STRATIGRAPHY AND PALEONTOLOGY OF THE EAGLE FORD FORMATION OF NORTH AND CENTRAL TEXAS

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Introduction

The present classification of the Cretaceous rocks in Texas is essentially that proposed by R. T. Hill (8, pp. 112-127) in his work on the Black and Grand prairies. He divided the system into a lower series which he called Comanche and an upper which he named Gulf. The Gulf series includes, from the base upward, the Woodbine, Eagle Ford, Austin, Taylor and Navarro formations. The present paper is concerned with the second of these, the Eagle Ford, which was named from a village six miles west of Dallas.

At the base of the Cretaceous section in Texas is a basement sand which rests upon the beveled edges of Paleozoic formations. This deposit, which was formed by a transgressive sea, is followed by limestones, marls, and clays, that compose the remainder of the Comanche series. At the base of the Gulf series in North Texas is a sandstone, but in Central and Southwest Texas beds of equivalent age are of different lithologic character or are absent. The succeeding formations consist wholly of shaly-clay, limestone, marl and clay in the order given.

The Paleozoic rocks dip toward the northwest whereas the Cretaceous rocks dip toward the southeast. The Cretaceous sea encroached from the southeast and spread over most of Texas as is shown by subsurface records and distribution of the outcrop. The sea oscillated considerabley during Cretaceous time, but it reached its greatest extent during the deposition of the Austin chalk. Since Austin time the sea has gradually receded as a result of successive uplifts of the Gulf Coast region. During this process of emergence the strata were slightly tilted toward the south and southeast, but the present dip is rarely observed to be more than one degree. Erosion has removed a great amount of Cretaceous rocks as is indicated by the outliers in northwest Texas and western Oklahoma.

As a result of the low angle of dip, the Cretaceous formations crop out as broad bands which extend in a northeasterly direction, across Texas, from northern Mexico to southeastern Oklahoma. The outcrop of the Eagle Ford formation in North and central Texas extends from Austin to Red River. Northwest of Sherman the outcrop bends sharply around the Preston Anticline and continues in an easterly direction to eastern Lamar County where it crosses into Oklahoma. The Eagle Ford pinches out by overlap in southeastern Oklahoma and northern Louisiana.

The width of the Eagle Ford outcrop varies from three fourths of a mile in central Texas to ten miles in north Texas, the average being about five miles. The accompanying sketch map (fig. 1) shows the relation of the Cretaceous rocks to older and younger formations and marks the location of the Eagle Ford area to be discussed. The section shows the stratigraphic position of the Eagle Ford formation in the Texas Cretaceous.

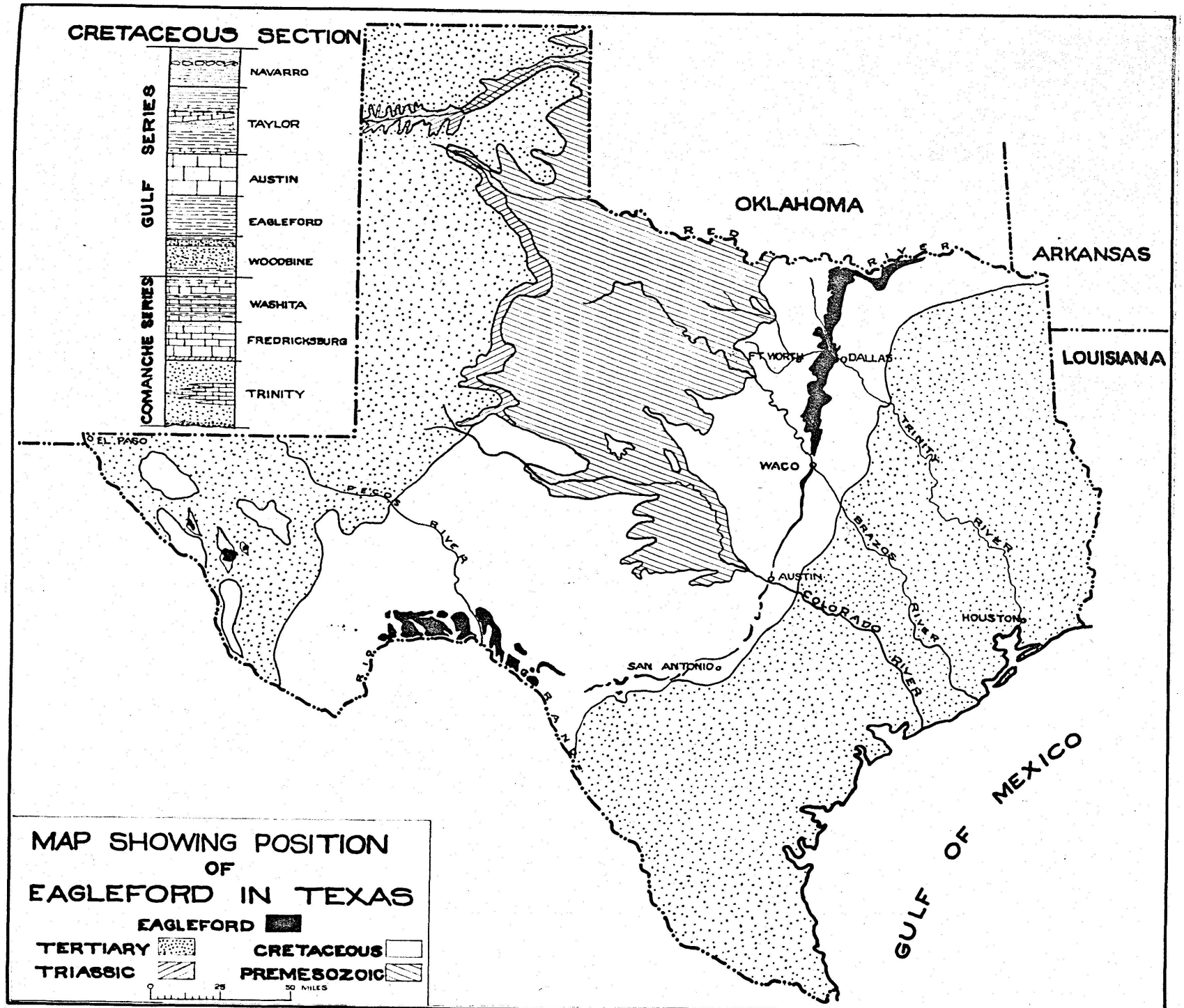

CRETACEOUS SECTION
GULF SERIES
COMANCHE SERIES
NAVARRO
TAYLOR
AUSTIN
EAGLEFORD
WOODBINE
WASHITA
FREDRICKSBURG
TRINITY
OKLAHOMA
ARKANSAS
LOUISIANA
RED RIVER
FT. WORTH
DALLAS
EL PASO
PECOS RIVER
WACO
TRINITY RIVER
BRAZOS RIVER
AUSTIN
COLORADO RIVER
HOUSTON
SAN ANTONIO
RIO GRANDE
GULF OF MEXICO
MAP SHOWING POSITION
OF
EAGLEFORD IN TEXAS
EAGLEFORD
TERTIARY
CRETACEOUS
TRIASSIC
PREMESOZOIC
25
50 MILES

Figure 1

History of Previous Work

The Cretaceous rocks of Texas were first recognized by Friedrich von Roemer in 1846. He collected from the Eagle Ford in the region of New Braunfels and in his work "Die Kreidebildungen von Texas" several species of fossils from this formation are described.

B. F. Shumard, in 1860 (30) wrote the first description of what is now called the Eagle Ford formation, his data being based on observations along Red River by G. G. Shumard. The formation was called the "Marly clay or Red River group" and assigned to the Lower Cretaceous division. The remainder of Shumard's lower Cretaceous consisted of the "Arenaceous group", now known as the Woodbine formation. Descriptions of thirty-two new fossil species, collected by G. G. Shumard, from the "Marly clay in Grayson, Fannin, Lamar and Red River counties are given by B. F. Shumard (31, 32). The publications dealing with the description of fossils were not accompanied by figures, and the types are lost, so only a few of his species have been identified by later investigators.

The observations by R. T. Hill from 1886 to 1901 include some of the most important contributions to the knowledge of the Cretaceous rocks of Texas. His investigations covered particularly the Black and Grand prairies, and in his last report (8) on this area he describes fully the formations of

the Comanche and Gulf series. This report is accompanied by a detailed geologic map of the area.

J. A. Taff, in 1891 (39), described two Eagle Ford exposures in central Texas, one on San Gabriel River below Town's Mill and another on Brushy Creek, three miles below Round Rock. Taff and S. Leverett, in 1893 (40), described a number of sections in north Texas and reffered to some of the more common fossils.

A short time before Taff's report in 1893, F. W. Cragin (6) described ten new species and two new varities of fossils from localities in Grayson and Dallas counties.

Alpheus Hyatt, in 1903 (9), described seven new species of ammonites from the Eagle Ford of Texas. Most of his specimens were collected from exposures on Elm Fork of Trinity River in Dallas County, near Horton's Mill.

L. W. Stephenson, in 1919 (34), described and mapped the Eagle Ford formation in northeastern Texas and southeastern Oklahoma. He includes in his report a number of local sections and a map of the area.

The Eagle Ford formation was described and mapped in Tarrant County by W. M. Winton and W. S. Adkins, in 1919 (42); in Johnson County by Winton and Gayle Scott, in 1922 (43); and in Denton County by Winton, in 1925 (44).

Scott, in 1926 (26), published a comprehensive work on the stratigraphy and paleontology of the Cretaceous of Texas. During the same year he discussed the Eagle Ford formation in two other papers (27, 28).

Stephenson, in 1927 (35), described important features of the Eagle Ford formation in a paper on the stratigraphy of the Upper Cretaceous of Texas.

W. L. Moreman, in 1927 (13), described three new fossil species and discussed the lithology and paleontology of the Eagle Ford formation.

Stephenson, in 1929 (38), published two papers which include discussions of the Eagle Ford formation. One of these discusses transgressions and regressions and the other the correlation of the Gulf series.

A hand book of Texas Cretaceous fossils by Adkins, in 1929 (2), includes descriptions of nine new species of ammonites collected from localities in Tarrant and Bell counties, and a list of all the previously described fossils from this formation.

Adkins, in 1930 (3), described and mapped the Eagle Ford formation in Bell County.

Besides the above more important contributions, several other references have been made to the Eagle Ford formation which will be mentioned in other parts of this work and included in the bibliography.

History of Present Work

The present work on the Eagle Ford formation had its beginning in 1925 when the Eagle Ford-Austin chalk transi-

tion zone was chosen as the subject of a Master's thesis at Texas Christian University. At that time the transition zone between the two formations, named by Taff (40) the "Fish Bed Conglomerate", was traced from Red River to Austin, and lithologic samples were collected at several stations along the outcrop. The study was mainly a microscopic examination of the sediments and it revealed an interesting foraminiferal fauna. This investigation proved to be so interesting that it led the writer to attempt a study of the whole Eagle Ford formation, and continued collecting has yielded many excellently preserved macrofossils. It was soon observed that the ammonites had a rather limited vertical range and in 1927 a paper was published (13) on the fossil zones of the Eagle Ford on north Texas, which was intented as a preliminary report to a more detailed study of the formation. The writer entered the Graduate School of the University of Kansas in 1928, and the study of the Eagle Ford formation was accepted as a suitable subject for a Doctors dissertation. During the last two years, in particular, the writer has collected much new information concerning the stratigraphy and paleontology of the Eagle Ford formation at its outcrop in North and central Texas.

Acknowledgments

The writer wishes to express grateful acknowledgment

for assistance given him by other geologists during the course of this research. Professor Raymond C. Moore, of the University of Kansas, has offered many helpful suggestions concerning the collection of data and preparation of the manuscript. Prof. W. M. Winton and Prof. Gayle Scott of Texas Christian University accompanied the writer on many field trips during the early part of this research and helped solve some of the more important problems. Mr. W. S. Adkins, of the Bureau of Economic Geology, Austin, Texas, has very generously loaned the writer his excellent collection of Eagle Ford fossils and has offered many helpful suggestions. Dr. E. H. Sellards, Associate Director of the Bureau of Economic Geology, has shown a great interest and has aided in carrying on this work.

The writer is indebted also for assistance of various sorts to Profs. K. K. Landes, W. H. Schoewe, and G. L. Knight, of the University of Kansas; and Drs. John B. Reeside Jr., and L. W. Stephenson of the U. S. Geological Survey.

