobaculites goodlandensis* Cushman and Alexander but there is no indication of the development of an evolute terminal sector, the umbilical depression is shallow, the periphery rounded and there are fewer chambers in the coil. This species has been found only in the new biofacies of the lower member of the Atkinson.

Haplophragmoides advenus (Cushman and Applin)

Plate 49, figures 2a, b

1946. *Ammobaculites stephensoni* Cushman and Applin, (not Cushman) Cushman Lab. Foram. Research Contr., v. 22, p. 72–73, pl. 13, fig. 1.
1947. *Ammobaculites advenus* Cushman and Applin, idem. Contr., v. 23, p. 53, pl. 13, figs. 1a-b.
1954. *Haplophragmoides advenus* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 59, pl. 1, figs. 25a–b.

This species is common in some microfossiliferous lenses of the lower member of the Atkinson formation. It is generally abundant in the new biofacies and is present to common in many outcrop samples from the Woodbine formation in north-central Texas.

Subfamily LITUOLINAE senu strictu

Genus AMMOBACULITES Cushman, 1910

Ammobaculites agrestis Cushman and Applin

Plate 49, figures 1a, b

1947. *Ammobaculites agrestis* Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 23, p. 53–54, pl. 13, figs. 2a-b, 3.
1954. *Ammobaculites agrestis* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 61, pl. 2, figs. 10a–b.

This species occurs in many surface and subsurface samples of Woodbine age, and is also a common species in the new biofacies of the lower member of the Atkinson formation.

Ammobaculites junceus Cushman and Applin

Plate 49, figures 6a, b

1946. *Ammobaculoides junceus* Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 22, p. 72, pl. 13, fig. 2a–b.
1951. *Ammobaculoides junceus* Lozo, Fondren Science Series, no. 4, pl. 4, figs. 1a–b.
1954. *Ammobaculites junceus* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 62, pl. 2, figs. 22a–b.

Specimens of this species of *Ammobaculites* occur sporadically in outcrop samples and in some subsurface samples of the Woodbine and its equivalent formations in the southeastern Gulf Coast. It is a fairly common species in the new biofacies of the lower member of the Atkinson.

Family TEXTULARIDAE

Subfamily SPIROPLECTAMMINAE

Genus AMMOBACULOIDES Plummer, 1932

Ammobaculoides plummerae Loeblich

Plate 49, figures 4a, b

1946. *Ammobaculoides plummerae* Loeblich, Jour. Paleontology, v. 20, p. 137–138, pl. 22, figs. 10–12b, text figures 3a–g.
1946. *Ammobaculoides plummerae* Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 22, p. 74–75, pl. 13, fig. 6a–b.
1950. *Ammobaculoides plummerae* Loeblich and Tappan, Univ. Kansas Paleont. Contr., art. 3, p. 9, pl. 1, figs. 24-27.
1951. *Ammobaculoides plummerae* Lozo, Fondren Science Series, no. 4, pl. 4, figs. 7a–b, 19a–b, 20, 21.
1954. *Ammobaculoides plummerae* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, pl. 4, figs. 33, 34.

A. R. Loeblich, Jr. described this species from the Pepper shale member of the Woodbine formation of Texas. Loeblich (1946, p. 137) stated that it "is the most common form in the Pepper shale." L. W.

Stephenson (1952) definitely established the age of the Pepper shale member on a faunal basis. Concerning the fauna of Pelecypods, Gastropods, and Cephalopods collected at Haunted Hill, near Moody, McLennan County, Tex., Stephenson (1952, p. 59) stated "The molluscan fauna from the Pepper shale at the Haunted Hill locality seems to afford clear confirmatory evidence of the Woodbine age of the shale."

A. plummerae, one of the most characteristic species of the typical microfauna of the Woodbine and its eastern subsurface equivalents, occurs also in the new biofacies of the lower member of the Atkinson. Loeblich and Tappan (1950, p. 9) also reported this species "from the Kiowa shale, Fredericksburg group, Kiowa County, Kansas."

Family VERNEUILINIDAE

Genus GAUDRYINA d'Orbigny, 1839

Gaudryina barlowensis n. sp.

Plate 48, figure 4

1937. *Gaudryina bentonensis* (Carmen) Cushman, (in part) Cushman Lab. Foram. Research, Spec. Pub. no. 7, p. 42–43.

Test small, elongate, nearly cylindrical; early portion triserial, latter and major portion biserial; aperture rounded, with a distinct lip, on a slight necklike projection at terminal end of the final chamber; walls finely arenaceous with much cement, smoothly finished; chambers increasing very gradually in size, very slightly inflated, width usually somewhat greater than height; sutures straight, distinct; color generally gray. Length of type 0.80 mm, breadth of type 0.20 mm.

Types and occurrence.—Holotype (USNM P2160), specimen from Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,710 ft.

