A Biofacies of Woodbine Age in Southeastern Gulf Coast Region

By Esther R. Applin

A Shorter Contribution to General Geology

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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A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

A BIOFACIES OF WOODBINE AGE IN THE SOUTHEASTERN GULF COAST REGION

By Esther R. Applin

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 Gümibelina. 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, Gümibelina, 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
LIST OF WELLS

1. Tindel No. 1
2. Cone No. 1
3. Bennett and Langsdale No. 1
4. Westbury No. 1
5. Johnson No. 1
6. Crapps "A" No. 1
7. Russell No. 1
8. Barlow No. 1
9. Kirkland No. 1
10. Smith Lumber Co. No. 1
11. Chandler No. 1
12. Granberry No. 1
13. Larah No. 1

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 non-marine 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—Continued**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name and location of well</th>
<th>Depth (feet)</th>
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<tr>
<td>7.</td>
<td>Sun Oil Co. Russell well 1, Suwannee County, Fla. Core</td>
<td>3,070–3,080</td>
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<tr>
<td>8.</td>
<td>Sun Oil Co. Barlow well 1, Clinch County, Ga Core</td>
<td>3,700–3,719</td>
</tr>
<tr>
<td>9.</td>
<td>Union Producing Co. Kirkland well 1, Houston County, Ala. Core</td>
<td>3,280–3,290</td>
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<tr>
<td>10.</td>
<td>Nelson Exploration Co. Smith Lumber Co. well 1, Crenshaw County, Ala. Core</td>
<td>3,021–3,031</td>
</tr>
<tr>
<td>11.</td>
<td>Mont Warren Chandler well 1, Early County, Ga Cuttings</td>
<td>3,007–3,075</td>
</tr>
<tr>
<td>12.</td>
<td>Mrs. Mamie Hammonds Granberry well 1, Jackson County, Fla. Cuttings</td>
<td>3,295–3,317</td>
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**SYSTEMATIC PALEONTOLOGY**

**Family REOPHACIDAE**

**Subfamily REOPHACINAE**

**Genus REOPHAX Montfort, 1808**

**Reophax deckeri** Tappan

Plate 48, figures 1, 2


1941. Reophax eckernex Vieaux, idem, v. 15, p. 625, pl. 85, fig. 1.

1943. Reophax deckeri Tappan, idem, v. 17, no. 5, p. 479–50, pl. 77, fig. 3.


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 3,228–3,331 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
A BIOFACIES OF WOODBINE AGE IN SOUTHEASTERN GULF COAST REGION

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

1947. Ammobaculites advenus Cushman and Applin, idem Contr., v. 23, p. 53, pl. 13, figs. 1a-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 senz strictu
Genus AMMOBACULITES Cushman, 1910
Ammobaculites juncinus Cushman and Applin
Plate 49, figures 6a, b

1946. Ammobaculoides juncinus Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 22, p. 72, pl. 13, fig. 2a-b.
1951. Ammobaculoides juncinus Lozo, Fondren Science Series, no. 4, pl. 4, figs. 1a-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.

Ammobaculoides plummerae (Cushman and Applin)
Plate 49, figures 6a, b

1946. Ammobaculoides plummerae Cushman and Applin, Cushman Lab. Foram. Research Contr., v. 22, p. 74-75, pl. 13, figs. 6a-b.
1954. 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


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


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


1943. *Placopsilina longa* Tappan, idem, v. 17, p. 493, pl. 79, figs. 8–9e.


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 P2165), figured paratypes (USNM P2166, P2167), specimens from Humble Oil & Refining Co. Bennett and Langdale 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 NODOSARINAE**

**Genus ROBULUS, Montfort, 1808**

*Robulus munsteri* (Roemer) Cushman

Plate 48, figure 12


1932. *Robulus munsteri* Cushman, Jour. Paleontology, v. 6, p. 334, pl. 50, figs. 2a–b.


1941. *Robulus munsteri* Cushman and Hedberg, idem, v. 17, p. 86, pl. 21, figs. 14a–b.


1944. *Robulus munsteri* Cushman and Deaderick, Jour. Paleontology, v. 18, p. 331, pl. 50, fig. 28.


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.

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 Langdale 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.
**Genus LENTICULINA Lamarck, 1804**

*Lenticulina cyprina* (Vieaux) Frizzell

Plate 48, figures 13, 14


1944. *Astoculus comanchensis* Lozo, idem, p. 555-556, pl. 2, figs. 1a-b.


