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FOSSIL ZONES OF THE EAGLE FORD OF NORTH TEXAS

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ABSTRACT

The Eagle Ford includes a great variety of both large and microscopic fossils. It is possible to divide the formation into definite zones based mainly on the ammonites as follows, from the bottom upward: zones of Acanthoceras rotomagense, Melloiceras irwini, Melloiceras whitei, Melloiceras swallowi, Helicoceras pariense, Melloiceras gibbosum, Gaughiericeras bravisi, Prionotropis woolgari, and zone of transition beds at the Eagle Ford–Austin chalk contact. Two of these horizons are present in the lower half of the formation, while the others are in the upper half. The microscopic fossils, especially the Foraminifera, have been checked at various levels. The transition between the Eagle Ford and Austin chalk can be traced from Sherman to Austin.

INTRODUCTION

This formation was first named by Hill from Eagle Ford, a village west of Dallas, where it is typically exposed. It corresponds to the Benton of the Meek and Hayden section in the west central states and has been correlated with the Turonian of the European section.

Many descriptions of the Eagle Ford may be found in the literature of this region, but its general lithological and paleontological characteristics are best described by Hill, and his observations furnish a basis for all future study. The most recent work is that by Scott, who established three fossil zones in the Eagle Ford. It is the purpose of this preliminary paper to indicate a number of additional zones; to present a more detailed study of the paleontology with relation to the fossil zones, particularly those formed by ammonites; to discuss their stratigraphic importance; and also to establish the relationship of occurrence of the microscopic and the larger fossils. The writer intends later to describe the fauna of the Eagle Ford in detail.

In the accomplishment of this piece of research the writer wishes to make grateful acknowledgment for the assistance given him by Professor W. M. Winton, head of the department of geology at Texas Christian University, for his suggestions and aid both in the field and with the photographic work; to Dr. Gayle Scott, professor of geology at Texas Christian University, for his suggestions and identification of some of the ammonites; to Helen Jeanne Plummer for invaluable aid in

1 North Texas indicates the area lying between Waco and Denison.

the identification and selection of the microscopic fossils; and to C. I. Alexander for identification of the Ostracoda.

LITHOLOGY AND PALEONTOLOGY

The Eagle Ford is very extensive in Texas, forming an outcrop across the entire state, from the Red River to the Rio Grande River. The thickness varies at different localities, reaching a maximum of from 500 to 600 feet in North Texas, between Dallas and Sherman; while at Austin it is only about 30 feet thick. West of Austin the thickness increases and is some 200 or 300 feet in the Rio Grande region. Hill states that the decrease in thickness southward from the Red River is probably due to a gradual disappearance in that direction of the lower beds, until at Austin only the upper part of the formation is represented. Observations of the writer and others tend to confirm this. The dip is 29 to 52 feet per mile.

The lithologic characters of the Eagle Ford are unlike at different levels, but the formation consists mainly of bituminous shales. In North Texas between Dallas and Tarrant Station, and between Britton and Midlothian, nearly the entire formation can be studied. A generalized section would be about as follows: Woodbine sand above which the Eagle Ford begins as a conglomeratic layer, next about 150 feet of typical blue to gray shale with occasional flaggy arenaceous and calcareous layers. Above this for 50 feet or more the shale contains a high percentage of calcareous material which gives it almost a white color. These beds are continuous for some distance and might be considered to locally represent a definite zone based on the lithology. The remaining 300 feet include the typical blue shale which becomes finely laminated toward the top. In places these beds are almost micaceous in texture and contain fossils preserved as casts with a thin film of the original nacre. At intervals there are flaggy layers, and at two levels 75 and 100 feet below the top these layers form beds which sometimes make distinct escarpments. Throughout the formation are septaria which become larger and more abundant in the upper layers. The upper member includes many large, rounded concretions some of which exhibit fantastic shapes.

Such minerals as gypsum, calcite, pyrite, glauconite, phosphate nodules, quartz, etc., may be found in the shale. Gypsum is especially abundant, filling cracks and crevices and sometimes forming large crystals.1

The Eagle Ford shales are important as a source of petroleum. The fields of the Mexia district have produced a great quantity of oil from the Woodbine sands. There seems little doubt that the origin of this was in the Eagle Ford shales.