Stratigraphy of the Eagle Ford Formation

The Eagle Ford formation lies next to the bottom formation of the Gulf series. It unconformably overlies the Woodbine sand and is in turn unconformably overlain by the Austin chalk. In north Texas, where the Gulf series has its greatest development, the Woodbine and Eagle Ford are not

separated by a very great hiatus; but in central and southwest Texas the Woodbine is greatly reduced and changed in lithology or is entirely absent. The evidence of an unconformity between the two formations in north Texas consists of a sharp change in lithology, from sandstone to clay and in places there is a layer of phosphate pebbles and reworked fossils at the base of the Eagle Ford formation. This condition was observed by Stephenson (36) at an exposure two miles east of Tarrant. The same condition exists in Ellis, Johnson, and Hill counties, and shows that there must have been a considerable withdrawal of the aea at the close of Woodbine time. South of Hill County the Woodbine sand is absent, except for a black shale in Bell County, which is thought to be Woodbine in age because it rests on the Buda limestone of uppermost Comanchean age and contains a Cenomanian fauna older than the one in the base of the Eagle Ford formation. There seems to be a gradual thinning of the Woodbine southward, which has resulted from slower deposition or subsequent erosion.

If the Woodbine is a southward built delta deposit, the very great thickness in north Texas ahd thinning in central Texas can be accounted for. The Woodbine sand in southeastern Oklahoma is a pinched out overlap and appears to have been deposited in a sea which transgressed toward the north and northwest.

The unconformity between the Eagle Ford and Austin chalk

represents a considerable length of time, as is shown by the conglomeratic nature of the sediments at the contact and the absence of certain fossils which are present at the top of Turonian sediments in other regions. This contact is best seen west of Dallas in the road cut at White Rock scarp. The transition zone, Taff's (40) "Fish Bed Conglomerate," is here about eighteen inches thick and is composed of phosphate pebbles and reworked fossils, such as pelecypods, and fish remains. Immediately below this conglomerate is an oyster bed composed of Alectryonia lugubris (Conrad). The unconformity between the Eagle Ford and Austin is of about the same magnitude from North to central Texas and is easily traced throughout its extent; but in southwest Texas this unconformity at the top is not so apparent, and the two formations may represent continuous sedimentation The Austin formation is everywhere a chalky limestone except in the region of Red River, where the basal part is composed of blue clay and has been named by Stephenson (35) the Bonham member.

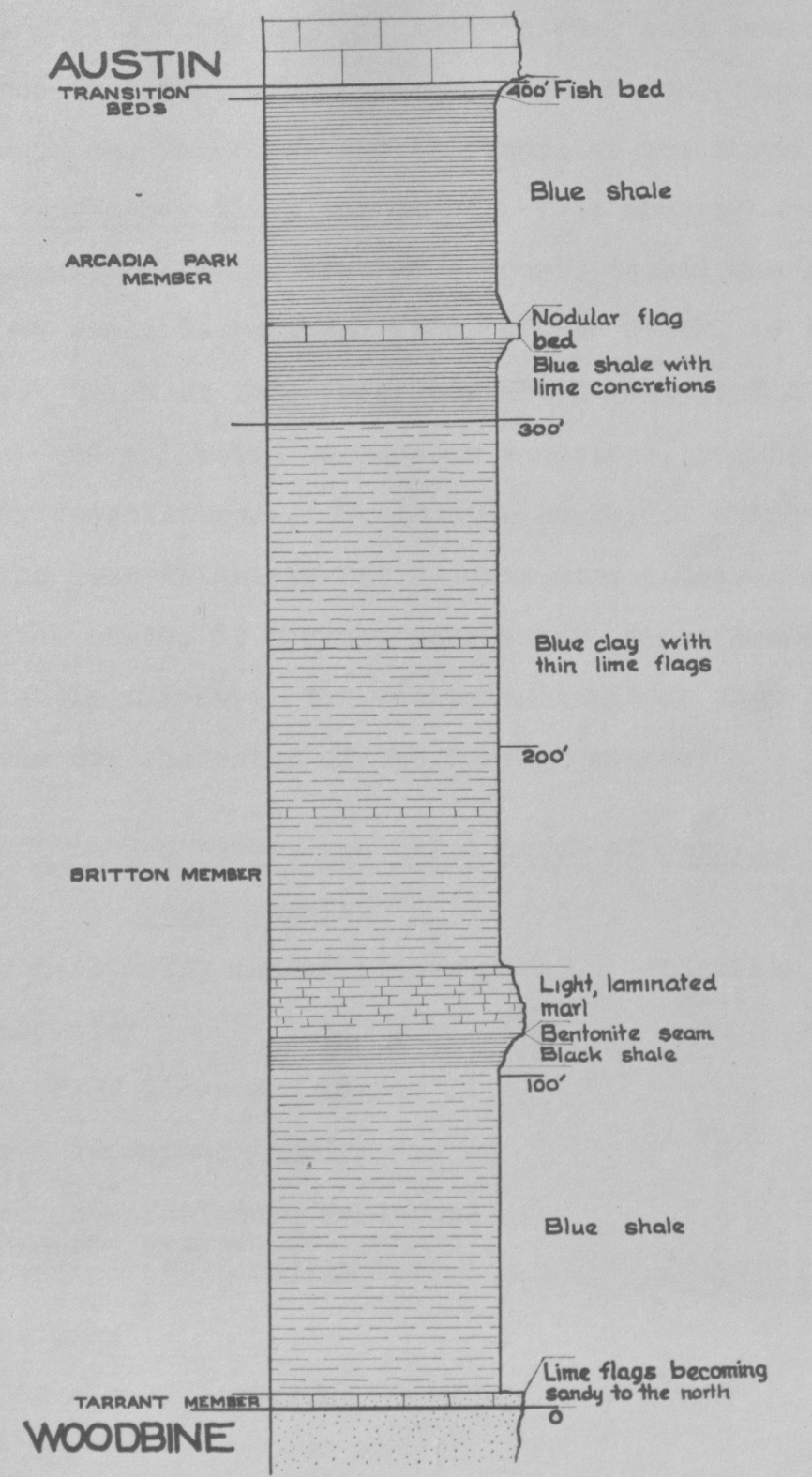
The Eagle Ford formation is made up principally of blue bituminous clay, although there are some calcareous layers and shale layers of considerable thickness and extent. Along Red River the basal Eagle Ford is more sandy and grades gradually from typical Woodbine sand to alternating layers of gray sandstone and sandy clay; the middle portion is blue clay with thin limestone layers and hard clay or lime-

stone concretions; and the upper part is more sandy, consisting of sandy clay, thin layers of gray sandstone and in places thin sandy limestone. These beds pass gradually into the Bonham clay of Austin age.

At the latitude of Dallas the basal member is a brownish calcareous sandstone about three or four feet thick, which changes rather abruptly into sandy clay, then into blue clay with a few blue limestone layers, the latter six inches or less in thickness and at intervals of from ten to twenty feet; next there is about ten feet of black bituminous shale, twenty feet of white to yellowish finely laminated marly clay, which is composed mainly of globigerina, inoceramus prisms, and fish scales; the remainder of the formation consists of blue shaly-clay with occasional blue limestone layers and numerous large concretions. The concretions have received various local names such as "Nigger heads" and "Turtle backs", the latter being very descriptive because some of the larger concretions are flattened and have been cracked and the crevices filled with calcite thus giving a pattern which resembles the scutes of a turtles shell.

In central Texas there is a basal flaggy limestone layer, a middle blue clay member and an upper marly clay member.

The lower, middle, and upper parts of the Eagle Ford formation have definite lithologic and paleontological characteristics thus it seems that they should be designated as members. The writer proposes the name Tarrant sandy limestone



GENERALIZED SECTION

Figure 2

member, for the lower division, Britton marly clay member for the middle division, and Arcadia Park shal member for the upper division. The accompanying section, figure 2, represents the character and thickness of the three members.

Tarrant sandy limestone member: This member named from the exposure two miles east of Tarrant, Texas, where the St. Louis and Santa Fe railroad crosses Bear Creek, is three or four feet thick at this location. It is composed of fine brownish and yellowish calcareous sandstone, evenly bedded and very fossiliferous. Toward the south, it maintains about the same thickness but becomes more calcareous; while toward the north, it becomes more sandy, cross bedded, and slightly thicker. The following sections show the relations and character of the Tarrant member:

Bluff on Red River, two miles north of Garret, Lamar County.

	Thickness Feet	Inches
Britton marly clay member (lower part).		
Sandy clay	20	0
Tarrant sandy limestone member		
Brown sandstone	2	0
Gray shale		2
Green concretionary sandstone	4	3
Brown and gray shale	2	0
Greensand cross-bedded	1	0
Woodbine sand		
Reddish gray sandstone	2	0

2.7 Miles East of Whitesboro, Texas

	Thickness Feet	Inches
Britton marly clay member (lower part)		
Sandy clay	10	0
Tarrant sandy limestone member		
Brown sandstone		6
Alternating gray clay and sandstone	5	0
Woodbine sand		
Red sandstone	4	0

2 Miles East of Tarrant, Texas

	Thickness Feet	Inches
Britton marly clay member (lower part)		
Blue sandy clay	20	0
Tarrant sandy limestone member		
Brownish calcareous sandstone	5	0
Phosphate pebble conglomerate	0	6
Woodbine sand		
Ostrea soleniscus agglomerate	0	6
Red sandstone	15	0

5 Miles Northeast of Venus, Texas

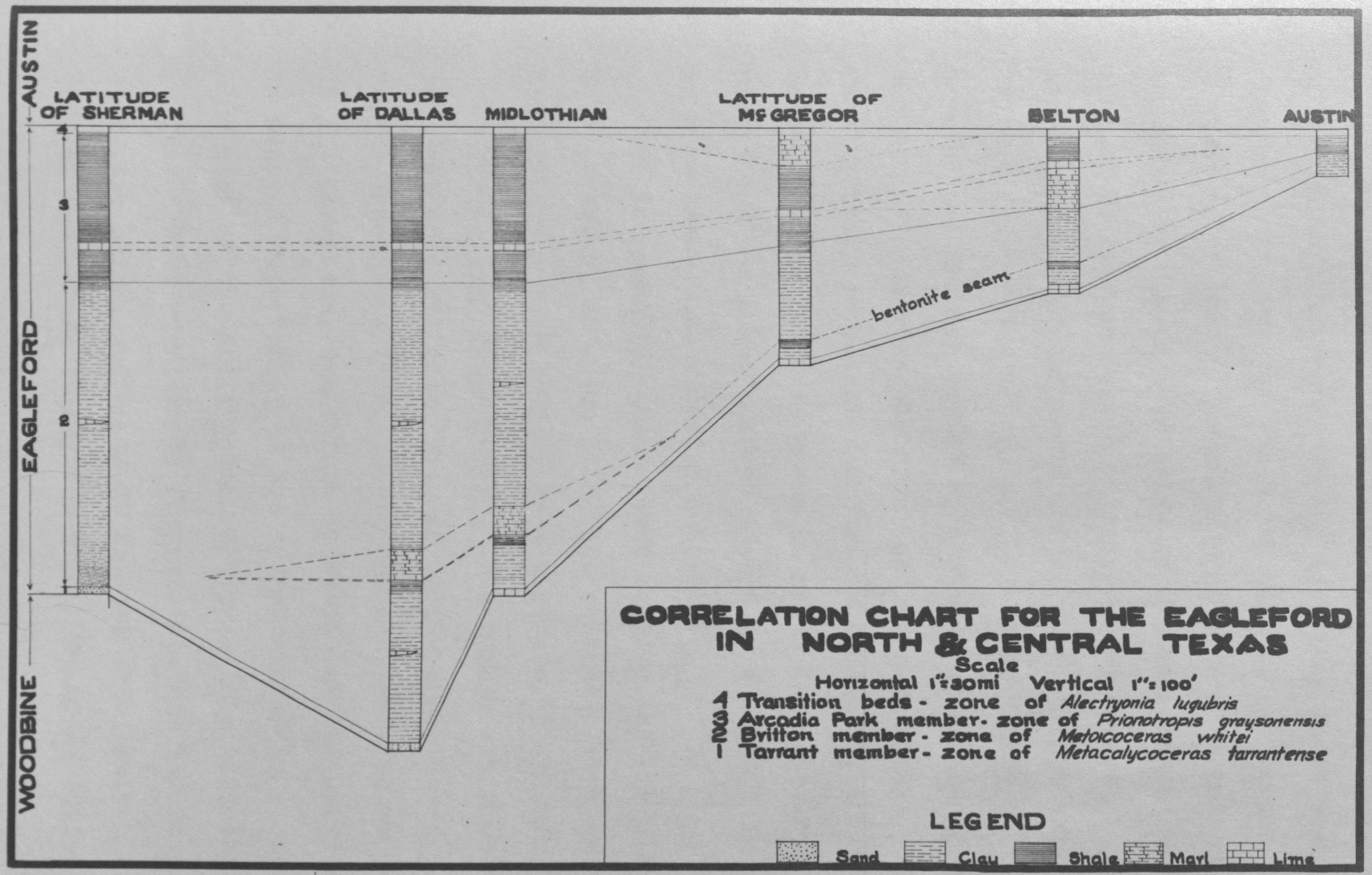
	Thickness Feet	Inches
Britton marly clay member (lower part)		
Blue sandy clay	12	0
Tarrant sandy limestone member		
Brownish sandy limestone	5	0

Pepper Creek, Between Belton and Temple, Texas.

