THE EAGLE FORD FORMATION

Approved:

F. L. Whitney

E. H. Sellards

J. E. Pearce

Approved:

Henry D. W. Harper
Dean of the Graduate School

May 26, 1928.

THIS IS AN ORIGINAL MANUSCRIPT
IT MAY NOT BE COPIED WITHOUT
THE AUTHOR'S PERMISSION

THE EAGLE FORD FORMATION

THESIS

Presented to the Faculty of the Graduate School
of The University of Texas in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF ARTS

by

Millard Boston Arick
Austin, Texas

June, 1928

PREFACE

The writer wishes to express his indebtedness to Professor F. L. Whitney, who suggested the problem, and under whose supervision this problem has been worked, for his advice, help, interest, and his company in the field.

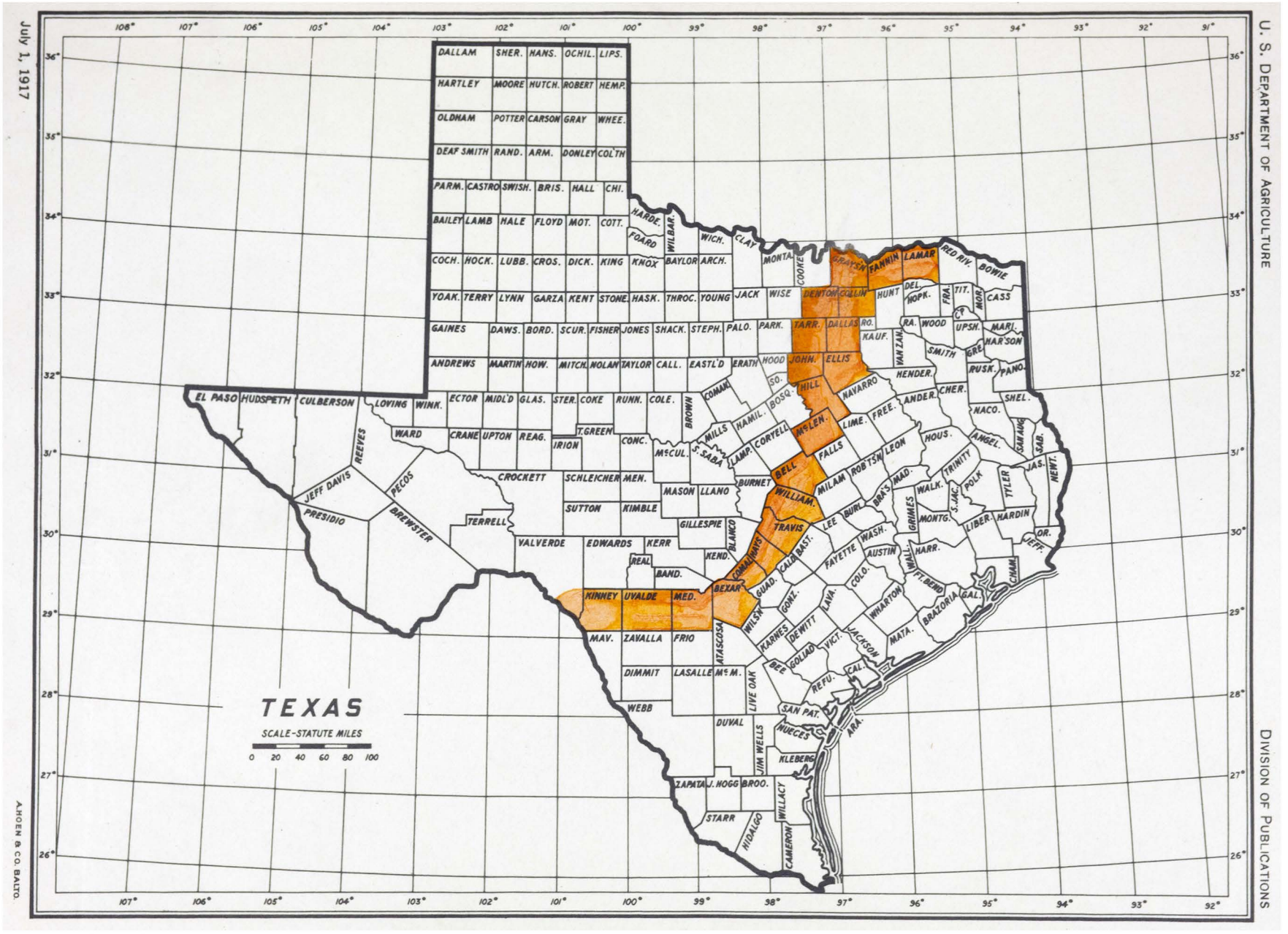
The writer wishes to extend thanks to Dr. T. W. Stanton, Dr. J. B. Reeside, Dr. C. W. Gilmore and Dr. T. S. Gidley of the U. S. National Museum for identification of fossils.