In the past it has been considered impossible to establish definite fossil zones in the Eagle Ford because the exposures are so few and widely separated. Nevertheless there are a few localities where the succession of the beds can be determined, for example, between Dallas and Tarrant Station along the St. Louis, San Francisco and Texas Railroad; between Midlothian and Britton along the Houston and

Texas Central Railroad, and between Lewisville and Hebron in Denton County. Where exposures do occur, fossils are usually abundant and the formation seems to yield itself readily to zoning.

As stated above, three zones have already been established by Scott, one at the base which is that of Acanthoceras aff. rotomagense (de France), another about the middle represented by Metoicoceras whitei Hyatt, and the zone of Prionotropis woolgari Mantell near the top. In addition to these, the writer has been able to determine several others, represented mainly by ammonites. The horizons which have been located up to the present time are as follows:

Zone of Eagle Ford--Austin chalk transition
Zone of Prionotropis aff. woolgari
Zone of Gäuthiericeras aff. bravaisi
Zone of Metoicoceras gibbosum
Zone of Helicoceras pariense
Zone of Metoicoceras swallovi
Zone of Metoicoceras whitei
Zone of Metoicoceras irwini
Zone of Acanthoceras aff. rotomagense

Paleontologically, the Eagle Ford is often considered dull; but at certain levels, notably in the upper beds, fossils are very abundant. Fish remains, such as teeth, vertebrae, and scales, may be found at almost any level. The teeth vary in size from large shark teeth to those of microscopic size. The most common bony fish which lived during this time was Holcolepis pulchellus Cockrell. Scales of this species are common and sometimes an entire cast may be preserved.

Inocerami are abundant throughout the formation and include Inoceramus labiatus Schlotheim, Inoceramus fragilis Hall and Meek, Inoceramus capulus Shumard, etc.

At the base of the Eagle Ford at its contact with the Woodbine there is a conglomeratic layer containing numerous fossils many of which are unrecognizable. The most common ones are Exogyra columbella Meek, Engonoceras planum Hyatt, and Acanthoceras aff. rotomagense (de France) (plate 13, fig. 1). The microscopic fossils include Foraminifera, Ostracoda, fish remains, and crustacean fragments.

Above this the light-gray to white beds contain numerous Inocerami and fish scales. A concentrated sample of this material consists almost entirely of Inoceramus prisms and several species of Globigerina.

At a level about 200 feet from the base of the formation are a number of fossils as Metoicoceras irwini, n. sp. (plate 13, figs. 3, 4), Placenticeras sp., Pachydiscus sp. A (plate 5, fig. 4), Hemitissotia sp. A (plate 14, fig. 1) and Inoceramus labiatus Schlotheim. The concentrated material contains a large variety of Foraminifera, Ostracoda, and other organic remains.

In the middle and upper part of the Eagle Ford the fossils are more numerous and varied as to species. The most common types are Inoceramus labiatus Schlo-

At the Eagle Ford–Austin chalk contact is a transition zone of considerable extent which has a rich microscopic fauna including Ostracoda, crustacean fragments, fish remains, and several genera of Foraminifera. A few large fossils are present as fish teeth, *Ostrea lugubris* Conrad, and other small clams.

Zone of *Acanthoceras* aff. *rotomagense*

*Acanthoceras* aff. *rotomagense* (de France) (plate 13, fig. 1) represents the first zone in the Eagle Ford. This fossil is abundant in the lower part of the formation 2½ miles east of Tarrant near the St. Louis, San Francisco and Texas Railroad. It has been listed and described by a number of writers from the upper Cenomanian of Europe and other countries; but very few, if any, specimens have been found in north Texas except at this locality and one or two others only a short distance from it.

Associated with *Acanthoceras* aff. *rotomagense* are *Engonoceras planum* Hyatt, *Exogyra columbella* Meek, *Ostrea soleniscus* Meek, *Gyrodes* sp., numerous fish teeth, and other fragmentary fossils. The conglomeratic layer at this zone is made up of fish teeth, fragmentary shells of various kinds, with a great amount of phosphate nodules and large concretions.