	Thickness Feet	Inches
Britton marly clay member (lower part)		
Blue clay	50	0
Tarrant limestone member		
Yellow flaggy limestone	5	0
Woodbine ?		
Black shale	50	0

Britton marly clay member: This member, which makes up the major part of the Eagle Ford formation is named from the village of Britton in Ellis County, Texas. It is some 200 or 300 feet thick in Grayson, Denton, Dallas, and Ellis counties but thins toward the north and south, being 30 to 50 feet along Red River and about 20 feet at Austin.

In the latitude of Britton this member begins as a sandy clay, succeeded by 75 feet of blue clay, 10 feet of black shale, a 3-inch bentonite seam, 20 feet of yellowish white laminated marl, and 95 feet of blue clay with intermittent flaggy limestone layers and calcareous concretions. In Dallas County, the lower portion contains thin layers of reddish clay and red ironstone concretions; while the remainder shows much the same lithology as at Britton. The marly bed is lens-like and fingers out northward in Denton County and southward in Hill County. The black shale bed extends from Grayson to Bell County and is succeeded by a thin seam


AUSTIN
LATITUDE OF SHERMAN
LATITUDE OF DALLAS
MIDLOTHIAN
LATITUDE OF McGREGOR
BELTON
AUSTIN
4
3
2
bentonite seam
WOODBINE
EAGLEFORD
CORRELATION CHART FOR THE EAGLEFORD IN NORTH & CENTRAL TEXAS
Scale
Horizontal 1"=30mi Vertical 1"=100'
4 Transition beds - zone of Alectryonia lugubris
3 Arcadia Park member - zone of Prionotropis graysonensis
2 Britton member - zone of Metoicoceras whitei
1 Tarrant member - zone of Metacalycoceras tarrantense
LEGEND
Sand
Clay
Shale
Marl
Lime

1/2

Figure 3

of bentonite. In Travis County the black shale changes into blue-gray clay but the bentonite seam is continuous.

The reduction in thickness of the Britton member toward the south is due to a thinning of the beds. The same time element is represented in both north and central Texas, but the deposition of sediments was apparently more rapid in the nothern portion of the sea. In Bell County the lower part of the Britton member is composed of flaggy limestone and is indistinguishable from the Tarrant member. Here five feet of flags represent the Tarrant and at least half of the Britton member as it is known in north Texas. Along Red River both the lower and upper part of the Britton member is more sandy than at other localities.

The accompanying generalized section and correlation chart, fig. 3, show the lithology of the Britton member and its variation in thickness from Red River to Austin.

Arcadia Park shale member: This member was named from a park situated six miles west of Dallas near the Fort Worth-Dallas interurban line. It is the most persistant member in the formation, and though it resembles the Britton member in general appearance, it has a characteristic fauna. The blue clay of the Britton member grades into blue shaly-clay 20 feet thick, overlain by flaggy limestone layers 6 inches to 3 feet thick, and 50 to 75 feet of blue shaly-clay which ends at the Austin transition zone. From Red River to Waco

the lithology is about the same, but in southern McLennan County the upper part becomes more calcareous or marly, and in central Texas the middle portion is marly. The flaggy limestone layers, which are well developed seven miles west of Dallas, are fairly persistent throughout the extent of the Eagle Ford in north and central Texas. There is a marly clay lens at the top of the Arcadia Park shale member in McLennan County.

Paleontology

The Eagle Ford, as a whole, in not very fossiliferous but at certain horizons fossils occur in great abundance and variety. The flaggy limestone layer in the Arcadia Park member, 7 miles west of Dallas is, in some instances, made up almost entirely of small ammonites, belonging to the genus Prionotropis. The upper part of the Britton member is fossiliferous in Dallas and Ellis counties and the Tarrant sandy limestone member is very fossiliferous throughout most of its extent in north and central Texas. Some beds are almost barren of fossils except for fish remains, but these are so abundant in the Eagle Ford-Austin chalk transition zone that Taff (40) named it the "Fish Bed Conglomerate". Aside from fish remains and foraminifera, Inocerami are about the most abundant forms in the formation, although ammonites occur in great variety, and are by far the most important group.

Most of the fossils are casts composed of hard clay, limestone, pyrite, limonite, phosphate, and in the case of foraminifera, sometimes, glauconite. It is not uncommon to find the original shell of Inocerami and ammonites preserved, although it is fragile. Often fossils form the nucleus of limestone concretions and some of the best specimens were obtained from them. In most cases, however, the concretion is cracked and the crevices filled with calcite thus making it impossible to extract the fossil complete.

More than 100 species of fossils have been identified from Eagle Ford outcrops, 76 being described only from this formation in Texas; and the others referred to species described from beds of the same age in other regions. The fauna is composed of foraminifera, ostracdes, pelecypods, gastropods, ammonoids, fish remains, and marine reptiles. Roemer, (24), described five species from the Eagle Ford of Texas, Shumard, (31, 32), thirty two species, Hyatt, (9), seven species, Moreman, (13), three species, and Adkins (2), nine species. The only type collections known to be preserved are those of Hyatt, deposited in the U. S. National Museum (includes only a part of his collection), of Moreman, in the museum at Texas Christian University, and of Adkins, in the Museum of yhe Bureau of Economic Geology.

Zones of the Eagle Ford Formation

Because of the short life, especially of the ammonites, which lived during Eagle Ford time, the formation contains several definite fossil zones. Some of these zones occupy only a very limited vertical extent, while others continue through a considerable thickness of sediments. Locally several zones can be recognized but only a few can be traced over a very wide area. The first zones in the Eagle Ford formation were designated by Taff (40), one at the base represented by Ostrea soleniscus Meek (at present upper Woodbine) and one at the top represented by Ostrea belli-plicata Shumard (synonymous with Alectryonia lugubris Conrad). Gayle Scott designated three zones which are, from the base upward: (1) Acanthoceras rotomagense De France, (2) Inoceramus labiatus Schlotheim , and (3) Metoicoceras whitei Hyatt. Moreman (13), proposed nine zones for the Eagle Ford formation which are from the base upward: (1) Acanthoceras rotomagense De France, (2) Metoicoceras irvini Moreman, (3) Metoicoceras whitei Hyatt, (4) Metoicoceras swallovi (Shumard), (5) Helicoceras pariense White, (6) Metoicoceras gibbosum Hyatt, (7) Gauthiericeras bravasi (d'Orbigny), (8) Prionotropis woolgari Mantell, and (9) Eagle Ford-Austin chalk transition zone.

Since the writerss first attempt to determine zones of the Eagle Ford formation, investigation has shown that nine

zones are not consistent over a large area but only locally in north Texas, where sediments are thickest. There are four zones, three ammonites and one pelecypod which are distinct and can be traced almost entirely across north and central Texas. The Tarrant member contains an Acanthoceran group, the Britton member a Mammitan group, and the Arcadia Park member a Prionotropid group, at the base, and an Oyster bed at the top. The accompanying chart shows the zones of the Eagle Ford with sub-zones and common associated species.

Fossil Zones of the Eagle Ford

Arcadia Park member (Prionotropid group).

Zone of *Alectryonia lugubris* Conrad

Associated species:

Cyprimeria excavata Morton
Fish remains, bones, etc.

Zone of *Prionotropis graysonensis* (Shumard)

Associated species:

Prionocyclus sp.
Prionotropis aff. *woolgari* Mantell
Prionotropis hyatti Stanton
Scaphites warreni M & H.
Inoceramus dimidius White

Britton Member (Mammitan group).

Zone of *Metoicoceras whitei* Hyatt

Subzones:

Metoicoceras gibbosum Hyatt
Exiteloceras pariense White
Inoceramus fragilis Hall & Meek
Scaphites vermiculus Shumard
Eucalycoceras leonense Adkins
Inoceramus capulus Shumard
Metoicoceras irwini Moreman
Inoceramus labiatus Schlotheim
Metoicoceras swallovi Shumard

Tarrant member (Acanthoceras group)

Zone of *Metacalycoceras tarrantense* Adkins

Associated species:

Epengonoceras dumblei (Cragin)
Acanthoceras bellense Adkins
Acanthoceras stephensoni Adkins
Acanthoceras lonsdalei Adkins

Correlation of the Eagle Ford Formation

The classic Mesocretaceous section of Europe includes three divisions which are from the base upward: (1) Albian, (2) Cenomanian and, (3) Turonian. The fossils as listed by L. F. Spath (48), for the Mesocretaceous, show that the upper Cenomanian is characterized by an Acanthoceran fauna, the lower Turonian by a Mammitan fauna, and the upper Turonian by a Prionotropid fauna. These ammonite groups correspond exactly to those found in the Eagle Ford formation of Texas, thus, the Eagle Ford is equivalent to upper Cenomanian and Turonian.

Formations in the Western Interior States which are equivalent to the Eagle Ford are: the Benton group of Kansas and eastern Colorado, the lower Mancos shale of southwestern Colorado, the lower Mawry shale of southern Wyoming, the Belle Fourche, Mowry, Greenhorn and Carlile of eastern Wyoming, and the Aspen shale of southwestern Wyoming.

The Benton group of Kansas is slightly thicker than the Eagle Ford being from 400 to 500 feet thick whereas the Eagle Ford has an average of about 300 feet. The Benton is composed of three formations which are as follows:

Carlile shale.

Codell sandstone member.
Blue hill shale member.
Fairport chalky shale member.

Greenhorn limestone.

Pfeifer shale member.
Jetmore chalk member.
Hartland shale member.
Lincoln limestone member.

Granerous shale.

The Granerous shale contains, near its base, an Acanthoceran fauna which is similar to that found in the base of the Eagle Ford, or Tarrant limestone member. The Greenhorn limestone contains species common to the Britton marly clay member of the Eagle Ford, such as, Metoicoceras whitei Hyatt, Inoceramus labiatus Schlotheim, etc. The Carlile contains, in its lower part, Prionotropis woolgari Mantell and near the top Prionocyclus wyomingensis Meek and Alectryonia (Conrad), which are the same species as those found in the Arcadia Park shale member of the Eagle Ford. At the top of the Carlile shale is a transitional bed, called the Codell sandstone, which is equivalent to the "Fish Bed Conglomerate" between the Eagle Ford and Austin chalk.

According to Reeside (52) there are two localities in Colorado where faunas equivalent to that of the Eagle Ford have been collected. One of these localities in in south-central Colorado, southwest of Pueblo. Here Acanthoceras occurs in the Granerous shale 60 feet above the Dakota sandstone (the Dakota is, for the most part, equivalent to the Woodbine sandstone of Texas). The next overlying fauna is in the upper Granerous shale and in the Greenhorn limestone

and includes such forms as Inoceramus labiatus, Metoicoceras whitei, and Baculites gracilis Shumard, which are the same species as those found in the Britton marly clay member of the Eagle Ford. Two hundred feet higher, at the top of the Carlile shale, a fauna including Prionocyclus wyomingensis and Alectryonia lugubris corresponds to the upper Ardadia Park shale member of the Eagle Ford. The second locality listed by Reeside is in the middle western part of Colorado, about 7 miles west of Delta. Here Acanthoceras is in the upper sandstone and upper shale of the Dakota sandstone. Higher in the section, in the Mancos shale, is a fauna consisting of Metoicoceras whitei, Inoceramus labiatus, and still higher Prionotropis woolgari. The upper part of the Mancos shale is younger than the Eagle Ford and beds equivalent to the top of the Eagle Ford are not definitely known.

The Aspen shale of southwestern Wyoming, the fauna of which was recently described by Reeside and A. Allen Weymouth (23), is equivalent to the Britton marly clay member of the Eagle Ford of Texas. This shale contains such species as, Inoceramus labiatus, Metoicoceras whitei, Helicoceras pariense White, Baculites gracilis, Placenticeras sp., and Kanabiceras kanabense Reeside and Weymouth.

The presence of specimens belonging to the genus Kanabiceras has been noted by Reeside (23) in the Eagle Ford of Texas, in the Mawry shale of southern Wyoming and the lower Colorado

group of southern Utah, in association with Inoceramus labiatus. The top of the Ferron, according to Raymond C.Moore (51), contains Alectryonia lugubris and, thus, is equivalent to the top of the Eagle Ford of Texas. The other formations of the Western Interior, which are thought to be equivalent to the Eagle Ford have not been sufficiently described to give a detailed correlation.

From the above facts it is apparent that the Turonian was one of the most widespread seas during Cretaceous time, and it also contained species of animals which migrated freely, as is shown by the presence of the fossils, Inoceramus labiatus and Prionotropis woolgari at almost every exposure of rocks of this age, in widely separated areas.