To Dr. E. H. Sellards, Mr. W. S. Adkins, and Dr. J. A. Udden of the Bureau of Economic Geology the writer wishes to make acknowledgement for valuable suggestions and access to certain literature not available elsewhere.

Especial acknowledgement is due Mr. W. B. McCarter for his company in the field and his aid in the preparation of photographs, collecting of fossils and in interpreting the evidence found in the lower part of the formation from Aquilla southward.

Many of the descriptions and sections in this paper have been taken from published reports on this formation and the writer wishes to give due credit to these authors. This material was taken from the published works of Messrs. W. S. Adkins, W. M. Winton, W. L. Moreman, R. T. Hill, L. W. Stephenson, Gayle Scott, R. A. Liddle, E. H. Sellards, and Emil Böse.

TABLE OF CONTENTS



Area of the Eagle Ford out crop in Texas

THE EAGLE FORD FORMATION OF TEXAS

Introduction

The Eagle Ford formation at Austin has been studied considerably in the past and also has been studied in considerable detail in the North Texas area. Although both areas have been worked extensively a reliable correlation of the two localities, and also the intervening areas is lacking.

In practically every case it is difficult to correlate widely separated areas. It has been well established that in such distances as two and three hundred miles formations may entirely change in lithology. The Eagle Ford, however, preserves its peculiar lithology over widely separated areas, and its lithology has been given due consideration in the working out of this problem. Certain physical phenomena in the formation have also been noted and given the importance that they seem to deserve.

General Discussion of the Eagle Ford

The Eagle Ford formation was so named by R.

T. Hill[1] from its type section near the town of Eagle Ford about five miles west of Dallas, in Dallas County, Texas. It lies conformably upon the Woodbine formation of North Texas, and unconformably upon the Del Rio formation in Central Texas and the Buda limestone of Central and South Texas. The formation attains its maximum thickness in Fannin and Grayson counties of North Texas, where it seems to have been deposited in a synclinal trough in the floor of the Eagle Ford sea. From this area southward the formation is reduced by gradual thinning to a point somewhere between San Antonio and Medina. West of this point the formation thickens, becomes more calcareous, so that in Kinney and Val Verde counties it is predominantly a marly and chalky limestone formation.

Age of Eagle Ford Formation

The Eagle Ford formation belongs to the Gulf

[1]Hill, R. T.: U.S. Geol. Surv., Twenty-first Ann. Rept., 1901, p. 323. The Geology of the Black and Grand Prairies.

Series of the Upper Cretaceous of Texas. In age these beds are identical with the lower part of the Colorado Formation of Stanton; the Benton of the Meek and Hayden section of the Western interior; the Boquillas Flags of Southwest Texas; the Benton of Mexico cited by Baker; the upper part of the Tuscaloosa Formation of Alabama; (Eutaw); the upper Cenomanian and the Turonian of the British Isles, Europe, Africa and Asia.

General Character and Lithologic Composition

The Eagle Ford is essentially a bituminous clay formation, carrying in the middle member thin sandy limestone flags from one-half to six inches in thickness. In extreme north Texas the transition from the underlying Woodbine sand appears to be gradual and in places the basal part of the formation is sandy. The Eagle Ford, however, preserves a similar lithology over remarkably long distances and can be subdivided into three members: (a) a basal shale member; (b) a middle flaggy and sandy member, and (c) an upper shale member. Concretions are present throughout, occuring in large numbers in the middle and upper members of the formation. From the type locality north these are often abundant,

and of such a large size that they have often proved obstacles in well drilling. In the upper member of the formation these concretions are often septarian in character.

General Occurence

The Eagle Ford formation occurs in an east-west belt in the Red river counties. This belt extends from the Eastern side of Grayson County to the Eastern side of Lamar County. This exposure is due to the influence of the Preston anticline. In Grayson County the area of outcrop turns south and extends intermittently in a north-south direction roughly following the line of the Balcones fault zone to the vicinity of San Antonio, Bexar County. From San Antonio, the outcrop, still following the Balcones fault zone, turns southwest and continues in this direction until it reaches the Rio Grande at the junction of Kinney and Val Verde counties with the Rio Grande.