The microscopic fossils are few, but sometimes *Globigerina dubia* Egger, *Globigerina cretacea* d’Orbigny (plate 16, figs. 14, 15), *Guembelina globulosa* (Ehrenberg) (plate 16, fig. 10), *Anomalina* sp., and Ostracoda are present. The concentrate consists mostly of sand grains and other inorganic particles.

Zone of *Metoicoceras irwini*

*Metoicoceras irwini*, n. sp. (plate 13, figs. 3, 4), the ammonite upon which this zone is based, was first found by the writer about 6 miles northwest of Irving at an exposure near the Irving Coppell Road. It represents a zone considerably below the middle of the Eagle Ford; probably at a level about 150 to 200 feet above the zone of *Acanthoceras* aff. *rotomagense*.

This species of *Metoicoceras* is much more compressed than the other members of the group, being about the same thickness near the umbilicus as it is at the ventral margin. The umbilicus is broader than in *Metoicoceras swallovi* and *Metoicoceras whitei*. In the specimen here figured, which is 22 cm. across, the umbilicus measures 4 cm. The two rows of tubercles along each side of the ventral-lateral margin are distinct but not so prominent as in other members of the genus. The ribs diminish toward the umbilicus so that the region of the umbilicus is relatively smooth.
FOSSIL ZONES OF THE EAGLE FORD OF NORTH TEXAS

LOWER AUSTIN CHALK

TRANSITION ZONE

300

PRIONOTROPIS WOOLGARI

GAUTHIERICERAS BRAVAISI

METOICOCERAS GIBOSSUM

HELICOCERAS PARIENSE

METOICOCERAS SWALLOVI

METOICOCERAS WHITEI

300

METOICOCERAS IRWINI

200

HIGHLY CAL-CAREOUS LAYERS

100

UPPER WOODBINE

ACANTHOCERAS ROTOMAGENSE

GENERALIZED SECTION

Fig. 1
The lobes of the suture increase in size gradually from the umbilicus toward the ventral margin and all of the lobes are broader and not as long as in *Metoicoceras swallowi* and *Metoicoceras whitei*. The first lateral lobe is especially broad and slightly longer than the ventral lobe. The suture is more closely related to *Metoicoceras gibbosum* than to any of the others. There are of course slight variations in other specimens of this species; sometimes they are a little thicker or the ornamentation may be more distinct.

The main differences, however, between *Metoicoceras irwini* and other members of this group thus far described are that it is more compressed, the ornamentation especially around the umbilicus is less distinct or even absent, while the lobes of the suture are broader and not as long as in other forms.

The ammonite in question has been compared with figures representing members of this group from the Turonian of Western France described by de Grossouvre, but the figures are not sufficient to justify reference of this form to any of his species.

It should be noted in passing that de Grossouvre considers the genus *Metoicoceras* Hyatt as identical with the genus *Mammites* Laube and Bruder. The suture of *Metoicoceras* is similar to *Mammites pervinquieri* de Grossouvre, but other characters are markedly different. The writer, however, is not prepared at present to enter into a discussion of this problem.

Two other ammonites, *Hemitissotia* sp. A (plate 14, fig. 1), and *Pachydiscus* sp. A (plate 15, fig. 4), probably new species, are associated with this zone. Only one specimen of each has been found so far, and it is possible that they will prove to represent two other zones when search has been made for more specimens.

The *Hemitissotia* sp. A is interesting because it is the only representative of this genus, so far as the writer knows, to be observed in the Western Hemisphere. The genus is, however, represented by many species and individuals in the region of North Africa and other Mediterranean districts. Fragments of a *Placenticeras* sp. have been found at this level but none sufficiently complete to be identifiable.

The microfossils are well preserved and represent a variety of forms. The Foraminifera include *Globigerina cretacea* d’Orbigny (plate 16, figs. 14, 15), *Globigerina dubia* Egger, *Guembelina globulosa* (Ehrenberg) (plate 16, fig. 10), *Gaudryina filiformis* Berthelin (plate 16, fig. 8), *Robulus cultratus* Montfort (plate 16, figs. 6, 7), *Verneuilina* sp., *Forincticularia alata* d’Orbigny, var., *Vaginulina* sp., *Anomalina eglefordensis*, n. sp. (plate 16, figs. 9a, b), *Anomalina* sp. The Ostracoda include *Cythereis ornatissima* (Reuss), *Bairdia subdeltoidea* (Münster) (plate 16, fig. 18), *Cythereella muensteri* (Roemer) (plate 16, fig. 13).