Remarks.—This species is closely similar to some specimens which have been referred to *G. bentonensis*. A critical study of the large group of specimens included in this species in the Cushman collections seems to indicate that at least some specimens collected from outcrops of the Eagle Ford and the lower part of the Austin formations show characteristics which, in the present report, are used to define the species *G. barlowensis*. *G. barlowensis* differs from type specimens of *G. bentonensis* in the character of the wall structure, which in *G. barlowensis* is very finely arenaceous and smoothly finished; in the clearly defined sutures; in noninflated to very slightly inflated chambers; and in type of aperture, a circular opening on a slight neck located near the center of the distal end of the final chamber.

It is a characteristic species of the new biofacies of the lower member of the Atkinson.

Family MILIOLIDAE

Genus QUINQUELOCULINA d'Orbigny, 1826

Quinqueloculina moremani Cushman, var. barlowensis n. var.

Plate 48, figures 10, 11

The variety is a consistently narrower form than the species and the neck is more strongly and clearly developed. Measurements of specimens of *Q. moremani* in the Cushman collection show an average length of 0.53 mm and an average width of 0.28 to 0.30 mm. Measurements of many specimens of the variety average 0.53 mm in length and 0.25 mm in width. The relatively narrow test and the strong carinae of the chambers, which are especially well developed on the central chamber of the variety, suggest a similarity to *Quinqueloculina lirellangula* Loeblich and Tappan. The chambers on the Washita species, however, are narrower and more sharply keeled.

Types and occurrence.—Holotype (USNM P2161), figured paratype (USNM P2162), specimens from Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,700 ft.

Remarks.—Cushman (1946a, p. 48) reported the species from several outcrop localities of the Eagle Ford, but it has not been seen by the writer of the present report in subsurface samples of that formation. The variety is a common and characteristic fossil in the new biofacies of the lower member of the Atkinson.

Family TROCHAMMINIDAE

Subfamily TROCHAMMININAE

Genus TROCHAMMINA Parker and Jones, 1859

Trochammina rainwateri Cushman and Applin

Plate 49, figures 3a–c

1946. *Trochammina rainwateri* Cushman and Applin. Cushman Lab. Foram. Research Contr., v. 22, p. 75, pl. 13, fig. 9a–c.

1951. *Trochammina rainwateri* Lozo, Fondren Science Ser. no. 4, pl. 4, figs. 9a–c.

1954. *Trochammina rainwateri* Frizzell, Tex. Bur. Econ. Geology. Rept. Inv. 22, p. 67, pl. 4, figs. 20, a–c.

This is a characteristic Woodbine species occurring commonly in both surface and subsurface materials of Woodbine age from Texas eastward into northern peninsular Florida. It is present in the new biofacies of the lower member of the Atkinson but is not considered diagnostic of the facies. It is distinguished from *T. wickendeni* Loeblich by its thicker test, the slightly larger number of chambers, and different angles of the sutures.

Family PLACOPSILINIDAE

Subfamily PLACOPSILININAE

Genus ACRULIAMMINA Loeblich and Tappan, 1946

Acruliammina longa (Tappan)

Plate 48, figures 5, 6

1940. *Plascopsilina longa* Tappan, Jour. Palentology, v. 14, p. 100, pl. 15, figs. 9a–10.
1943. *Haplostiche texana* Tappan, (not *Nodosaria texana* Conrad 1857) Jour. Palenotology, v. 17, p. 480, pl. 77, fig. 5.
1943. *Placopsilina longa* Tappan, idem, v. 17, p. 493, pl. 79, figs. 8–9c.
1944. *Placopsilina longa* Lozo, Am. Midland Naturalist, v. 31, p. 552, pl. 3, fig. 3, text figure 20.
1946. *Acruliammina longa* Loeblich and Tappan, Jour. Paleontology, v. 20, p. 252, pl. 36, figs. 20a–c.
1954. *Acruliammina longa* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 80, pl. 71, figs. 28a–b.

Mrs. Loeblich compared specimens from the new biofacies of the lower member of the Atkinson with the holotype and with paratypes of *A. longa* in Washita collections and concurred with the specific determination.

The species was described from the Grayson formation and has been found in all the formations of the Washita group. It is recorded, also, from the Kiamichi formation of the Fredericksburg group.

In the new biofacies of the lower member of the Atkinson, it is one of the most characteristic and common species.

Types and occurrence.—Figured hypotypes (USNM P2163, P2164), specimens from Sun Oil Co. Barlow well 1, Clinch County, Ga. (Table 1; fig. 41), core 3,709–3,719 ft.

Genus Placopsilina d'Orbigny, 1850

Placopsilina langsdalensis n. sp.

Plate 48, figures 7–9

Test, attached, in part; amount and position of attached area varying with the specimens; early portion planispirally coiled, latter portion evolute; uniserial; chambers in evolute sector often staggered, or narrowing rapidly toward the periphery on alternating sides of tests suggesting an incipient biserial arrangement. About four chambers in initial coil, poorly defined. Chambers in linear series inflated, cyptic when not attached, breadth about equal to height. Chambers of evolute sector much larger than chambers in coil, increasing gradually in size; walls thick, of fine quartz grains well cemented; sutures depressed; aperture small, rounded, central, terminal. Specimens with final chamber attached have aperture a small curved slit, central and close to attached edge of chamber. Many specimens are broken, complete specimens indicating an average of four to six chambers in the linear series. Height of holotype 1.34 mm, breadth of coil 0.40 mm, breadth final chamber 0.45 mm. Color light gray to white.