The formation has its greatest development in the northern part of the state where the thickness is estimated at five hundred feet. The formation gradually decreases in thickness southward, measuring only forty two feet at Austin, and only thirty-five

at San Antonio, whence the formation thickens again southwesterly, reaching a thickness of about three hundred feet where it crosses the Rio Grande. These beds are everywhere in contact above with the white limestones of the Austin Chalk, into which they pass conformably in extreme north Texas and along the Rio Grande but rather abruptly in the intervening areas.

The Eagle Ford sea contained a profusion of life; the formation almost everywhere carrying an abundance of fossil remains. Numerous pelecypods of the Inoceramus and Ostrea types are present; cephalopod remains are frequently encountered and fish remains such as teeth, Copralites and scales are abundant. (See plate 2). In some places these fish remains occur in a thin layer in such profusion that this layer has been called the "fish bed" or "fish bed conglomerate."

This formation also carries several layers of bentonite interstratified with the shales and flags. Selenite has been noted at several localities, being particularly abundant in Grayson and Collin counties where the beds have their greatest development. Phosphate nodules are scattered throughout the formation and in the so-called "fish bed conglomerate"

these nodules are especially abundant. (See plate 2).

North Texas Area

In North Texas the Eagle Ford is predominantly a shale formation and here the division into three members representing the basal, middle and upper parts of the formation is not sharply differentiated. The middle member is more arenaceous and contains sandy limestone flags, but these flags are in the form of lentils and are not continuous. The formation conformably overlies the Woodbine and the contact is not sharply differentiated. The contact here was arbitrarily established by R. T. Hill[2] as occuring where the Ostrea soleniscus Meek horizon of the Woodbine sand comes into contact with the Exogyra columbella Meek horizon. In Grayson, Collin, Denton, Tarrant and Dallas counties, the Eagle Ford has its greatest development, preserving a similar lithology over this area. In Grayson County the members show the following sequence: near the contact with the Woodbine the lower member is composed of very thinly laminated deep-blue to black shales with an occasional thin layer of sand, passing upward into purer clays

[2]Hill, R. T.: U. S. Geol. Surv., Twenty-first Ann. Rept., 1901, p. 310. The Geology of the Black and Grand Prairies.

with some calcareous and ferruginous clay concretions. No limestone is known from this lower member in this area except that found in these concretions (See plate 3) which sometimes have such a regular horizontal distribution as to suggest a layer. These concretions are sometimes flattened, evidently by the pressure of the overlying beds, and are of varying size. This lower member in its basal portion carries fossils of upper Cenomanian age. The upper part of the member however has Inoceramus labiatus, a typical Turonian fossil. This clay is usually laminated and hard. In places it is thoroughly impregnated with selenite. At one locality, three and one half miles north of Sherman on the old Denison-Sherman pike, selenite is present in thin horizontal layers; the clay between these thin layers being reticulated with this mineral.

The middle member of the formation in these counties is characterized by thin arenaceous flags. In this area these flags while forming a fairly persistent horizon are not in themselves persistent. Where they can be traced for any distance they are usually found to be lenses. These flags are well exposed in southwest Grayson County on Mustang Creek near the Denton County line and also in Denton County on the same creek. These flaggy layers are usually taken as the base of the middle member. Above

the flags there is a considerable thickness of black shale which contains a large number of well preserved fossils, that still retain their original nacreous coating. This horizon is marked by the presence of Bacculites. A further marker that serves to distinguish this section of the formation is the presence of large, round, and sometimes flattened septaria, some of which are over three feet across.

The upper member of this formation is slightly arenaceous and, like the middle member, contains flags of sandy limestone. These flags are characterized by the presence of numerous fish scales, fish teeth, and reworked pelecypod shells. These layers suggest an emerging condition, having been laid down in a shallow sea. There are numerous Ostrea lugubris remains in this member; (See plate 4) this distinctive little oyster being confined to the upper part of the formation. In Grayson County there is a shell conglomerate formed of these oysters. This conglomeratic layer thins to the south and is not present at Dallas, Texas. In the exposure of the Austin-Eagle Ford contact at White Rock Cuesta on the Dallas-Fort Worth Pike (see plate 5) this conglomerate is absent, the O. lugubris here being reworked, some specimens appearing in the

bottom layer of the Austin. In this section also the upper clayey phase present in Grayson County is absent. A section measured by Shuler[3] at the type locality illustrates this change.