The following list includes macrofossils identified or reported from the Eagle Ford formation:

Lingula shumardi Cragin
Nucula bellastriata Shumard
Nucula serrata Shumard
Nucula hayden Shumard
Yoldia septerina Cragin
Cucullaea millestriata Shumard
Inoceramus crenistriatus F. Roemer
Inoceramus fragilis Hall and Meek
Inoceramus labiatus Schlotheim
Inoceramus problematicus Schluter
Ostrea anomiaeformis Roemer
Ostrea congesta Conrad
Alectryonia lugubris (Conrad)
Phacoides sublenticularis (Shumard)
Veniella laphami (Shumard)
Isocardia humilis Cragin
Cyprimeria crassa Meek
Cyprimeria excavata Morton
Venus sublamellosus Shumard
Meretrix lamarensis (Shumard)
Tapes hilgardi Shumard
Corbula graysonensis Shumard
Corbula tuomeyi Shumard
Panope subparallela Shumard
Epitonium lamarensis (Shumard)
Epitonium bicarinifera (Shumard)
Natica striaticostata Cragin
Anchura modesta Cragin
Acteon texana (Shumard)
Ringicula subpellucidae Shumard
Ringicula acutespira Shumard
Baculites gracilis Shumard
Exiteloceras pariense (White)
Turrilites wiesti Sharp
Turrilites hugardianus dOrbigny
Turrilites tuberculatus Bosquet
Turrilites irridens Schluter
Turrilites tridens Schluter
Turrilites varians Schluter
Ancyloceras annulatum Shumard
Mantelliceras sellardsi Adkins

Eucalycoceras leonense Adkins
Metacalycoceras tarrantense Adkins
Acanthoceras lonsdalei Adkins
Acanthoceras bellense Adkins
Acanthoceras stephensoni Adkins
Metoicoceras swallovi (Shumard)
Metoicoceras gibbosum Hyatt
Metoicoceras whitei Hyatt
Metoicoceras accelleratum Hyatt
Metoicoceras irwini Moreman
Prionotropis graysonensis Shumard
Prionotropis woolgari Mantell
Prionotropis hyatti Stanton
Prinocyclus sp.
Placenticeras cumminsi Cragin
P. stantoni var. bolli Hyatt
P. pseudoplacenta var. occidentale Hyatt
Scaphites vermiculus Shumard
Scaphites septem-seriatus Cragin
Scaphites texanus Roemer
Protengonoceras planum Hyatt
Epengonoceras dumbli Cragin
Epengonoceras acutum Hyatt

Description of Species

Phylum Protozoa

Class Foraminifera

The study of the foraminifera has been undertaken by Dr. Joseph A. Cushman, director of the Cushman Laboratory of Foraminiferal Research, Sharon, Massachusetts, and will be published simultaneously with the present work.

Phylum Mollusca

Class Pelecypoda

Order Prionodesmacea

Superfamily Pteriacea

Family Pernidae

Genus Gervillea De France

Gervillea gregaria Shumard
Plate 2, figure 4.

1860. Gervillea gregaria Shumard, Trans. Acad. Sci. St. Louis, I, p. 606.

1928. Gervillea gregaria Adkins, Univ. Tex. Bull. 2838, p. 91. (gives synonymy to 1928).

Original description: "Shell inequivalve, oblique, subovate, approaching subquadrate, moderately gibbous; wider than long; right valve more gibbous than left, its anterior

third strongly rounded; umbonal region convex for a short distance from the beak and thense flattened to the anal extremity, which is subtruncate on the pallial side and furnished on the cardinal side with a long, narrow, triangular expansion; anterior margin forming a long, sweeping curve from beak to base; cardinal line straight, forming with the posterior margin an obtuse angle; beaks nearly terminal, scarcely passing the cardinal line; ligament facet rather shallow, and about equal to the spaces between; surface with numerous fine concentric lines of growth, which toward the base, assume a subimbricated character.

"Length of cardinal margin, 1.20 inches; from point of beak to anal extremity, 1.86 inches; thickness of right valve, 0.32 inches.

Remarks: One specimen of this species was found by the writer which agrees with Shumard's description very closely except for its smaller size. A drawing of the holotype made by Shumard, after the species was described, is illustrated by White (41, Pl. 18, fig. 3a.). Our specimen is wider in proportion to the hight than the original and the right valve is slightly more rounded. The left valve was not figured by White but in our specimen it is only slightly convex and the cardinal margin flattens out sooner than it does on the right valve. The measurements of our specimen are: cardinal margin 20 mm.; from point of beak to anal extremity 40 mm., thickness of right valve 3 mm.

Gervillea gregaria is not abundant in the Eagle Ford and at present is known only from localities along Red River. This species of Gervillea resembles Gervillea linguiloides Forbes somewhat, but differs from the latter in having a more convex right valve and is taller in proportion to the width.

Horizon: Upper Britton member.

Locality: Bluff of Red River at Telephone Bridge, 3 miles north of Telephone, Texas.

Neoholotype: Bureau of Economic Geology, Austin, Texas.

Genus Inoceramus Sowerby

Inoceramus capulus Shumard
Plate 1, figure 1, 3.

1860. Inoceramus capulus Shumard, Trans. Acad. Sci. St. Louis, I, p. 606.

1928. Inoceramus capulus Adkins, University of Tex. Bull. 2838, p. 92.

Original description: "Shell subequivalve, elongate-ovate, section subcordate, antero-posterior diameter much shorter than from beak to base; umbonal region very gibbous; anterior slope falling abruptly to the margin, flattened above and more or less rounded below, margin sinuous; straight or slightly posterior slope convex; anal margin rounded, forming with the cardinal an obtuse angle; base strongly arched; beaks terminal or nearly so, much elevated,

curved forward, pointed; surface neatly ornamented with small, unequal, distinct concentric folds. In well preserved specimens the umbo is marked with a few obscure, radiating ribs. The shell structure is made up of thin concentric laminae.

"Length 1 inch; height 1.83 inches; thickness about 1.50 inches".

Remarks: Inoceramus capulus was not figured by Shumard but the writer has a number of specimens which agree with his description exactly. The very gibbous umbonal region, anterior slope falling abruptly to the margin, flattened above and more or less rounded below, and obscure radiating ribs which extend back from the umbo for half the length of the shell are features which are characteristic . This species has been called Inoceramus labiatusSchlotheim by most paleontologists in Texas, but the latter is thinner and the surface is marked with regular coarse concentric lines of growth with from four to six smaller lines of growth between them. The specimen which is being designated as the neoholotype is considerably larger than the holotype, but in the description, Shumard states that his collection contained fragments of large specimens. This specimen has a length of 40 mm.; height 75 mm.; and thickness of one valve 25 mm. The specimen is in an excellent state of preservation, includes both valves and retains most of the original shell.

Shumard states that Inoceramus capulus resembles Inoceramus umbonatus Meek and Hayden, but its height is greater, the opening of the valves is ovate instead of subcircular and the ornamentation is not so strongly developed. This species, so far as the writer has been able determine, is found only in the Eagle Ford formation of north Texas.

Horizon: In the lower and middle Britton member.

Locality: Three miles west of Prosper, Texas.

Necholotype: Bureau of Economic Geology.

Inoceramus fragilis Hall and Meek

Plate 1, figure 5.

1854. Inoceramus fragilis Hall and Meek, Mem. Am. Acad. Arts and Sci. (n. s.), VIII, p. 388, Pl. 2, fig. 6.

1893. Inoceramus fragilis Stanton, U. S. Geol. Surv. Bull. 106, p. 76, Pl. 9, fig. 1-5. (synonymy to 1893).

L928. Inoceramus fragilis Adkins, Univ. Tex. Bull. 2838, p. 94. (synonymy to 1928).

The original description and figures were taken from an imperfect specimen but later Meek (12, p. 42) gave a description of a complete specimen from the type locality, as follows: "Shell thin, broad-subovate, higher than long, moderately convex, subequivalve; anterior side vertically truncate from the beaks, with a slightly concave outline; basal and posterior borders forming a more or less regular, nearly semicircular curve; hinge-line rather short, and standing nearly at right angles to the truncate anterior.

Beaks pointed, equal, scarcely rising above the hinge, curving inward and slightly forward at the points. Surface marked by fine lines of growth, and a few obscure traces of concentric undulations.

"Height, about 1.43 inches; length, 1.07 inches".

Remarks: Hill records Inoceramus fragilis from the Eagle Ford but is figure was taken from Meek, thus the exact nature of his material is unknown. A number of excellently prexerved specimens have been collected in north Texas which agree with Meek's description. Some of the Texas specimens, however, show variations, particularly in the development of the beak, which is not so elongate as in the typical form; also the concentric undulations are narrower and more uniform. The specimen being figured has a length of 70 mm.; width of 45 mm.; and thickness of one valve 15 mm. Inoceramus fragilis occurs abundantly and usually in an excellent state of preservation.

Horizon: In the upper Britton member.

Locality: Indian Creek, near Hebron road east of Lewisville.

Figured specimen: Bureau of Economic Geology.

Inoceramus labiatus Schlotheim

Plate 1, figure 6.

L893. Inoceramus labiatus Stanton, U. S. Geol. Surv. Bull. 106, p. 77, Pl. 10, fig. 4; Pl. 14, fig. 2. (synonymy to 1893).

L928. Inoceramus labiatus Adkins, Univ. Tex. Bull. 2838, p. 94. (synonymy to 1928).

This species is thin, elongate ovate in outline, beaks right-angled; the axis of the shell is at 45 degrees to the hinge line, and the sculpture is of regular linguiform concentric ribs on which are imposed finer parallel ribs.

Remarks: Inoceramus labiatus is known from the lower Turonian of Europe and in the United States it occurs in beds of equivalent age. This species is not present in as great abundance, in the Eagle Ford, as was once thought because other forms have been confused with it. Inoceramus labiatus is not as abundant in the Eagle Ford as it is in the Benton of the Interior, and is usually somewhat smaller. The sculpture of this species is characteristic and should not be confused with any other. The specimen figured is rather poorly preserved but it is typical in form. The measurements are: length 50 mm.; height 25 mm.; and thickness of one valve 5 mm.

Horizon: Lower and middle Britton member.

Locality: Three and four tenths miles southeast of Pottsboro.

Figured specimen: Bureau of Economic Geology.

Inoceramus dimidius White

Plate 1, figure 2, 4.

1874. Inoceramus dimidius White, Expl. and Surv. west 100th Meridian, Prelim. Rept. Invert. Foss., p. 25;

1893. Inoceramus dimidius Stanton, U. S. Geol. Surv. Bull.

106, p. 78, Pl. 10, fig. 5, 6. (synonymy to 1893.).

Shell small, inflated; valves subequal; beaks small, prominent and pointing a little forward; hinge line straight but rather short. Shell marked by strong, regular concentric folds and fine lines of growth.

Remarks: This species is characterized by its small size, prominent pointed beaks and prominent ornamentation. The Texas specimens are slightly larger than those described from the Interior by Stanton, averaging about 3 or 4 cm. in greatest length. Inoceramus dimidius occurs abundantly near the base of the Arcadia park member in association with Prionotropis, and according to Stanton it occurs at a similar horizon in the Mancos shale of New Mexico.

Horizon: Lower Arcadia Park member.

Locality: Near Fort Worth-Dallas pike, 7 miles west of Dallas.

Figured specimen: Bureau of Economic Geology.

Inoceramus carroltonensis Moreman n. sp.

Plate 1, figure 8.

Shell large, external outline roughly triangular but internal view subcircular, gibbous, the greatest convexity being near the center; beaks prominent curving slightly inward; axis of shell at right angles to the hinge line; hinge line rather short for the size of the shell; anterior

and posterior margins in umbonal region convex, anterior margin slightly more convex, posterior-ventral margin flattened out slightly near edge; shell thin. Surface ornamented with irregular concentric undulations with numerous fine lines of growth.

Length of figured specimen, 80.0 mm.; height 65 mm.; and thickness of left valve 30 mm.

Remarks: This species resembles Inoceramus deformis Meek in the appearance of the ornamentation but differs in the shape of the outline and position of the beaks. The beaks in the latter species are not at right angles to the hinge line.

Horizon: Upper Britton member, associated with Metoicoceras whitei hyatt.

Locality: One mile east of Carrolton.

Figured specimen: Bureau of Economic Geology.

Inoceramus dallasensis Moreman n.sp.

Plate 1, figure 7.

Shell large and suboval in outline, gibbous, the greatest convexity being slightly anterior to the middle; beaks prominent, curved inward and slightly anteriorly; hinge line short and directed at right angles to the long axis of the shell; anterior margin slopes abruptly but flattens slightly near the edge, posterior margin convex; shell thin and ornamented with regular but obscure concentric undulations and fine lines of growth.

Length of figured specimen 55 mm.; height 90 mm.; thickness of left valve 30 mm.

Remarks: This species resembles Inoceramus proximus Tuomey in general outline and ornamentation but differs in that the hinge line is longer and directed at a smaller angle with the long axis of the shell. This species is not very abundant in the Eagle Ford but it usually occurs in an excellent state of preservation.