**Zone of *Metoicoceras whitei***

*Metoicoceras whitei* Hyatt (plate 15, fig. 1) is one of the most abundant forms in the Eagle Ford, and the extent of the zone has been closely traced. Numerous

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specimens have been collected about 3 miles northwest of Midlothian in a small creek near the Houston and Texas Central Railroad. Also a number of other localities occur in Travis, Ellis, Dallas, Denton, and Grayson counties.

This zone is situated above the middle of the formation approximately 100 feet below the top (see generalized section, page 93, fig. 1). It is the first of a series of zones in the upper part of the formation which occur rather close together.


The microfossils include *Quinqueloculina stelligera* Schlumberger (plate 16, fig. 11), *Guembelina globulosa* (Ehrenberg) (plate 16, fig. 10), *Globigerina cretacea* d’Orbigny (plate 16, figs. 14, 15), *Bairdia subdeltoidea* (Münster) (plate 16, fig. 18), *Cytherella muensteri* (Roemer) (plate 16, fig. 13), etc.

Zone of *Metoicoceras swallovi*

*Metoicoceras swallovi* (Shumard) (plate 15, fig. 3) occurs some 10 to 15 feet above *Metoicoceras whitei*; and at localities where 25 or 30 feet of the sediments are exposed, the two species are often found together in the stream beds. However, several localities occur where the two species may be found separately, and *Metoicoceras swallovi* is always above *Metoicoceras whitei*. It is likely that these zones may be found to overlap in some cases since they are so close together.

*Acanthoceras?* *knabense* Stanton (plate 13, fig. 5) is present in both the zone of *Metoicoceras whitei* and *Metoicoceras swallovi*. This species is well preserved and has long spines extending from the large rounded knobs on the lateral margin, as shown in figure 5. Other imprints in the shales show even longer spines than this specimen has. Stanton places this species in the genus *Acanthoceras* but states that it is unlike the typical *Acanthoceras* and should be referred to a different genus.1

*Baculites gracilis* Shumard, *Scaphites verniformis* Meek, and Hayden, *Inoceramus labiatus*, and small clams, gastropods, and fish remains are also common.

The microfossils are very much the same as listed in the zone of *Metoicoceras whitei*.

Zone of *Helicoceras pariense*

*Helicoceras pariense* White (plate 14, fig. 3) makes up a zone several feet in thickness and occurs just above *Metoicoceras swallovi*. A typical locality where this species occurs is found about 3 miles northwest of Midlothian at an exposure north of the Houston and Texas Central Railroad. This form is very abundant in the shale layers and is sometimes preserved in the hard concretions. *Helicoceros pariense* is also abundant at localities in Dallas and Denton counties.

Many small clams, such as Pectens and razor clams, are abundant and preserved with the original nacre. They are very delicate and are never seen except

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when the unweathered shale is broken open. *Baculites gracilis* is again found at this level; in fact, this fossil seems to have considerable range, being found in most of the upper half of the formation.

Microfossils are about the same as listed in the zone of *Metoicoceras whitei*.

**Zone of *Metoicoceras gibbosum***

*Metioicoceras gibbosum* Hyatt (plate 14, fig. 4) represents the uppermost species of this genus known to me. It is especially abundant in exposures west and southwest of Dallas. At these localities the lithology is that of very finely laminated shale containing much gypsum and other minerals which make preservation of fossils poor.

Fragments of *Placenticeras* sp. were found with *Metoicoceras gibbosum*, but no other forms of interest have been noted.

No microscopic fossils have been found in this material.

**Zone of *Gauthiericeras* aff. *bravaisi***

*Gauthiericeras* aff. *bravaisi* (d'Orbigny) (plate 14, fig. 2) forms a zone which has been closely studied over a considerable area in North Texas, especially in McLennan, Hill, and Denton counties. The specimen figured was found in a locality 7 miles east of Lewisville. Other localities occur northeast of Maypearl and southwest of Waco.