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 lower member of the Atkinson formation in the Florida peninsula. A study of suites of specimens shows that *Astoculus comanchensis* Lozo is a variant of *Lenticulina cyprina* (Vieaux.)

Types and occurrence.—Figured hypotypes (USNM P2168, P2172, P2173), specimens from Humble Oil & Refining Co. Bennett and Langsdale well 1, Echols County, Ga. (Table 1; fig. 41) Core 7,709-7,719 ft.

**Genus NODOSARIA Lamarck, 1812**

*Nodosaria affinis* Reuss, var.

Plate 48, figures 18-20


1890. *Nodosaria affinis* Perner, Foram. Ceskeho Cenomana, p. 57, pl. 6, figs. 10, 14a-b.


1929. *Nodosaria proxima* W. Berry and Kelley (not Silvestri), idem, p. 7, pl. 1, fig. 13.


1931. *Nodosaria affinis* Cushman, Jour. Paleontology, v. 5, p. 305, pl. 35, figs. 8-10 (not fig. 2).

1931. *Nodosaria affinis* Cushman, Cushman Lab. Foram. Research Contr., v. 7, p. 38, pl. 5, fig. 4.


1940. *Nodosaria affinis* Cushman, Cushman Lab. Foran. Research Contr., v. 16, p. 86, pl. 13, figs. 8-23.

1943. *Nodosaria affinis* Cushman and Todd, idem, v. 10, 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.


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 3,548-3,556 ft.

**Genus CITHARINA d'Orbigny, 1839**

*Citharina recta* (Reuss) Frizzell

Plate 48, figure 15


1880. *Vaginulina recta* Berthelin, Soc. geol. France, Mem., Ser. 3, v. 1, mem. 5, p. 41, pl. 25, figs. 5a-b, 6a-b.


1940. *Vaginulina recta* Cushman, Cushman Lab. Foran. Research Contr., v. 6, p. 4, pl. 1, figs. 17-22.


1943. *Vaginulina recta* Tappan, idem, v. 17, p. 501, pl. 80, figs. 22a-b.

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, 1896

**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


**Genus VALVULINERIA** Cushman, 1926

**Valvulineria infrequens** Morrow var.

Plate 48, figures 21, 22
from the basal strata of the Niobrara chalk of Kansas, ern Georgia and Alabama. The species was described portion of beds of Austin age in the subsurface of south­

sissippi.

Atkinson formation. The variant is generally more some subsurface samples of beds of Woodbine age, in­

subsurface of the southeastern Gulf Coast, and in out­

and from the lower part of the Selma group in Mis­

A few specimens showing these variations may be found in the shape of the test in the variant seems to be due characteristic of beds of Austin age. This difference among suites of specimens of the typical species, 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 as­

semblages 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 GLOBOROTALIDAE

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.


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 synonymy 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 synonymy 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

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., 2012, 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.

LITERATURE CITED
Loeblich, A. R., Jr., 1946, Foraminifera from the type Pepper shale of Texas: Jour. Paleontology, v. 20, p. 130–139, pl. 22, text figs. 1–3.
PLATES 48, 49
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 longidulensis 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. Acritammamna longa (Tappan). (p. 193).
6. Haplophragmoides langsdalensis Applin, n. sp. (p. 191).
   Side view of holotype, USNM P 2158, × 30.
   8. Initial end, hypotype, USNM P 2163, × 30.
10. Quinqueloculina moremani Cushman, var. barlowensis Applin, n. var. (p. 192).
   11. Opposite side of paratype, USNM P 2162, × 40.
   Side view of hypotype, USNM P 2168, × 30.
   Side views of holotypes, USNM P 2169 and P 2170, × 40.
   Hypotype, USNM P 2174, × 30.
17. Nearly complete specimen of holotype showing general contour, USNM P 2175, × 30.
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.
22. Ventral view, hypotype, USNM P 2177, × 40.
24. Ventral view, hypotype, USNM P 2181, × 40.
27. Ventral view, hypotype, USNM P 2183, × 40.
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).
1. a, side view; b, peripheral view; × 60.

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

   a, dorsal view; b, ventral view; c, peripheral view; × 75.

   a, side view; b, apertural view; × 75.

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

   a, side view; b, apertural view; × 75.