Horizon: Middle Britton member, associated with Epengonoceras acutum Hyatt.

Locality: Three miles north of Irving.

Holotype: Bureau of Economic Geology.

Super family Ostracea

Family Ostreidae Lamark

Genus Alectryonia Fischer De Waldheim

Alectryonia lugubris (Conrad)

Plate 2, figure 12.

1857. Ostrea lugubris Conrad, U. S. and Mex. Boundary Rept. Vol. I, p. 156, Pl. 10, fig. 5a, b.

1893. Ostrea lugubris Stanton, U. S. Geol. Surv. Bull. 106, p. 58, Pl. 4, fig. 1-10. (synonymy from 1857 to 1893).

1928. Alectryonia lugubris Adkins, Univ. Tex. Bull. 2838, p. 104, Pl. 18, fig. 5; Pl. 24, fig. 8, 9.

(synonymy from 1893 to 1928).

Outline of shell usually broad subovate, but in small specimens often nearly circular and in larger ones occasionally subtriangular. Surface marked by from twelve to eighteen plications, that radiate from the beak or scar of attachment, and by strong concentric lines of growth. The plications are usually simple but occasionally they bifurcate.

Remarks: Stanton gives a complete description and discussion of this species of oyster, in which he shows that Ostrea belliplicata Shumard and Ostrea blackii White are large varities of Conrad's type. The type specimen came from the Colorado group of New Mexico, and is much smaller than the Texas form. Specimens showing the great variety of size and shape and sculpture of this species are found at the top of the Arcadia Park shale member. Alectryonia lugubris occurs, in the Eagle Ford, at the same stratigraphic level as it does in the Interior States.

Horizon: At the top of the Arcadia Park shale member.

Locality: Chalk Hill, on the Fort Worth-Dallas pike, 6 miles west of Dallas.

Figured specimen: Bureau of Economic Geology.

Superfamily Veneracea

Family Veneridae Lamark

Genus Cyprimeria Conrad

Cyprimeria excavata Morton

Plate 2, figure 9.

1928. Cyprimeria excavata Adkins, Univ. Tex. Bull. 2838, p. 163. (synonymy to 1928).

Cast of shell subovate, slightly elongate, beaks not very prominent. Sculpture indistinct . Length of figured specimen 23 mm.; height 21 mm.; thickness 9 mm.

Remarks: A detailed description of this species is difficult because it occurs only as casts of phosphate which appear to have been reworked. The Eagle Ford specimens are slightly smaller than the type but other features are so similar that it does not seem advisable to describe a new species at this time.

Horizon: Upper Arcadia Park shale, where it is abundant and associated with Alectryonia lugubris Conrad.

Locality: Chalk Hill, near the Fort Worth-Dallas pike, 6 miles west of Dallas.

Figured specimen: Bureau of Economic Geology.

Genus Meretrix Lamark

Meretrix lamarensis (Shumard)

Plate 5, figure 5, 7.

1860. Cytherea lamarensis Shumard, Trans. Acad. Sci. St. Louis, I, p. 600.

1883. Cytherea lamarensis White, 12th Ann. Rept. U. S. Geol. Surv. Appendix, p. 39, Pl. 18, fig. 4a, b.

1928. Meretrix lamarensis Adkins, Univ. Tex. Bull. 2838, p. 164.

Shell elliptical, small, with tall prominent beaks; anterior end sharply rounded, but posterior end broadly rounded, base a broad curve. Surface marked by fine growth lines and at intervals coarser growth lines.

Length of figured specimen 25 mm.; height 23 mm.; thickness of one valve 5 mm.

Remarks: This fossil occurs as casts with the original shell still present in some cases. The species is distinguished from others of this genus by the elliptical outline, rather prominent beaks and compressed form. A drawing of the type, made by Shumard after the original description was published, is figured by white.

Horizon: Middle and upper Britton member, especially along Red River.

Locality: Bluff of Red River near Telephone Bridge, 5 miles north of Telephone.

Figured specimen: Bureau of Economic Geology.

Meretrix gibbosum Moreman n. sp.

Plate 2, figure 7, 8.

Shell, small, extremely gibbous, taller than long;

anterior margin sharply rounded, posterior margin broadly rounded, and basal margin circular; beaks elevated prominently and curved anteriorly, separated by hinge line which is slightly elevated into a sharp ridge. Surface marked by fine growth lines with a few coarser lines of growth.

Length 12 mm.; height 20 mm.; and thickness of one valve 8 mm.

Remarks: This species is characterized by its very gibbous shell, anteriorly curved beaks and greater height than length. Meretrix lamarensis Shumard is thinner, has a slightly greater length than height and the beaks are not so prominent.

Horizon: Middle and upper Britton member, associated with Meretrix lamarensis and Tapes hilgardi Shumard

Locality: Bluff of Red River at Telephone Bridge, 5 miles north of Telephone.

Genus Tapes Megerle

Tapes hilgardi Shumard

Plate 2, figure 2, 3.

1860. Tapes hilgardi Shumard, Trans. Acad. Sci. St. Louis, I, p. 601.

1883. Tapes hilgardi White, 12th Ann. Rept. U. S. Geol. Surv. appendix p. 39, Pl. 16, fig. 3a.

1928. Tapes hilgardi Adkins, Univ. Tex. Bull. 2838,

p. 165.

Shell elongate-ovate and rather compressed; anterior end rounded and not as tall as the posterior end which is somewhat truncate; beaks prominent, directed slightly anteriorly and almost touching. Surface marked with coarse concentric ridges and fine growth lines.

Length of figured specimen 38 mm; height 25 ,,; and thickness of one valve 7. 5 mm.

Remarks: This specimen was described without illustration but later White figured some drawings of the type which were made by Shumard. The specimen which is being designated as a neoholotype corresponds exactly with Shumard's description and illustration. The species is characterized by its elongate form and coarse sculpture.

Horizon: Middle and upper Britton member, associated with Moretrix lamarensis (Shumard), Tapes hilgardi Shumard, and Metoicoceras whitei Hyatt.

Locality: Bluff of Red River at Telephone Bridge, 5 miles north of Telephone.

Neoholotype: Bureau of Economic Geology.

Class Cephalopoda

Sub-Class Dibranchiata

Order Ammonoidea Zittel

Family Baculitidae

Genus Baculites Lamark

Baculites gracilis Shumard

Plate 2, figure 6.

1860. Baculites gracilis Shumard, Trans. Acad. Sci. St. Louis, I, p. 596.

1928. Baculites gracilis Adkins, Univ. Tex. Bull, 2838, p. 206.

Shell coiled in the earliest portion, straight and slender in the remainder; cross section ovate to subcircular; surface marked with prominent rounded costae on the venter where they are arched toward the aperture, on the sides the costae curve backward and downward to the dorsal mrgin where they become nearly obscure.

Remarks: This species is very abundant in the Eagle Ford, especially at certain localities. In Ellis County concretionary limestone slabs are found which are made up largely of casts of this fossil. Baculites gracilis occurs also in some of the formations of the same age in the Interior States, for example, the Aspen shale of Wyoming.

Horizon: Throughout the Britton member.

Locality: Three miles northwest of Midlothian.

Figured specimen: Bureau of Economic Geology.

Family Hamitidae Hyatt

Genus Hamites Parkinson

Hamites eaglefordensis Moreman n. sp.

plate 6, figure 14.

This species is represented by a fragment only which is nearly straight with an oval cross-section. Surface ornamemted with oblique ribs on the sides, arched forward on the venter and straight across the dorsum; ribs moderately fine there being 6 in a distance of 8 mm. Suture unobserved.

Length 8 mm. Long diameter of cross-section 10 mm. short diameter 8 mm.

Remarks: Hamites is rather rare in the Eagle Ford, the only specimen found by the writer is an ironstone cast of a portion of the living chamber. Some of the specimens that have been refered to as Hamites, in the Eagle Ford, were no doubt fragments of Exiteloceras. The latter differs in having two rows of notes on the venter. This species is characterized by the arrangement of the ribs which are directed obliquly across the flanks and straight across the truncate dorsum, also they are much finer and more numerous than in other species. Hamites is rather abundant at certain levels in the Washita division of the Cretaceous where the

individuals reach a length of five of six inches and have rather coarse distant ribs.

Horizon: Lower Britton member.

Locality: Three miles north of Irving.

Holotype: Bureau of Economic Geology.

Family Nostoceratidae Hyatt

Genus Exiteloceras Hyatt

Exiteloceras pariense (C. A. White)

Plate 6, figure 20.

1876. Helicoceras pariense White, U. S. Geog. and Geol. Surv. west 100th Meridian, Vol. 4, p. 203, Pl. 19, fig. 2a, b.

1928. Exiteloceras pariense Adkins, Univ. Tex. Bull. 2838, p. 212.

Shell an unsymmetrical spire in the ephebic stage; cross-section of living chamber oval; surface marked with coarse costae which entirely encircle the shell and bear on the venter two rows of small tubercles; there are 12 ribs in a space of 24 mm.

Remarks: This species is abundant in the Eagle Ford where it occurs as compressed impressions in the shale and as limestone casts, sometimes the original shell is preserved. The Eagle Ford specimens are not identical with the forms found in the Interior States, where the

species was described, the only difference is finer ribs on the Texas forms.

Horizon: Middle Britton member.

Locality: Three miles northwest of midlothian.

Figured specimen: Bureau of Economic Geology.

Exiteloceras dentonensis Moreman n. sp.

Plate 6, figure 15.

A fragment of the last part of the living chamber shows the shell to be an open unsymmetrical spire; cross-section of living chamber oval. Length of fragment 34 mm.; height of whorl 13 mm.; breadth of whorl 10 mm. Surface ornamemted with prominent ribs which extend entirely around the volution; each bears a pair of pointed tubercles on the venter; venter flat, dorsum rounded. Suture unobserved.

Remarks: This species is not very abundant but is distinct, it differs from Exiteloceras pariense in being more robust, the whorls being taller and thicker; ribs more numerous for the size and the tubercles more prominent.

Horizon: Middle Britton member, associated with Pachydiscus scotti Moreman, and Metoicoceras irwini Moreman.

Locality: Six miles northwest of Irving.

Holotype: Bureau of Economic Geology.

Family Phlycticrioceratidae

Genus Allocrioceras Spath

Allocrioceras texana Moreman n. sp.

Plate 4, figure 2.

Shell open coiled but not in contact, cross-section of last volution oval. Length of living chamber 90 mm; height 30 mm; thickness 25 mm; diameter about 90 mm. Surface marked with prominent coarse ribs half of which entirely circle the shell, more prominent on the venter, directed obliquely anteriorly on flanks and straight across the dorsum; there are alternating short ribs which do not reach the dorso-lateral margin; the long ribs bear on the dorso-lateral margin raised, elongated nodes; nodes absent on the venter; venter rounded. Suture consists of a regularly denticulate first lateral lobe and broad bifid lobe, second lateral lobe similar to the first lateral but shorter and narrower, siphonal lobe unobserved.

Remarks: This is the first specimen of this genus to be found in Texas and the species is based on one fragmentary individual. Ammonites of this group are hard to define because it is rare to find a complete specimen

and the nature of the coiling is usually a diagnostic generic character. This species is closely related to Allocrioceras ellipticum Woods, but differs in having alternating long and short ribs and a slightly more complex suture.

Horizon: Middle Britton member, associated with Metoicoceras whitei Hyatt and Placenticeras spp.

Locality: Seven miles northwest of Irving.

Holotype: Bureau of Economic Geology.

Family Desmoceratidae Zittel

Genus Pachydiscus Zittel

Pachydiscus scotti Moreman n. sp.

Plate 3, figures 2, 5.

Shell inflated, discoid and involute, cross-section of living chamber sub-oval; whorls thick, taller than wide; umbilicus small. Diameter 65 mm; height of living chamber 34 mm; width 24 mm; umbilicus 7 mm. Surface ornamented with distant rounded ribs which cross the venter uninterrupetd and extend in about the same development almost to the umbilicus; approximately straight on the flanks but arch slightly anteriorly over the venter; over the venter the ribs are spaced from 12 to 15 mm. apart and in between are numerous fine obscure ribs or striae which more or less parallel the larger

ribs. Suture only partially preserved but is typically Pachydiscus in character.

Remarks: This species is closely related to the Pachydiscus peramplus (Mantell) group, especially in the development of its ornamentation, but differs in having a much smaller umbilicus. Only one large specimen was found but at another nearby locality a number of small pyritized specimens were collected which certainly belong to the same species. Panhydiscus has not been cited from the Eagle Ford before but it is not especially rare.

Horizon: Lower Britton member.

Locality: Seven miles northwest of Irving.

Holotype: Bureau of Economic Geology.

Pachydiscus bellense Moreman n. sp.