*Gauthiericeras bravaisi* occurs in the Turonian of Europe only in a few places. It has received very little attention in American literature but is abundant in the upper Eagle Ford at the localities mentioned above. Meek¹ suggests that *Ammonites bravaisianus*, as described by d'Orbigny, resembles *Prionotropis woolgari* and that these names may have been proposed for young specimens of this species at different stages of development. Many specimens, representing different stages in the development of these two forms, have been examined by the writer, and there seems to be no doubt that the two species are distinct. *Gauthiericeras bravaisi* is characterized by the two rows of tubercles on each side of the ventral-lateral margin at all stages of its development; while the young of *Prionotropis woolgari* has ribs which are devoid of tubercles in the extremely young stage. A comparison of the figures on plates 1 and 2 will show the different characteristics. The two forms occur at different levels, another fact in favor of their distinction.

In Denton County *Gauthiericeras* aff. *bravaisi* occurs in the shale just below a number of flaggy limestone layers which comprise several feet of sediments, and occasionally imprints have been found in the hard layers. In Hill County, northeast of Maypearl, this species is found in the shale and in thin sandstone ledges. Numerous Inocerami may be found at this zone. Bones of a large reptile were exposed at the Denton locality 7 miles east of Lewisville. Mososaurs have been found before in the Eagle Ford.

The microfossils are not very abundant at this level.

Zone of Prionotropis aff. woolgari

Prionotropis aff. woolgari (Mantell) (plate 13, fig. 2), so far as the writer knows, represents the last zone of ammonites in the Eagle Ford, as no others have been cited above this level. Prionotrofios aff. woolgari is present in both the shale and flaggy layers about 75 feet below the top of the formation. Exposures are quite numerous making it possible to study this zone over a considerable part of North Texas. The best exposures are in eastern Denton County where Prionotropis aff. woolgari forms a zone some 20 feet in thickness. Here it is preserved in the shale, while west of Dallas the flaggy layers contain numerous specimens. At the Dallas locality they are excellently preserved, sometimes retaining the original shell covering.

Most of the specimens are of young forms, but a few fragments of adults have been found. The adult of this species occurs in great abundance in the Benton of the west central states.

A concentrated sample of material from this zone reveals Globigerina cretacea d'Orbigny (plate 16, figs. 14, 15), Guembelina globulosa (Ehrenberg) (plate 16, fig. 10), Anomalina eaglefordensis, n. sp. (plate 16, figs. 9 a, b), etc.

Zone of Eagle Ford–Austin Chalk Transition

This zone has been traced and carefully studied at a number of places between Sherman and Austin. It is represented by a thickness of from a few inches to 4 or 5 feet and is usually very fossiliferous. The large fossils and lithologic samples have been gathered from exposures near Sherman, at Frisco, west of Dallas, Midlothian, northeast of Maypearl, southwest of Waco, northeast and southwest of Austin, etc. At all of these places the lithology is much the same and the association of fossils and minerals is similar.

The sediments making up this zone are blue to gray in appearance and slightly more granular than the shale below. This bed is overlain by the massive white limestone of the Austin chalk.

Large fossils found in this zone include numerous fish remains, especially teeth and vertebrae. One specimen of the bony fish Holcolepis pulchellus Cockrell was obtained from an exposure in Grayson County. Ostrea lugubris Conrad, Tapes sp., Inoceramus sp., etc., are abundant.

The concentrated material consists of black and gray granules and contains a very rich microscopic fauna. The common forms include Globigerina cretacea d'Orbigny (plate 16, figs. 14, 15), Robulus cultratus Montfort (plate 16, figs. 6, 7), Guembelina globulosa (Ehrenberg) (plate 16, fig. 10), Anomalina eaglefordensis, n. sp. (plate 16, figs. 9 a, b), Globotruncana arca (Cushman) (plate 16, fig. 16), Vaginulina simondsi Carsey (plate 16, fig. 1), Vaginulina webbervillensis Carsey (plate 16, fig. 2), Frondicularia alata d'Orbigny (plate 16, fig. 3), Frondicularia hebronensis, n. sp. (plate 16, fig. 4), Nodosaria communis d'Orbigny (plate 16, fig. 5), Ostracoda as Cythereis ornatissima (Reuss), Cytherella muensteri (Roemer) (plate 16, fig. 13),
and *Cythere cornuta* (Roemer). Crustacean fragments as the chela and fish remains are also present.