Types and occurrence.—Holotype (USNM P2165), figured paratypes (USNM P2166, P2167), specimens from Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,710 ft.

Remarks.—Specimens and fragments of this species are fairly common in the new biofacies, and specimens have been collected by the writer from outcrops of the Main Street limestone in Denton County, Tex.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus ROBULUS, Montfort, 1808

Robulus munsteri (Roemer) Cushman

Plate 48, figure 12

1839. *Robulina munsteri* Roemer, Verstein. norddeutschen Oolithengebirges, Nachtrag., p. 48, pl. 22, fig. 29.
1840–41. *Robulina munsteri* Roemer, Verstein. norddeutschen Kreidegebirges, p. 98, pl. 15, fig. 30.
1862. *Cristellaria munsteri* Reuss, Akad. Wiss. Wien, Math-naturwiss. Kl., Sitzungsber., Band 46, pt. 1, p. 77, pl. 9, figs. 3–4.
1932. *Robulus munsteri* Cushman, Jour. Paleontology, v. 6, p. 334, pl. 50, figs. 2a–b.
1941. *Robulus munsteri* Cushman Lab. Foram. Research Contr., v. 17, p. 58, pl. 15, fig. 6.
1941. *Robulus munsteri* Cushman and Hedberg, idem, v. 17, p. 86, pl. 21, figs. 14a–b.
1942. *Robulus munsteri* Cushman and Deaderick, idem, v. 18, p. 56, pl. 10, figs. 10–13.
1944. *Robulus munsteri* Cushman and Deaderick, Jour. Paleontology, v. 18, p. 331, pl. 50, fig. 28.
1944. *Robulus munsteri* Cushman, Cushman Lab. Foram. Research Contr., v. 20, p. 85, pl. 13, fig. 7.
1946. *Robulus munsteri* Cushman, U. S. Geol. Survey Prof. Paper 206, p. 53, pl. 17, figs. 3–9.
1954. *Robulus munsteri* Frizzell, Texas, Bur. Econ. Geology, Rept. Inv. 22, p. 81, pl. 8, figs. 1a–b, 2, 3, 4.

Specimens that can be referred to this long-ranging Cretaceous species in the Gulf series often occur, but are never abundant in the new biofacies of the lower member of the Atkinson formation.

Types and occurrence.—Figured hypotype (USNM P2168), specimens from Sun Oil Co. Crapps "A" well 1, Dixie County, Fla. (Table 1; fig. 41), core 3,548–3,556 ft.

Genus LENTICULINA Lamarck, 1804

Lenticulina cyprina (Vieaux) Frizzell

Plate 48, figures 13, 14

1941. *Marginulina cyprina* Vieaux, Jour. Paleontology, v. 15, p. 625, pl. 85, figs. 3a–b.
1944. *Marginulina cyprina* Lozo, Am. Midland Nat., v. 31, p. 556, pl. 2, fig. 9.
1944. *Astacolus comanchensis* Lozo, idem, p. 555–556, pl. 2, figs. 1a–b.
1951. *Marginulina cyprina* Stead, Tex. Jour. Science, no. 4, p. 595, pl. 3, fig. 5.
1954. *Lenticulina cyprina* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 82, pl. 8, fig. 13.

This species was described from the Denton clay of north Texas and is common in all formations of the Washita group in that area. Stead (1951, p. 595) identified the species from outcrops of the Glen Rose limestone in Hays County, Texas. It occurs in the new biofacies of the lower member of the Atkinson, and occurs, sporadically, in association with typical arenaceous faunas of the lower member of the Atkinson formation in the Florida peninsula. A study of suites of specimens shows that *Astocolus comanchensis* Lozo is a variant of *Lenticulina cypina* (Vieaux.)

Types and occurrence.—Figured hypotypes (USNM P2169, P2170), specimens from Humble Oil & Refining Co. Keen well 1, Hardee County, Fla. (Table 1; fig. 41) Core 7,709–7,719 ft.

Genus NODOSARIA Lamarck, 1812

Nodosaria affinis Reuss, var.