Plate Figure

Shell large, inflated, discoid and involute, cross-section of living chamber sub-oval, venter rounded. Diameter 18 inches; height of living chamber 6 inches; breadth 4 inches; umbilicus 4 inches. Surface ornamented with low rounded costae which extend from near the umbilicus across the venter uninterruptedly; ribs numerous, spaced about one fourth of an inch apart in the early portion but are further apart and less well developed in the adult portion. Suture complex, typically

that of Pachydiscus.

Remarks: This species is fairly abundant and well preserved in Bell County, it reaches a diameter of from 2 to 3 feet when fully developed. Pachydiscus bellense differs from Pachydiscus scotti in its larger size, more uniform ornamentation, more numerous ribs, and wider umbilicus. This is the largest ammonite ever reported from the Eagle Ford, although some specimens of Placenticeras have been collected which measure more than a foot in diameter.

Horizon: Tarrant limestone member, associated with Acanthoceras, Metacalycoceras, Turrilites, etc.

Locality: Near Belton-Temple highway, Bell, County.

Collection: W. S. Adkins.

Holotype: Bureau of Economic Geology.

Family Mantelliceratidae Hyatt

Genus Eucalycoceras Spath

Eucalycoceras brittonensis Moreman n. sp.

Plate 6, figure 16, 19.

1927. Acanthoceras sp. A, Moreman, Jour. Pal. Vol. 1, no. 1, p. 95, Pl. 15, fig. 2.

Shell involute, inflated, whorls somewhat depressed. Flanks flattened and almost parallel. Surface

ornamented with prominent costae which croww the venter, some of the ribs become obscure toward the umbilicus while a few become more prominent and bear tubercles near the umbilicus, sometimes to unite on the umbilical shoulder and bear a prominent tubercle. Cross-section of living chamber roughly quadrate, cross-section of earlier portion more oval. There are five rows of tubercles, three on the venter and one row on each ventro lateral margin. Suture indistinct.

Remarks: This species is preserved as casts of limestone and usually only the living chamber remains. A few complete specimens were collected but in these the suture was not preserved. Eucalycoceras brittonensis differs from Eucalucoceras leonense Adkins in that the tubercles, especially the median row, are more prominent and persistant, continuing to the end of the living chamber. Also the ribs curve posteriorly in this species more than in the latter.

Horizon: Middle Britton member, associated with Metoicoceras whitei Hyatt and Kanabiceras kanabense (Stanton).

Locality: On Indian Creek, between Lewisville and Hebron.

Holotype: Bureau of Economic Geology.

Genus Metacalycoceras Spath

Metacalycoceras tarrantense Adkins

Plate 5, figure 4.

1926. Acanthoceras rotomagense Scott, Bull. Amer. Assoc. Pet. Geol. Vol. 10, no. 6, Pl. 22, fig. 1.

1928. Metalycoceras tarrantense Adkins, Univ. Tex. Bull. 2838, p. 241, Pl. 28, fig. 3; Pl. 29, fig. 1.

Shell discoid, involute, cross-section of volution quadrate in adult portion, sides convex, venter truncate. Ribs prominent and crossing venter uninterruptedly; mid-ventral tubercles absent in adult and others reduced.

Remarks: The genus Metacalycoceras was erected by Spath to include those Acanthoceran form in which the ribs are continuous across the venter. The early stages of this group have typical Acanthoceran characters but in the adult stage the ribs become better developed and the median row of tubercles as well as the lateral rows become reduced. This species was identified first as Acanthoceras rotomagense by Scott; it occurs at the same horizon but differs in that the ornamentation is more fully developed.

Horizon: Tarrant member, associated with Acanthoceras.

Locality: Two miles east of Tarrant Station, from type locality.

Figured specimen: Bureau of Economic Geology.

Metacalycoceras tuberculata Moreman n. sp.

Plate 6, figure 18, 21.

Shell discoidal, involute; cross-section of last volution subquadrate. Surface ornamented with strong ribs which cross the venter, strongest over venter and directed slightly anteriorly but some of the ribs curve slightly posteriorly near the umbilicus; each rib bears five tubercles on the venter and ventro-lateral margin. The tubercles are prominent in the early stage but absent on the last portion of living chamber in the adult stage, the mid-ventral row becoming obscure first. Suture only partially preserved but appears to be acanthoceran in nature.

Remarks: This species differs from Metacalycoceras tarrantense Adkins in being smaller and, has a diameter of about three inches whereas the latter has a diameter of about six inches. This species is also more compressed.

Horizon: Middle britton member, in north texas, but in the lower flag member in central Texas, which represents part of the Britton and all of the Tarrant member.

Locality: Between Lewisville and Hebron on Indian Creek.

Holotype: Bureau of Economic Geology.

Metacalycoceras indianensis Moreman n. sp.

Plate 2, figure 10, 11.

Shell involute, flanks slightly flattened, venter rounded. Diameter 80 mm; thickness 24 mm; height of living chamber 30 mm; umbilicus 25 mm. Surface ornamented with prominent ribs which cross the venter and dear one mid-ventral and two lateral rows of tubercles; the two outer rows are composed of rounded rodes; the median row of tubercles diminish soon after reaching the living chamber and all the tubercles are absent on the last five ribs or are represented only by low swellings. The suture consists of a long siphonal lobe, a lateral lobe and two broad bifid saddles.

Remarks: This form resembles Metacalycoceras tuberculata very closely, the two have the same type of suture and same type of ornamentation. They may be distinguished from one another by the character of the cross section; the cross section of Metacalycoceras tuberculata is more quadrate, the height is greater than the thickness and the sides are parallel. In this species the cross section of the living chamber is more circular, it is almost as thick as it is high, the sides are not parallel, but it is thickest near the umbilicus. These two forms are about the same size of Eucalycoceras and look considerably like

it in general appearance, but the tubercles are more persistent in Eucalycoceras and the suture is more like that of Acanthoceras.

Horizon: Middle Britton member, associated with the above species.

Locality: Between Lewisville and Hebron, on Indian Creek.

Holotype: Bureau of Economic Geology.

Genus Kanabiceras Reeside

A genus recently described by Reeside (23) to include a form described by Stanton and called Acanthoceras kanabense. Original description: " Shell fairly stout whorls somewhat depressed. Sculpture irregular, coarse, consisting of three rows of small, uneven nodes on the venter, the median row at places forming a rough keel; a row of rather distant, long marginal spines which appear to be hollow at the base and on the internal molds appear as rounded or truncated, heavy, blunt nodes; between the marginal nodes faint uneven ribs; a row of uneven umbilical nodes. The suture only moderately dissected, with first lateral saddle narrow, first lateral lobe wide, bifid; other elements small."

Kanabiceras kanabense (Stanton)

Plate 4, figure 6.

1893. Acanthoceras kanabense Stanton, U. S. Geol. Surv. Bull. 106, p. 181, Pl. 36, fig. 6 to 8.

1927. Acanthoceras kanabense Moreman, Jour. Pal. Vol. I, no. 1, Pl. 13, fig. 5.

1931. Kanabiceras kanabense Reeside and Weymouth, Proc. U. S. Mus. Vol. 78, Art. 17, p. 11, 12.

The specimen here figured is identical with that described by Stanton from Wyoming and occurs at the same level. This specimen was reffered to by Reeside in his description of the new genus Kanabiceras, it shows the marginal spines in full development.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Figured specimen: Bureau of Economic Geology.

Kanabiceras boharti Moreman n. sp.

Plate 4, figure 3, 5.

Shell inflated, depressed, discoid and involute; cross-section oval, lateral axis longest. Diameter 85 mm; umbilicus 27 mm, or about one third the diameter. Surface elaborately ornamented; early stage with regular coarse ribs but in adult they are very irregular, coarse distant ribs with numerous fine ribs between, the ribs arch slightly anteriorly over the vanter and curve anteriorly again near the umbilicus; nodes in five rows, two on the ventro-lateral surface, rather large and

distant, inner two rows lower and more numerous whereas the median row is still smaller and more numerous resting on a low keel. Suture only partially preserved but is Acanthoceran in nature.

Remarks: This species is closely related to Kanabiceras kanabense Stanton in shape and sculpture but differs in the nature of the median row of tubercles. In K. kanabense the median tubercles form a more or less continuous keel, elevated and furrowed on each side. This species has a median row of tubercles which are distinct and rest on a low rounded keel which is not furrowed on each side.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Holotype: Bureau of Economic Geology.

Family Pseudotissotidae Hyatt

Genus Hemitissotia Peron

Hemitissotia eaglefordensis Moreman n. sp.

Plate 4, figure 1, 4.

1927. Hemitissotia sp. A Moreman, Jour. Pal. Vol. I, no. 1, Pl. 14, fig. 1.

Whorls close coiled, compressed and elevated; cross-section of volution elliptical. Height of volution 6 mm; thickness 30 mm; umbilicus 15 mm. Surface sparcly orna-

mented, ornamentation consists of low obscure distant ribs on flanks; venter narrow and smooth; umbilicus smooth. Suture consists of bifid lobes, first lateral saddle bifid and denticulate, second lobe dissected but not bifid and remaining saddles smooth; there are six lateral lobes and saddles.

Remarks: This species is based onone fragmentary specimen and is the only record of this genus in sediments of this age in North America. The genus was described from material in Europe where many species are recognized. Our species is more closely related to Hemitissotia cazini Peron than to any other, but it differs from that species in being more compressed and by having less conspicuous ornamentation. Most of the European Hemitissotia are robust smulptured forms.

Horizon: Lower Britton member, associated with Metoicoceras irwini Moreman.

Locality: Six miles northwest of Irving.

Holotype: Bureau of Economic Geology.

Family Tissotidae Hyatt

Genus Tissotia Douville

Tissotia wintoni Moreman n. sp.

Plate 6, figure 7, 8.

Shell close coiled, compressed, elevated. Diameter

7 mm; thickness 3 mm; umbilicus 2 mm; height of last volution 3 mm. Surface smooth except for a midventral carina and two ventro-lateral ridges. Suture unobserved.

Remarks: This species is distinguished by its small, compressed shell and smooth sculpture. It is a rare form in the Eagle Ford and occurs as small pyritized casts. So far as the writer has been able to determine, this is the first record of Tissotia in this country, although it is an abundant form in Europe, etc.

Horizon: Britton member, associated with Pachydiscus scotti Moreman and Hamites eaglefordensis Moreman.

Locality: Seven miles northwest of Irving.

Holotype: Bureau of Economic Geology.

Family Metoicoceratidae Hyatt

Genus Metoicoceras Hyatt

There have been five species of Metoicoceras described from the Eagle Ford formation and ther are two new species to be described. The genus ranges through the lower two thirds of the formation and it comprises one of the most characteristic groups in tegard to species and individuals. The members of this genus have a more or less compressed shell, elevated and involute. The venter is flat and there are characteristically two

rows of lateral tubercles. The suture is characteristic, consisting of from five to six lobes and saddles, the siphonal and first lateral lobes being the longest.

Metoicoceras swallovi (Shumard)

1860. Ammonites swallovi Shumard, Trans. Acad. Sci. St. Louis, I, p. 591, 592.

1901. Metoicoceras swallovi Hyatt, Mon. U. S. Geol. Surv. Vol. 44, p. 118, Pl. 11, fig. 7-24; Pl. 13, fig. 1, 2; Pl. 15, fig. 1-4.

Originally Metoicoceras swallovi included all of the species of this genus but later Hyatt revised the group, erected a new family and separated the different forms into four species. This species is very rare and occurs only in the region of Red River, according to the present knowledge. This species is characterized by having rather rounded flanks, ribs broadly rounded, umbilicus large, umbilical tubercles large and elevated and others distinct. Suture characteristically with broad lobes and broad smooth saddles.

Horizon: Lower Britton member. Upper Woodbine and Tarrant member of Eagle Ford doubtful. In Europe Metoicoceras occurs only in the lower Turonian.

Locality: Grayson County (type locality).

Metoicoceras gibbosum Hyatt

Plate 5, figure 1.

1901. Metoicoceras gibbosum Hyatt, Mon. U. S. Geol. Surv. Vol. 44, p. 121, 122, Pl. 15, fig. 5-8.

This species is not very abundant and has been collected only in Ellis and Dallas counties., it differs from Metoicoceras swallovi in being more robust, having a smaller umbilicus and no tubercles on the umbilicus. Suture similar to that of latter species but the saddles are more denticulate and both the saddles and lobes are more elongated.

Horizon: Upper Britton member.

Locality: Six and one half miles west of Dallas, and about 1 mile south of the Fort Worth pike.

Figured specimen: Bureau of Economic Geology.

Metoicoceras whitei Hyatt

Plate 3, figure 8.

1901. Metoicoceras whitei Hyatt, Mon. U. S. Geol. Surv. Vol. 44, p. 122-127, Pl. 13, fig. 3-5; Pl. 14, fig. 1-10, 15.

1928. Metoicoceras whitei Adkins, Univ. Tex. Bull. 2838, p. 249. (synonymy from 1901- 1928).

This is one of the most abundant and characteristic species of the Eagle Ford formation, and it has also the greatest vertical range of any other species of this

of the genus. Metoicoceras whitei has a rather small umbilicus, more complex suture, and less well developed tubercles around the umbilicus than Metoicoceras swallovi.