Besides the great variety of organic remains, there are a number of minerals such as jasper, garnet, calcite, gypsum, glauconite, pyrite, and phosphate nodules. One of the characteristics of this zone is the presence of a great amount of glauconite and phosphate nodules. These minerals are abundant at every locality studied and indicate that the sea at this time was shallow and in transgression.¹

From the evidences furnished by the glauconite, phosphate nodules, and broken shell fragments there is sufficient indication to show that the sea withdrew at the end of the Eagle Ford time and returned in transgression at the beginning of the Austin chalk. The gap between the two formations could not have been very long, although there is no way to determine its exact duration.

There are other phosphate ledges in the Eagle Ford near the Red River region which indicate that the sea must have had a number of short regressions and transgressions. Besides containing phosphate nodules, these ledges have a great many fish teeth imbedded in them; and one in particular, exposed in Fannin County, is called by Taff the “Fish Bed Conglomerate.” The transition zone at the Eagle Ford–Austin chalk contact is often referred to by this name.

**DESCRIPTION OF MICROFOSSILS**

The microscopic fossils were studied principally at two levels in the Eagle Ford. One from the zone of *Metococeras irwini* which is situated some 150 to 200 feet from the base of the formation. The locality is 6 miles northwest of Irving near the Irving-Coppell Road where a small creek that runs toward the Elm Fork has exposed sediments with small escarpments which face the southeast.

The other level is that of the transition zone at the contact with the Eagle Ford and Austin chalk. The locality from which samples were studied is 2.2 miles north of Hebron at an exposure made by a small creek which cuts through the escarpment ¼ mile east of the St. Louis, San Francisco and Texas Railroad, and to the south of a cross-road running east and west.

The type specimens from which the species have been described will be deposited in the Museum at Texas Christian University, Fort Worth, Texas.

**VAGINULINA SIMONDSI** Carsey

Plate 16, fig. 1


Locality, 2 miles north of Hebron.

**VAGINULINA WEBBERVILLENSIS** Carsey

Plate 16, fig. 2


Locality, 2 miles north of Hebron.

FRONDICULARIA ALATA d'Orbigny
Plate 16, fig. 3


Locality, 2 miles north of Hebron.

FRONDICULARIA HEBRONENSIS, n. sp.
Plate 16, fig. 4

Test triangular, composed of numerous chambers, much compressed but rather broad especially near the lower angles; early chambers usually slightly coiled, succeeding chambers V-shaped with arms that become longer with each addition; walls of test smooth; sutures depressed; aperture terminal, round. Length, about 3 mm.

Locality, 6 miles north of Hebron.

NODOSARIA COMMUNIS (d'Orbigny)
Plate 16, fig. 5


Locality, 6 miles northwest of Irving.

ROBULUS CULTRATUS Montfort
Plate 16, figs., 6, 7

*Cristellaria cultrata* Cushman, Bull. 71, pt. 3, U. S. Nat. Mus., 1913, p. 64, pl. 29, fig. 4.

Locality, 6 miles northwest of Irving.

GAUDRYINA FILIFORMIS Berthelin
Plate 16, fig. 8

*Gaudryina filiformis* Berthelin, Mem. Soc. Geol. France, ser. 3, vol. 1, 1880, p. 25, pl. 1, figs. 8 a–d.

Locality, 6 miles northwest of Irving.

GUEMBELINA GLOBULOSA (Ehrenberg)
Plate 16, fig. 10


Locality, 6 miles northwest of Irving.