Plate 48, figures 18–20

1845. *Nodosaria affinis* Reuss, Verstein. bohm. Kreideformation, pt. 1, p. 26, pl. 13, fig. 16.
1872–75. *Nodosaria affinis* Reuss, Palaeontographica, v. 20, pt. 2, p. 83, pl. 2 (20), fig. 12 (1874).
1892. *Nodosaria affinis* Perner, Foram. Ceskeho Cenomanu, p. 57, pl. 6, figs. 10, 14a–b.
1925. *Nodosaria affinis* Franke, Greifswald Univ., Geol.-palaeont. Inst., Abh., Band 6, p. 37, pl. 3, fig. 25.
1929. *Nodosaria affinis* W. Berry and Kelley, U. S. Natl. Museum Proc., v. 76, art. 19, p. 6, pl. 1, fig. 8.
1929. *Nodosaria proxima* W. Berry and Kelley (not Silvestri), idem, p. 7, pl. 1, fig. 13.
1931. *Nodosaria affinis* Cushman, Tennessee Div. Geology Bull. 41, p. 30, pl. 3, figs. 16–20.
1931. *Nodosaria affinis* Cushman, Jour. Paleontology, v. 5, p. 305, pl. 35, figs. 3–5 (not fig. 2).
1931. *Nodosaria affinis* Cushman, Cushman Lab. Foram. Research Contr., v. 7, p. 38, pl. 5, fig. 4.
1932. *Nodosaria affinis* Cushman and Jarvis, U. S. Natl. Museum Proc., v. 80, art. 14, p. 34, pl. 10, fig. 13.
1936. *Nodosaria affinis* Cushman, Geol. Soc. America Bull., v. 47, p. 417.
1940. *Nodosaria affinis* Cushman, Cushman Lab. Foram. Research Contr., v. 16, p. 86, pl. 15, figs. 8–23.
1943. *Nodosaria affinis* Cushman and Todd, idem, v. 19, p. 57, pl. 10, fig. 11.
1944. *Nodosaria affinis* Cushman, idem, v. 20, p. 7, pl. 2, fig. 1.
1944. *Nodosaria affinis* Cushman, idem, v. 20, p. 87, pl. 13, fig. 18.
1944. *Nodosaria affinis* Cushman and Deaderick, Jour. Paleontology, v. 18, p. 333, pl. 51, figs. 19–21.
1946. *Nodosaria affinis* Cushman, U. S. Geol. Survey Prof. Paper 206, p. 70–71, pl. 25, figs. 8–23.
1954. *Nodosaria affinis*, Frizzell Texas Bur. Econ. Geology, Rept. Inv. 22, p. 89, pl. 10, figs. 3–7.

The species has been recorded (Cushman, 1946a, p. 71) as apparently ranging "throughout the Upper Cretaceous above the Eagle Ford shale." The stratigraphic range is here extended downward to include the basal portion of the Gulf series since a varietal form of the species occurs in the new biofacies of the lower member of the Atkinson formation. Specimens in this biofacies differ from the typical forms in having an average of eight longitudinal costae, rather than the thirteen or more common on typical specimens of the species. The tests are also much smaller, averaging 0.30 mm in length and 0.05 mm in width whereas specimens in upper parts of the Gulf series are commonly 2 mm long and about 0.30 mm across.

Types and occurrence.—Figured hypotypes (USNM P2171, P2172, P2173), specimens from the Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,710 ft.

Genus CITHARINA d'Orbigny, 1839

Citharina recta (Reuss) Frizzell

Plate 48, figure 15

1863. *Vaginulina recta* Reuss, Akad. Wiss. Wien., Sitz., Band 46, p. 48, pl. 3, figs. 14–15.
1880. *Vaginulina recta* Berthelin, Soc. geol. France, Mem., Ser. 3, v. 1, mem. 5, p. 41, pl. 25, figs. 5a–b, 6a–b.
1890. *Vaginulina recta* Burrows, Sherborn and Bailey, Roy. Micros. Soc., Jour., pt. 5, p. 559, pl. 10, figs. 10–13.
1894. *Vaginulina recta* Chapman, Roy. Micros. Soc., Jour., p. 422, pl. 8, fig. 1.
1907. *Vaginulina recta* Egger, Nat. Verh. Nassau, Bericht., 20, p. 32, pl. 3, figs. 21–22.
1910. *Vaginulina recta* Egger, Verh. Regensburg., Bericht., p. 112–113, pl. 1, fig. 6.
1928. *Vaginulina recta* Franke, Preuss. geol. Landes., Abh., n. ser., v. 3, p. 82, pl. 7, figs. 27–28.
1929. *Vaginulina recta* Schmitt, Zeitsch. fur Geschiebef., Band 5, Heft 3, pl. 5, fig. 21.
1930. *Vaginulina recta* Cushman and Alexander, Cushman Lab. Foram. Research, Contr., v. 6, p. 4, pl. 1, figs. 17–22.
1940. *Vaginulina recta* Tappan, Jour. Paleontology, v. 14, no. 2, p. 110–111, pl. 17, figs. 7a–8.
1943. *Vaginulina recta* Tappan, idem, v. 17, p. 501, pl. 80, figs. 22a–b.
1954. *Citharina recta* Frizzell, Texas Bur. Econ. Geology. Rept. Inv. 22, p. 95, pl. 11, figs. 19–21.