Horizon: All of the Britton member.

Locality: Three miles northwest of Midlothian.

Figured specimen: Bureau of Economic Geology.

Metoicoceras accelleratum Hyatt

1901. Metoicoceras accelleratum Hyatt, Mon. U.S. Geol. Surv. Vol. 44, p. 127, 128, Pl. 14, fig. 11-14.

1928. Metoicoceras accelleratum Adkins, Univ. Tex. Bull. 2838, p. 249. (synonymy to 1928).

This species is very rare in the Eagle Ford and not much is known about it. The distinguishing characteristics are, its small size, small umbilicus which is much smaller than in any other species, and the smoother sculpture.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Metoicoceras irwini Moreman

Plate 3, figure 6, 7.

1927. Metoicoceras irwini Moreman, Jour. Pal. Vol. 1, no. 1, p. 92, 93, Pl. 13, fig. 3, 4.

This species is characterized by its more compressed form wide umbilicus, absence or umbilical tubercles and

more numerous but less prominent ribs.

Horizon: Lower Britton member

Locality: Six miles northwest of Irving (type locality).

Holotype: Texas Christian University.

Metoicoceras ornatum Moreman n. sp.

Plate 3, figure 3, 4.

1927. Metoicoceras swallovi Moreman, Jour. Pal. Vol.I, no. 1, p. 90, Pl. 15, fig. 3.

Shell slightly compressed, elevated, planospiral and involute; cross-section of last volution suboval, greatest thickness about one half inch above the umbilicus, narrows toward venter. Diameter 100 mm; height of last whorl 40 mm; thickness 33 mm; umbilicus 20 mm, or one fifth the total diameter. Sculpture consists of prominent straight ribs which bear two pair of elongated nodes on the sides of the venter; venter concave on the costae and rounded in between; venter rather narrow; ribs terminate near the umbilicus as prominent elongated nodes, these nodes begin in the darly stage and continue through to the last volution; there are alternating ribs which do not reach the umbilicus and bear only ventro-lateral nodes. Suture consists of a siphonal lobe and five lateral lobes, the first lateral lobe being the longest; lobes dissected whereas the saddles are simple or

only slightly dissected.

Remarks: This species resembles M. swallovi in the nature of the suture, width of umbilicus, and character of the umbilical nodes in the young stage, it differs from the latter species in having umbilical nodes which are persistent to the adult stage, ribs straight instead of curvingposteriorly on the flanks.

Horizon: Upper Britton member.

Locality: Three miles northwest of Midlothian.

Holotype: Bureau of Economic Geology.

Metoicoceras planum Moreman

Plate 5, figure 6, 8.

Form slightly compressed, convex, elevated, planospiral and involute; cross-section of last volution elliptical; thickest portion about one third of distance from umbilicus to venter. Diameter 80 mm; greatest thickness 22 mm; umbilicus 4 mm or one twentieth the diameter. Sculpture relatively smooth compared with other species of this genus; the ribs are numerous but rather obscure and reach only about two thirds of the distance to the umbilicus; two pairs of tubercles on ventro-lateral margin, outer row almost obscure but inner row distinct; ribs of about equal length; umbilicus smooth; venter flat or slightly concave. Suture comples both lobes and saddles finely denticulated.

Remarks: This species is distinguished by its biconvex outline, small umbilicus and obscure ornamentation. Metoicoceras accelleratum Hyatt has a small umbilicus but the cross section of the last volution is quadrate in outline. The ornamentation is similar to Metoicoceras irwini Moreman, but the latter has a wide umbilicus and the cross section more quadrate in outline than it is convex.

Horizon: Middle Britton member, associated with Metoicoceras whitei Hyatt, Baculites gracilis Shumard Placenticeras spp. etc.

Locality: Three miles northwest of Midlothian.

Holotype: Bureau of Economic Geology.

Family Prionotropidae Zittel

Genus Prionotropis Meek

Prionotropis graysonensis Shumard

Plate 6, figure 13.

1860. Ammonites graysonensis Shumard, Trans. Acad. Sci. St. Louis, I, p. 593, 594.

1860. Ammonites meekianus Shumard, 1860, Trans. Acad. Sci. St. Louis, I, p. 592, 593.

These two species described by Shumard are undoubtedly the same but represent different stages in development; Prionotropis graysonensis the young stage and Prionotropis meekianus the more adult stage. In the

young stage the shell is more or less compressed and has a distinct keel while in the older stage the volutions are more quadrate in cross-section and the ribs are more distant and bear long nodes.

This species is the most abundant ammonite in the Eagle Ford and is limited to a narrower vertical range. The closely related species Prionotropis woolgari Mantell, of Europe, has a more serrated keel and is not quite so compressed. Prionotropis in the Eagle Ford is rarely represented by an adult specimen but there are numerous form about one inch in diameter. Adults reach a diameter of from 6 to 10 inches.

Horizon: Lower part of the Arcadia Park shale.

Locality: Seven miles west of Dallas, on Fort Worth pike.

Figured specimen: Bureau of Economic Geology.

Family Placenticeratidae Hyatt

Genus Placenticeras Meek

Hyatt described two varities of Placenticeras from the Eagle Ford, Placenticeras stantoni var. bolli Hyatt, and Placenticeras pseudoplacenta var. occidentale. These two forms are very abundant in Ellis and Dallas counties but are seldom found outside of this area. They are among the largest ammonites found

in the Eagle Ford, some attain a diameter of over one foot. Most all of the species of Placenticeras have about the same sculpture, but they are distinguished on differences in the complex suture.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Family Stepeoceratidae Neumayr

Genus Scaphites Parkinson

Scaphites vermiculus Shumard

Plate 6, figure 2, 3, 4, 10.

1860. Scaphites vermiculus Shumard, Trans. Acad. Sci. St. Louis, I, p. 594.

1928. Scaphites vermiculus Adkins, Univ. Tex. Bull. 2838, p. 259.

Original description: "Shell small, ovate, length not quite one-third greater than the height; sides gently convex, dorsum strongly rounded ventral side flattened, obtusely subangular at junction with sides; body whorl slightly sinuate, very gradually enlarging, and produced horizontally for a distance equal to the diameter of the regularly coiled part, then curved backward so as to bring the aperture to within a short distance of the middle of the long diameter of the shell; volutions of the spire partially embracing, leaving a deep umbilicus

in which three or four coils are visible; surface marked with a few obscure, transverse folds, and fine striae of increase. The folds are usually perceptible only on the septate portion of the shell."

Remarks: One specimen in our collection agrees exactly with Shumard's description and with the figure of a drawing of the type published by White. The length of this specimen is possibly one or two millimeters shorter than the type. Length 13 mm; height 7 mm; and thickness 3 mm. This is not abundant in the Eagle Ford but one specimen was found perfectly preserved in a lomestone cnncretion, near the middle of the Britton member. It is characterized by its small size, wide umbilicus and smooth sculpture.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Neoholotype: Bureau of Economic Geology.

Scaphites texanus Roemer

Plate 6, figure, 1, 6.

1852. Scaphites texanus Roemer, Die Kreidebildungen von Texas und ihre organishhen Einschlusse, p. 35, Pl. 1, fig. 4a-c.

1928. Scaphites texanus Adkins, Univ. Tex. Bull. 2838, p. 259.

Remarks: This species is abundant in the Eagle Ford but it has not been referred to in recent literture except in fossil lists. The species is characterized by its coarse sculpture, which consists of strong ribs and strong nodes, especially along the margins of the uncoiled portion. There are 16 primary ribs with two secondary ribs between each two. The primary ribs, in some cases join near the margin to form elongate nodes.

Horizon: Upper Britton and lower Arcadia Park members, associated with Prionotropis graysonensis (Shumard), and Inoceramus dimidius White.

Scaphites sp. aff. aequalis Roman an Mazerin

Plate 6, figure 5, 9, 11, 12.

1928. Scaphites sp. aff. aequalis Adkins, Univ. Tex. Bull. 2838, p. 258.

Remarks: This species is very abundant in the middle of The Britton marly clay. It differs from the typical S. aequalis in being slightly smaller and in having finer and more numerous ribs. The species in question is close coiled in the early portion, and the uncoiled part is very short. Length 17 mm; thickness 10 mm.

Horizon: Middle Britton member.

Locality: Three miles northwest of Midlothian.

Figured specimens: Bureau of Economic Geology.

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Explanation of Plates

Plate 1

Figs. 1, 3. *Inoceramus capulus* Shumard, 1, posterior view of neololotype, natural size; 2, lateral view of neoholotype, natural size.

2, 4. *Inoceramus dimidius* White, natural size.

5. *Inoceramus fragilis* Hall and Meek, natural size.

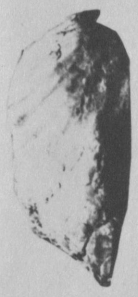
6. *Inoceramus labiatus* Schlotheim, natural size.

7. *Inoceramus dallasensis* Moreman, n. sp., holotype natural size.

8. *Inoceramus carroltonensis* Moreman, n. sp., holotype natural size.

PLATE 1

1



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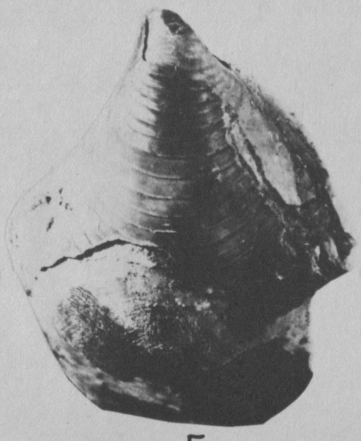

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Plate 2

Figs. 1, 5. *Metoicoceras whitei* Hyatt.

2, 3. *Tapes hilgardi* Shumard.

4. *Gervillea gregaria* Shumard.

6. *Baculites gracilis* Shumard.

7, 8. *Meretrix gibbosum* Moreman n. sp.

9. *Cyprimeria excavata* Morton.

10, 11. *Metacalycoceras indianensis* Moreman n. sp.

12. *Alectryonia lugubris* (Conrad)

(All natural size)

PLATE 2

Plate 3

Figs. 1. *Epengonoceras planum* Hyatt.

2, 5. *Pachydiscus scotti* Moreman n. sp.

3, 4. *Metoicoceras ornatum* Moreman n. sp.

6, 7. *Metoicoceras irwini* Moreman.

8. *Metoicoceras whitei* Hyatt.