ANOMALINA EAGLEFORDENSIS, n. sp.
Plate 16, fig. 9 a, b

Test nearly symmetrical, much compressed laterally, composed of many chambers with about two and one-half convolutions visible; chambers somewhat flattened, forming umbilici slightly concave, eight or nine chambers in last-formed involutions; sutures depressed; periphery squarely angled; wall perforate; aperture at the middle of the base of the periphery of the chamber. Diameter, 0.7 mm.
This species is distinguished by the compressed shell with more or less square angles. It is very abundant in the Eagle Ford, especially in the upper beds.

Locality, 2 miles north of Hebron.

**QUINQUELOCULINA STELLIGERA** Schlumberger

Plate 16, figs. 11, 12


Locality, 2 miles north of Hebron.

**GLOBIGERINA CRETAEEA** d'Orbigny

Plate 16, figs. 14, 15


Locality, 6 miles northwest of Irving.

**GLOBOTRUNCANA ARCA** (Cushman)

Plate 16, figs. 16, 17


*Globotruncana arca* Cushman, *ibid.*, vol. 3, pt. 1, 1927, p. 91, pl. 19, fig. 11.

*Globigerina rosetta* Carsey, Univ. Tex. Bull. No. 2612, 1926, p. 44, pl. 5, figs. 3 a–c.

Locality, 2 miles north of Hebron.

**BAIRDIA SUBDELTOIDEA** (Münster)

Plate 16, fig. 18

*Cythere subdeltoidea* Münster, Neues Jahrbuch für Min., etc., 1830, p. 64; 1835, p. 446.

*Cytherina subdeltoidea* Roemer, *ibid.*, 1838, p. 517, pl. 6, fig. 16.

Locality, 6 miles northwest of Irving.

**CYTHERELLA MUENSTERI** (Roemer)

Plate 16, fig. 13

*Cytherina muensteri* Roemer, Neues Jahrbuch für Min. Geol., 1838, p. 516, pl. 6, fig. 13.


**EXPLANATION OF PLATES**

**PLATE 13**

Fig. 1.—*Acanthoceras* aff. *rotomagens* (de France), ×\(\frac{1}{2}\).

2.—*Prionotropis* aff. *woolgari* (Mantell), ×2.

3.—*Metioicoceras* *irwini*, n. sp., ×\(\frac{1}{2}\).

4.—Ventral view of same specimen, ×\(\frac{1}{2}\).

5.—*Acanthoceras* *knabense* Stanton, ×1.

**PLATE 14**

Fig. 1.—*Hemitissolia* sp. A, ×1.

2.—*Gauthiericeras* aff. *bravaisi* (d'Orbigny), ×2.

3.—*Helicoceras* *pariense* White, ×1.

4.—*Metioicoceras* *gibbosum* Hyatt, ×1.
FIG. 1.—*Meloicoceras whitei* Hyatt, ×1.
2.—*Acanthoceras* sp. A, ×1.
3.—*Meloicoceras swallowi* (Shumard), ×½.
4.—*Pachydiscus* sp. A, ×1.

PLATE 16

FIG. 1.—*Vaginulina simondsii* Carsey, ×25.
2.—*Vaginulina webbervillensis* Carsey, ×25.
3.—*Frondicularia alata* d’Orbigny, ×25.
4.—*Frondicularia hebronensis*, n. sp., ×25.
5.—*Nodosaria communis* d’Orbigny, ×50.
6.—*Robulus cultratus* Montfort, ×50.
7.—*Robulus cultratus* Montfort, section, ×50.
8.—*Gaudryina filiformis* Berthelin, ×50.
9.—*Anomalina eaglefordensis*, n. sp., ×50. a. ventral view; b. edge view.
10.—*Guembelina globulosa* (Ehrenberg), ×50.
11.—*Quinqueloculina stelligera* Schlumberger, ×50.
12.—*Quinqueloculina stelligera* Schlumberger, section, ×50.
13.—*Cytherella nuensteri* (Roemer), ×50.
14.—*Globigerina cretacea* d’Orbigny, ×50.
15.—*Globigerina cretacea* d’Orbigny, ventral view of another specimen, ×50.
16.—*Globotruncanana arca* (Cushman), ×50.
17.—*Globotruncanana arca* (Cushman), ventral view, ×50.
18.—*Bairdia subdelioidea* (Münster), ×50.