According to Cushman and Alexander (1930, p. 4) this species is "widely recorded in the Cretaceous of Europe." Tappan (1943, p. 501) states that in formations in Texas "it ranges throughout the Washita group but is somewhat less common than *V. kochii* Roemer." Cushman and Alexander (1930, p. 4) call attention to the close similarity of *Citharina kochii*, (Roemer) and separate *C. recta* from *C. kochii* on the basis of its "narrower test with nearly parallel sides." Using these criteria, the species *C. recta* is the most common form in the new biofacies of the lower member of the Atkinson, although some specimens of *C. kochii* also appear in the fauna. *C. kochii* has been considered a key microfossil for the recognition of beds of Washita age.

Types and occurrence.—Figured hypotype (USNM P2174), specimen from Sun Oil Co. Barlow well 1, Clinch County, Ga. (Table 1; fig. 41), core 3,709–3,719 ft.

Genus FRONDICULARIA Defrance, 1826

Frondicularia barlowensis n. sp.

Plate 48, figures 16, 17

Test lanceolate, strongly compressed, broad faces flattened, periphery truncate. Small narrow proloculum and first two or three chambers on a short, spike-like projection, several additional early chambers extended dorsally to terminate in a slightly outward and upward slanting line giving a wedge shaped appearance to this portion of the test. First two or three chambers, on some specimens added only on one side, as in *Vaginulina*, remaining chambers symmetrical, narrow, increasing very slowly in width as added. Sutures, distinct, raised, limbate; surface smooth; aperture on the narrowly pointed distal end of test.

Types and occurrence.—Holotype (USNM P2175), figured paratype (USNM P2176), specimens from the Sun Oil Co. Barlow well 1, Clinch County, Ga. (Table 1; fig. 41), core 3,709–3,719 ft.

Remarks.—This species is most closely related to *F. inversa* Reuss, under which specific classification a large and highly variable group of forms is included. It is distinguished from *F. inversa* on the basis of the raised and limbate sutures, the truncate periphery, and the tendency of a few early chambers to show a *Vaginulina* stage. This species is characteristic of the new biofacies of the lower member of the Atkinson formation.

Family SPIRILLINIDAE

Subfamily PATELLINA Williamson, 1858

Patellina subcretacea Cushman and Alexander

1930. *Patellina subcretacea* Cushman and Alexander, Cushman Lab. Foram. Research Contr., v. 6, p. 10, pl. 3, figs. 1a–b.

1943. *Patellina subcretacea* Tappan, Jour. Paleontology, v. 17, p. 511, pl. 82, figs. 4a–b.

1944. *Patellina subcretacea* Lozo, Am. Midland Nat., v. 31, p. 561, pl. 4, fig. 8.

1949. *Patellina subcretacea* Loeblich and Tappan, Jour. Paleontology, v. 23, p. 264, pl. 51, fig. 3.

1954. *Patellina subcretacea* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 122 pl. 18, figs. 26a–b.

Specimens of this species have been found only in samples from the Humble Oil & Refining Co. Cone well 1, Columbia County, Fla. (Table 1; fig. 41), core 3,328–3,331 ft. Because of their small size and fragility, specimens may have been overlooked or destroyed in preparation of concentrates from other wells. Specimens from the new biofacies were compared with the holotype and paratypes in the Cushman collection and seem to be typical. The species was described from the Goodland limestone, and its range, as recorded by Lozo (1944, p. 561), is in the Fredericksburg group and the lower part of the Washita group. It has not previously been reported from formations younger than the Denton clay.

Family ROTALIIDAE

Subfamily DISCORBINAE

Genus DISCORBIS Lamarck, 1804

Discorbis minima Vieaux

1941. *Discorbis minima* Vieaux, Jour. Paleontology, v. 15, p. 627, pl. 85, figs. 10a–c.

1943. *Discorbis minima* Tappan, idem, v. 17, p. 511, pl. 82, figs. 7a–8b.

1949. *Discorbis* cf. *minima* Loeblich and Tappan, idem, v. 23, p. 265, pl. 51, figs. 12a–13.

1954. *Discorbis minima* Frizzell Texas Bur. Econ. Geology, Rept. Inv. 22, p. 122, pl. 18, figs. 29a–b.

This little fossil has been found at only one locality, the Humble Oil & Refining Co. Cone well 1, Columbia County, Fla. (Table 1; fig. 41), core 3,328–3,331 ft. Like the specimens of *Pattelina subcretacea*, it may have been present but not noted in other wells in assemblages of the new biofacies of the lower member of the Atkinson formation. The specimens conform in all respects with specimens identified and figured by Tappan from the Duck Creek formation of Texas and Oklahoma.

The species has been reported from the Denton, Fort Worth, and Duck Creek formations of the Washita group in Texas and Oklahoma, and from the Walnut clay of the Fredericksburg group in Oklahoma.

Genus VALVULINERIA Cushman, 1926

Valvulineria infrequens Morrow var.

Plate 48, figures 21, 22

1934. *Valvulineria infrequens* Morrow, Jour. Paleontology, v. 8, p. 197, pl. 30, figs. 3a–c.