PLATE 3

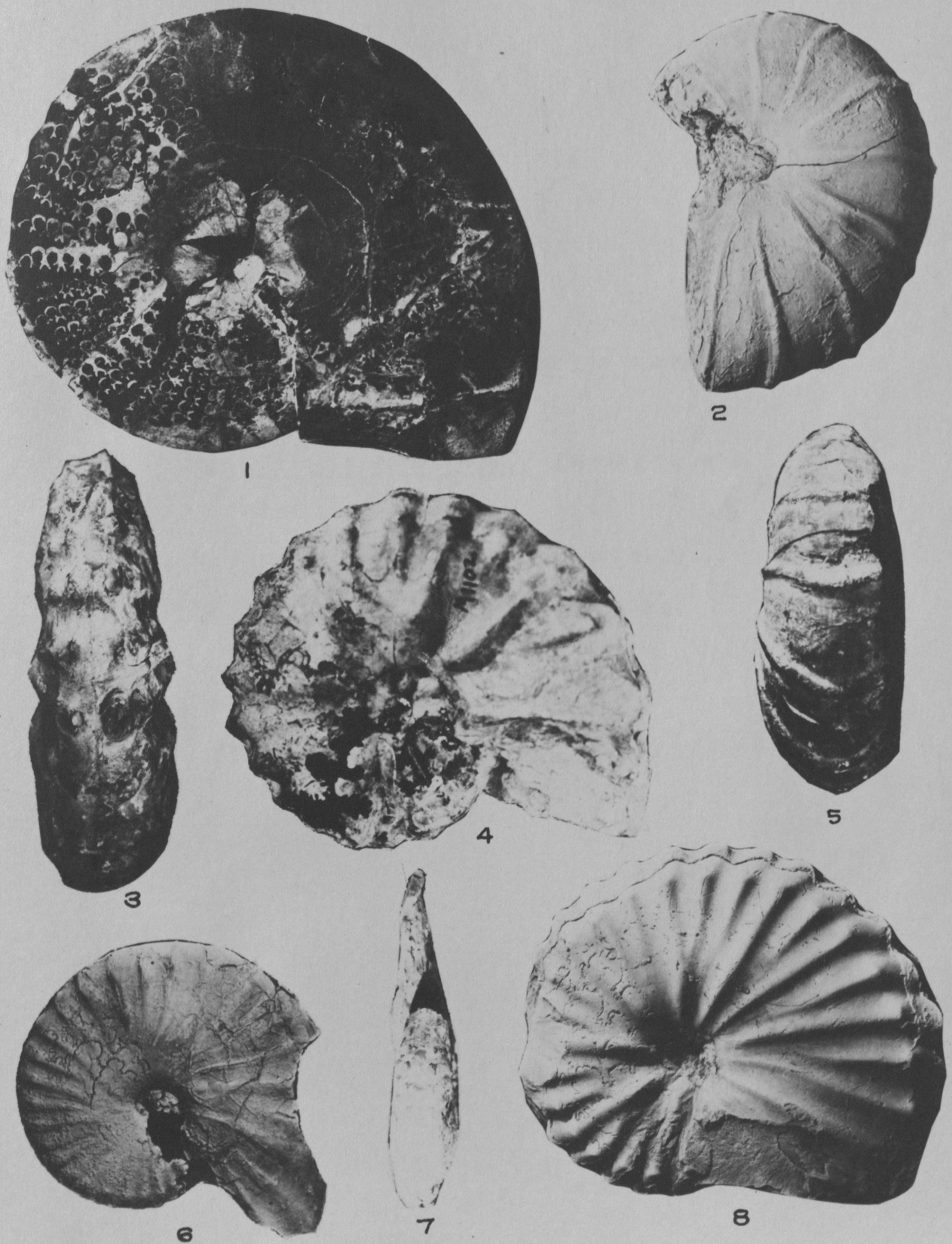


Plate 4

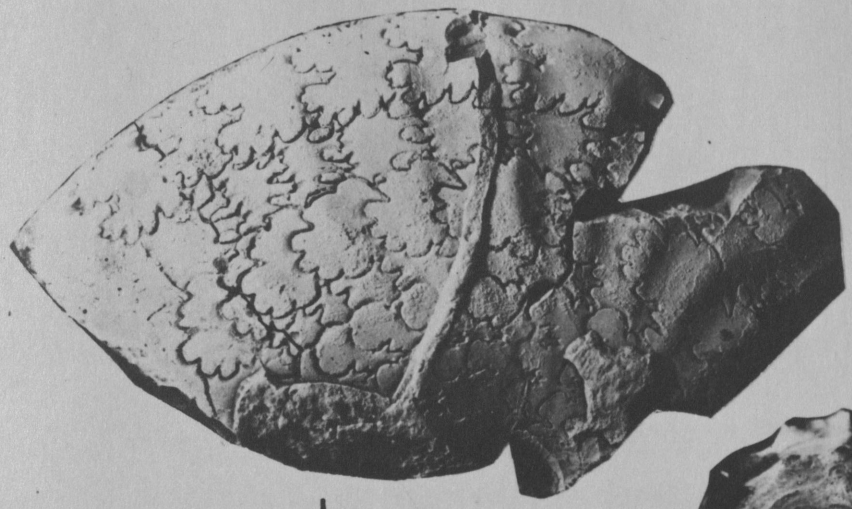
Figs. 1, 4. *Hemitissotia eaglefordensis* Moreman n. sp., holotype.

2. *Allocrioceras texana* Moreman n. sp., holotype.

3, 5. *Kanabiceras boharti* Moreman n. sp., holotype

6. *Kanabiceras kanabense* (Stanton)

PLATE 4



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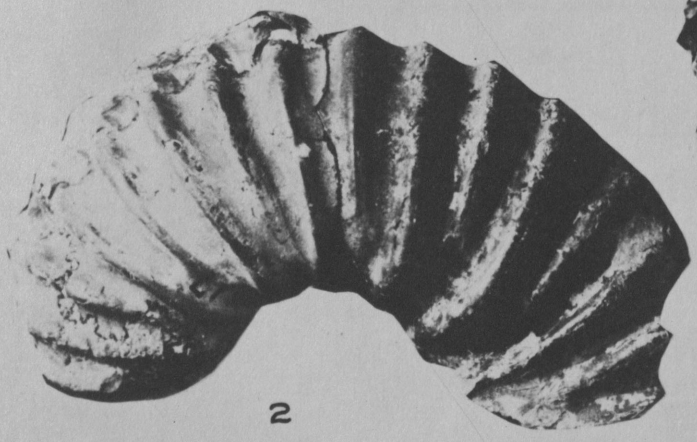

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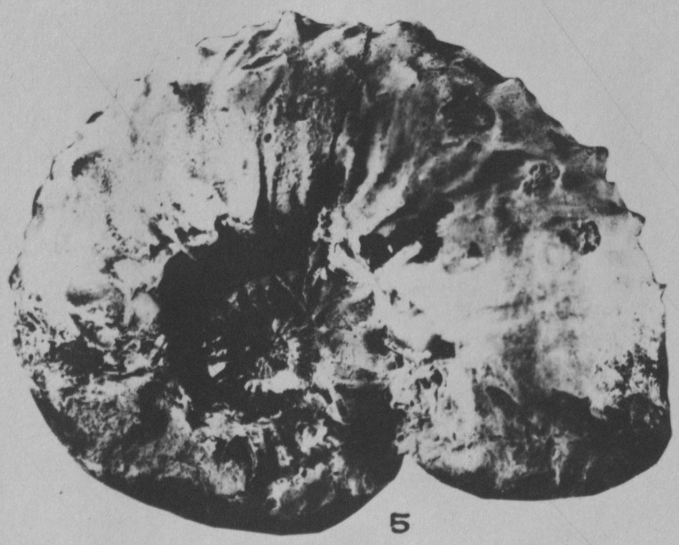

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Plate 5

Figs. 1. Metoicoceras gibbosum Hyatt.

2. Epengonoceras dumblei (Cragin).

3. Prionotropis graysonensis (Shumard), neoholotype.

4. Metacalycoceras tarrantense Adkins.

5, 7. Meretrix lamarensis (Shumard).

6, 8. Metoicoceras planum Moreman n. sp., holotype.

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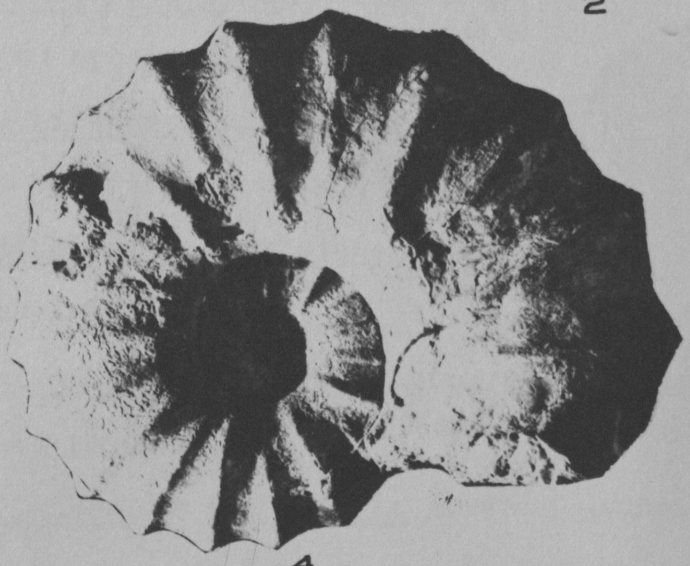

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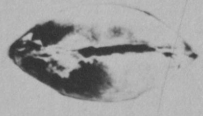

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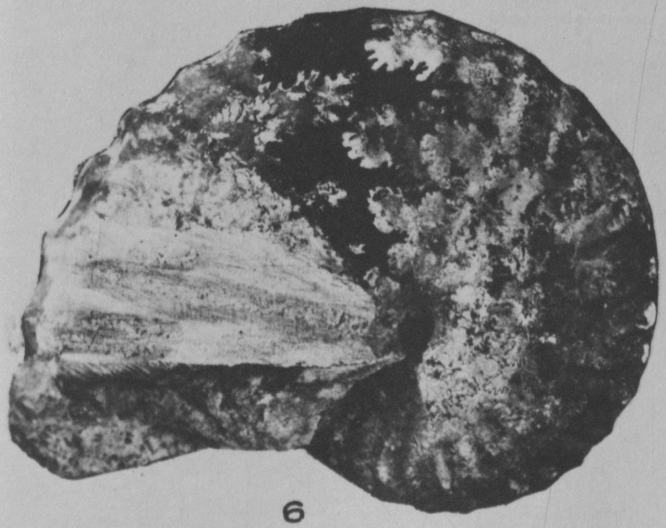

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Plate 6

Figs. 1, 6. *Scaphites texanus* Roemer. X 2.

3, 4. *Scaphites vermiculus* Shumard, neoholotype, X 2.

2, 10. *Scaphites vermiculus* Shumard, larger specimen, X 2.

5, 9, 11, 12. *Scaphites* sp. aff. *aequalis* Roman and Mazerine. X 2.

13. *Prionotropis graysonensis* Shumard, neoholotype X 2.

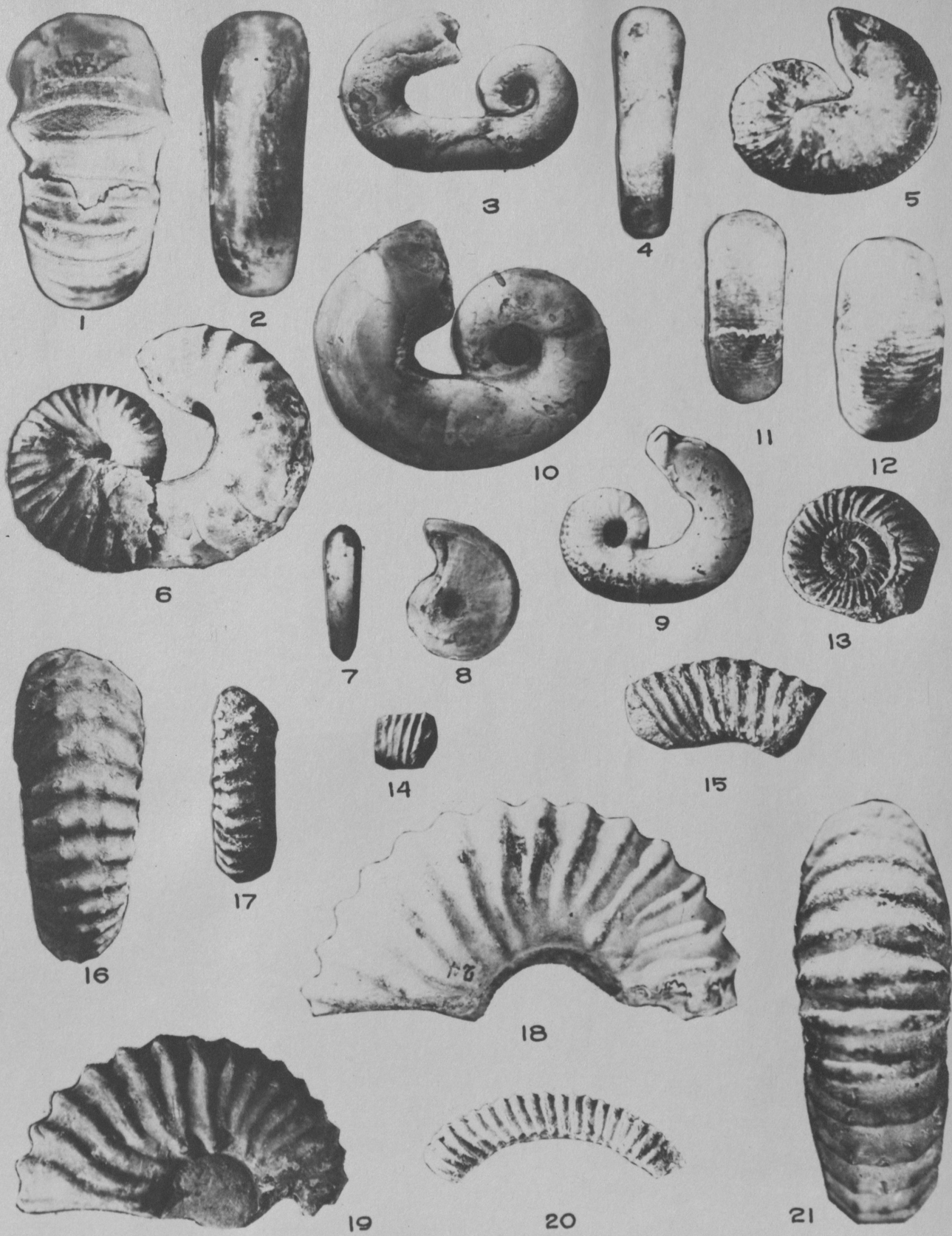
14. *Hamites eaglefordensis* Moreman n. sp. Holotype X 2.

15, 17. *Exiteloceras dentonensis* Moreman n. sp., holotype natural size.

16, 19. *Eucalycoceras brittonensis* Moreman n. sp., holotype natural size.

20. *Exiteloceras pariense* (White).

18, 21. *Metacalycoceras tuberculata* Moreman n. sp., holotype natural size.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