1942. *Valvulineria infrequens* Cushman and Deaderick, Cushman Lab. Foram. Research Contr., v. 18, p. 64, pl. 15, figs. 17–19.
1944. *Valvulineria infrequens* Cushman, idem, v. 20, p. 95, pl. 14, fig. 22.
1946. *Valvulineria infrequens* Cushman, U. S. Geol. Survey Prof. Paper 206, p. 138, pl. 57, figs. 5a–c.
1954. *Valvulineria infrequens* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 123, pl. 18, figs. 35a–c.

Typical specimens of this species occur in the basal portion of beds of Austin age in the subsurface of southern Georgia and Alabama. The species was described from the basal strata of the Niobrara chalk of Kansas, and Cushman (1946a, p. 138) records its occurrence in beds of Austin and Taylor age from Arkansas and Texas, and from the lower part of the Selma group in Mississippi.

A variant of the species is a common and characteristic feature of microfaunas of Eagle Ford age in the subsurface of the southeastern Gulf Coast, and in outcrops of the Eagle Ford at Chispa Summit in west Texas. Small specimens of the same form occur in some subsurface samples of beds of Woodbine age, including the new biofacies of the lower member of the Atkinson formation. The variant is generally more elliptical in outline than typical specimens that are characteristic of beds of Austin age. This difference in the shape of the test in the variant seems to be due to the presence of fewer chambers in the initial coil and a tendency of mature specimens to consist of five rather than the six chambers, common to the typical species. A few specimens showing these variations may be found among suites of specimens of the typical species, and a few typical specimens of the species may occur in assemblages in which the variant is dominant.

Types and occurrence.—Figured hypotypes (USNM P2184, P2177), specimens from the Nelson Exploration Co. Smith Lumber Co. well 1, Crenshaw County, Ala. (Table 1; fig. 41), core 3,021–3,031 ft.

Family GLOBOROTALIIDAE

Genus GLOBOROTALIA Cushman, 1927

Globorotalia cushmani Morrow

Plate 48, figures 25, 26

1934. *Globorotalia cushmani* Morrow, Jour. Paleontology, v. 8, p. 199, figs. 2a–b, 4a–b.
1946. *Globorotalia cushmani*, Cushman, U. S. Geol. Survey Prof. Paper 206, p. 152, pl. 62, figs. 9a–c.
1954. *Globorotalia cushmani*, Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 129, pl. 20, figs. 28a–c.

The species was described from the Greenhorn limestone of Kansas, and Cushman (1946a, p. 152) records its presence at several localities in Texas from beds of Austin age, and from one locality in the Eagle Ford.

It is a common and characteristic fossil in the new biofacies of the lower member of the Atkinson formation

Superficially, the species is similar to the Washita species *Globorotalia marginaculeata* Loeblich and Tappan but can easily be distinguished from the Comanche form on the basis of the very broad and strongly depressed sutural areas, the convexity of the ventral surface, the presence of 5 rather than 6 or more chambers in the final convolution, and the rounded and thickened periphery. *G. marginaculeata* develops a distinctly spinose Keel.

Type and occurrence.—Figured hypotypes (USNM P2178, P2179), specimens from Humble Oil & Refining Co. Tindel well 1, Jackson County, Fla. (Table 1; fig. 41), cuttings 3,470–3,500 ft.

Genus GLOBIGERINA d'Orbigny, 1826

Globigerina cf. cretacea d'Orbigny

Plate 48, figures 23, 24

1840. *Globigerina cretacea* d'Orbigny, Soc. geol. France Mem., ser. 1, v. 4, p. 34, pl. 3, figs. 12–14.
1917. *Globigerina cretacea* Champan, Geol. Survey Western Australia, Bull. 72, p. 37, pl. 9, fig. 102; pl. 12, fig. 124.
1940. *Globigerina cretacea* Tappan, Jour. Paleontology, v. 14, p. 121, pl. 19, figs. 11a–c.
1943. *Globigerina cretacea* Tappan, Jour. Paleontology, v. 17, p. 512, pl. 82, figs. 16a–17.
1946. *Globigerina cretacea* Cushman, Cushman Lab. Foram. Research, v. 22, p. 17, pl. 3, fig. 5a–6, pl. 4, figs. 5–6.
1953. *Globigerina cretacea* Crespin, Cushman Foundation Foram. Research Contr., v. 4, p. 35, pl. 6, figs. 15a–c.

In a restudy of this species, Cushman (1946b, p. 17) commented:

> This is a very common species in the Upper Cretaceous of Europe and America and probably elsewhere. There are a great many published records for this species ranging from Jurassic to Recent, mostly without figures. In those records accompanied by figures it is evident that several species have been included under this name.

In all major details, the specimens common in the lower member of the Atkinson conform with the description and figures of the type, and they agree, also, with the specimens assigned to the species in the synonomy given above. However, the original surface was not preserved on specimens from the new biofacies, and the form is, therefore, compared to the species.

Type and occurrence.—Figured hypotypes (USNM P2180, P2181), specimens from the Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41), core 3,690–3,710 ft.

Specimens common in the new biofacies of the lower member of the Atkinson are in all respects identical to those described by Tappan from the Washita group. Helen Tappan made the comparisons on which this statement is based. Frizzell (1954, p. 127) included

G. cretacea d'Orbigny, Tappan in the synonomy of *G. delrioensis* Carsey. The present writer is not in complete accord with this assignment.

Family ANOMALINIDAE

Subfamily ANOMALININAE

Genus ANOMALINA d'Orbigny, 1826

Anomalina obesa Cushman and Applin

Plate 49, figures 5a, b

1947. *Anomalina obesa* Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 23, p. 55, pl. 13, figs. 7a–b.

This species was described from a subsurface sample of the "marine shale" zone of the Tuscaloosa in Mississippi. It is rare to abundant in samples that contain the new biofacies of the lower member of the Atkinson formation, and it occurs in a few typical samples of the lower member of the Atkinson formation in the northern part of the Florida peninsula.

Anomalina petita Carsey

Plate 48, figures 27, 28

1926. *Anomalina petita* Carsey [nomen nudum] Univ. Texas Bull. 2612, p. 48 [through error a cristellarian test represents this species, pl. 7, fig. 31.]
1931. *Anomalina falcata* (Reuss) Plummer, Univ. of Tex. Bull. no. 3101, p. 202–203, pl. 14, fig. 7a–c, 8a-b.
1940. *Anomalina plummerae* Tappan, Jour. Paleontology, v. 14, p. 124, pl. 18, figs. 15a–16.
1943. *Anomalina plummerae* Tappan, idem, v. 17, p. 514, pl. 83, figs. 6–8c.
1954. *Anomalina petita* Frizzell, Texas Bur. Econ. Geology, Rept. Inv. 22, p. 131, pl. 21, figs. 5a–c.

Tappan (1943, p. 514) says of this species, that it "ranges abundantly throughout the Washita group." This characteristic Washita species is fairly common in the new biofacies of the lower member of the Atkinson.

Type and occurrence.—Figured hypotypes (USNM P2182, P2183), specimens from Sun Oil Co. Crapps "A" well 1, Dixie County, Fla. (Table 1; fig. 41), core 3,548–3,556 ft.

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PLATES 48, 49

PLATE 48

Figures 1, 2. *Reophax deckeri* Tappan (p. 190).
1. Finely arenaceous hypotype, USNM P 2156, × 40.
2. Coarsely arenaceous hypotype, USNM P 2157, × 40.

3. *Haplophragmoides langsdalensis* Applin, n. sp. (p. 191).
Side view of holotype, USNM P 2158, × 30.

4. *Gaudryina barlowensis* Applin, n. sp. (p. 192).
Holotype, USNM P 2160, × 40.

5, 6. *Acruliammina longa* (Tappan). (p. 193).
5. Initial end, hypotype, USNM P 2163, × 30.
6. Attached apertural end, hypotype, USNM P 2164, × 30.

7–9. *Placopsilina langsdalensis* Applin, n. sp. (p. 193).
7. Holotype, USNM P 2165, × 40.
8. Initial end broken specimen, paratype, USNM P 2167, × 40.
9. Slightly crushed paratype, USNM P 2166, × 40.

10, 11. *Quinqueloculina moremani* Cushman, var. *barlowensis* Applin, n. var. (p. 192).
10. Holotype, USNM P 2161, × 40.
11. Opposite side of paratype, USNM P 2162, × 40.

12. *Robulus munsteri* (Roemer) Cushman. (p. 192).
Side view of hypotype, USNM P 2168, × 30.

13, 14. *Lenticulina cyprina* (Vieaux) Frizzell. (p. 194).
Side views of hypotypes, USNM P 2169 and P 2170, × 40.

15. *Citharina recta* (Reuss) Frizzell. (p. 194).
Hypotype, USNM P 2174, × 30.

16, 17. *Frondicularia barlowensis* Applin, n. sp. (p. 195).
16. Nearly complete specimen of holotype showing general contour, USNM P 2175, × 30.
17. Broken specimen of paratype showing chamber arrangement, USNM P 2176, × 30.

18–20. *Nodosaria affinis* Reuss var. (p. 194).
18. Apertural end of form with inflated chambers, hypotype, USNM P 2172, × 30.
19. Initial end, hypotype, USNM P 2173, × 30.
20. Apertural end of form with chambers slightly inflated, hypotype, USNM P 2171, × 40.

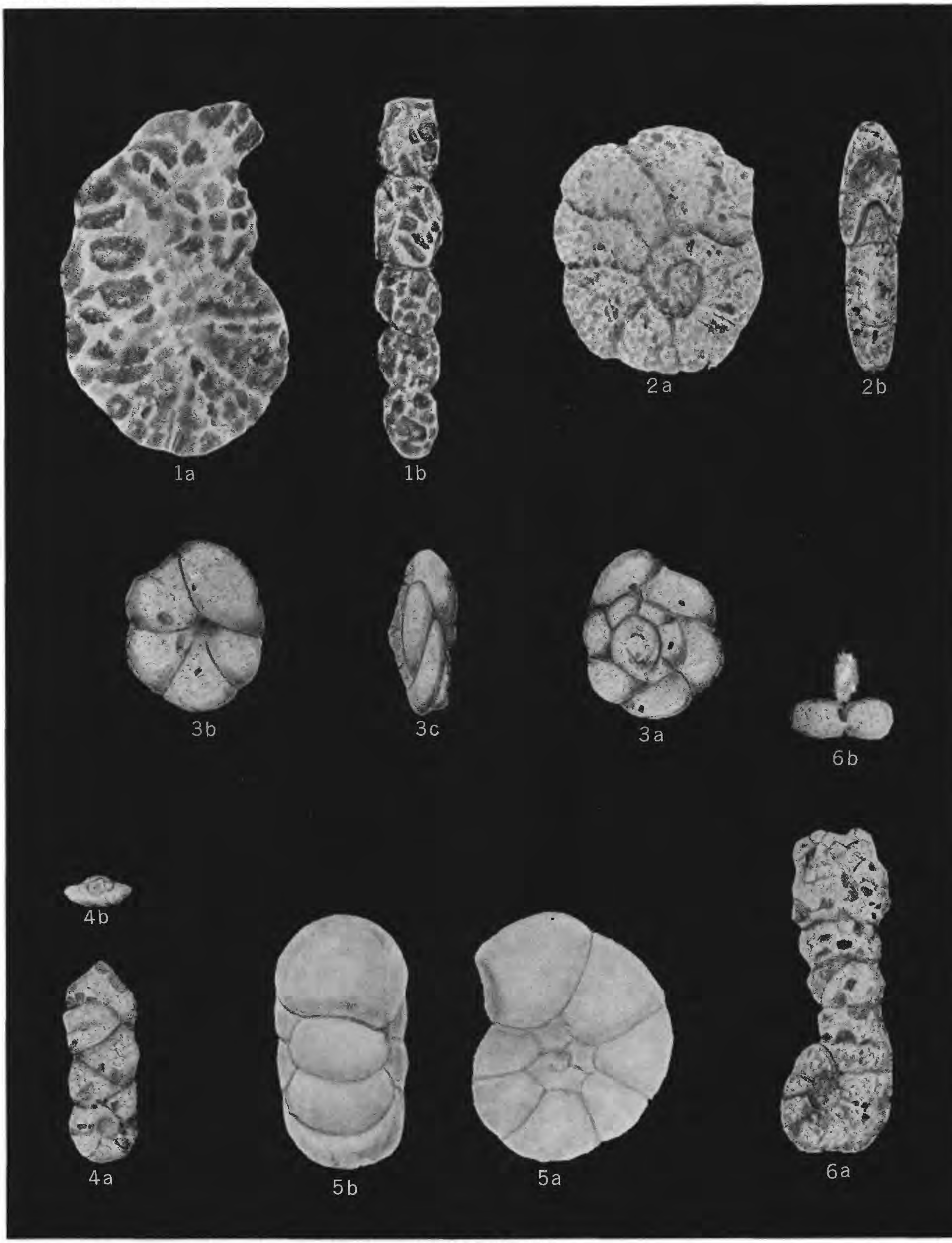
21, 22. *Valvulineria infrequens* Morrow var. (p. 195).
21. Dorsal view, hypotype, USNM P 2184, × 40.
22. Ventral view, hypotype, USNM P 2177, × 40.

23, 24. *Globigerina* cf. *cretacea* d'Orbigny. (p. 196).
23. Dorsal view, hypotype, USNM P 2180, × 40.
24. Ventral view, hypotype, USNM P 2181, × 40.

25, 26. *Globorotalia cushmani* Morrow. (p. 196).
25. Dorsal view, hypotype, USNM P 2178, × 30.
26. Ventral view, hypotype, USNM P 2179, × 40.

27, 28. *Anomalina petita* Carsey. (p. 197).
27. Ventral view, hypotype, USNM P 2183, × 40.
28. Dorsal view, hypotype, USNM P 2182, × 40.

BARLOW FAUNA



BARLOW FAUNA

PLATE 49

(Figures 3, 4, 6 after Cushman and Applin, 1946; figures 1, 2, 5 after Cushman and Applin, 1947.)

FIGURE 1. *Ammobaculites agrestis* Cushman and Applin. (p. 191).
a, side view; b, peripheral view; × 60.

2. *Haplophragmoides advenus* (Cushman and Applin) Frizzell. (p. 191).
a, side view; b, apertural view; × 60.

3. *Trochammina rainwateri* Cushman and Applin. (p. 192).
a, dorsal view; b, ventral view; c, peripheral view; × 75.

4. *Ammobaculoides plummerae* Loeblich. (p. 191).
a, side view; b, apertural view; × 75.

5. *Anomalina obesa* Cushman and Applin. (p. 197).
a, side view; b, peripheral view; × 120.

6. *Ammobaculites junceus* Cushman and Applin. (p. 191).
a, side view; b, apertural view; × 75.