SECTION AT HARRY'S BRICK PLANT, WEST DALLAS

	Feet
Austin Chalk	
Chalk, deeply weathered and yellow in color	10
Eagle Ford Shale	
Shale, laminated, bluish gray, occasional sandy and pyritiferous laminae	20
Shale, with large lime concretions, up to four feet in diameter, with numerous fossils	2
Shale, bluish gray to gray, laminated .	11
Shale and sandstone, alternating slabby layers with occasional concretions	3
Shale, gray, laminated, uniform in texture	14

In the Grayson section, also, the upper part of the formation is lighter colored and more argillaceous than farther south as shown by the following section measured on Post Oak Creek two miles east of Sherman, Texas.

[3]Shuler, E. W.: "The Geology of Dallas County," Univ. of Texas Bull. No. 1818, 1918, p. 15.

SECTION IN UPPER EAGLE FORD BETWEEN BASE OF FISH-BED CONGLOMERATE AND BASE OF AUSTIN CHALK

	Feet
(a) Shell breccia cemented with calcium carbonate and slightly arenaceous. Fossils: Ostrea lugubris; Ostrea sp.	2.0
(b) A layer of soft, argillaceous, ferriginous sand interstratified with thin layers of ferriginous clay. Color: brownish to light yellow; moss covered in places	2.5
(c) Shell breccia similar to (a) with fucoids (?) irregularly diffused throughout formation. Fossils: Ostrea sp.; Ostrea lugubris	1.0
(d) Dark ferruginous, argillaceous sand containing concretions of calcite with small pebble forming the center of concretion	3.25
(e) Light blue to yellow clay with thin veins of ferruginous clay which grades into a light yellow marl about five feet from base of formation. This formation probably contains veins of chalk in the upper six to eight feet.	18.25
Total	27.0

This is further illustrated by a section measured by Hill[4] in the same vicinity.

Section at Sherman, Grayson County, 2 miles west of Binkley House, Texas (after Hill)

7. Austin chalk

[4]Hill, R. T.: Twenty-first Ann. Rept. U.S.G.S., p. 326.

Eagle Ford shale; Feet

6. Sandy clay shales with Ostrea lugubris.. 10

5. Thin slabs of brown sandstone with small rounded conglomerate of jasper pebble (Phosphate nodules ?) Ostrea lugubris and fish teeth 5

4. Blue laminated clay, weathering into limonitic colors 10

3. Massive agglomerate of Ostrea lugubris.. 16

2. Sandy clay shale in thin alternations of clay and sand; clay efflorescent and drab-colored on drying, Ostrea lugubris. 40

1. Blue clays with gigantic septaria ..

This clayey phase of the upper member in Grayson and Fannin counties is due to the proximity of this section to the land mass from which the sediments were derived. There is abundant evidence that southern Oklahoma, southwestern Arkansas and western Louisiana existed as a land mass during Eagle Ford time. The alternating arenaceous and argillaceous layers noted in the above sections are interpreted as evidence of oscillation of this land mass. Further evidence of this is seen in the lens-like nature of the sand layers in this portion of the formation.

A comparison of the two sections taking into account the transitional nature of the Grayson County section, and the disconformable contact of the type section makes it appear that at least fifty feet of the upper member of the formation is absent at the type section.

In the area between Dallas and Fort Worth the contact with the underlying Woodbine does not exhibit the transitional character of the Grayson County beds. This contact is excellently exposed along the Rock Island R.R. at a point near the Dallas-Tarrant County line east of Tarrant Station. Here the uppermost Woodbine is a sandstone ledge which contains numerous fossils. This ledge is overlain by the blue shales of the Eagle Ford, the bottom stratum of which contains Acanthoceras sp.

These phenomena, i.e. the absence of any transition beds at the Woodbine-Eagle Ford contact, the absence of the typical Ostrea lugubris at the Eagle Ford-Austin contact, together with the thinness of the section in this area compared with the Grayson County area may mean that either the Woodbine underwent erosion before deposition of the Eagle Ford and that the latter formation had at least fifty feet removed by erosion before the deposition of the

Austin; or that the seas at this point were so shallow that no deposition took place due to wave action and that these phenomena simply represent diastems. The contact is so abrupt, however, that the writer believes that the disconformities are due to erosion.

Central Texas Area

This area embraces the Eagle Ford formation as it is exposed in the following counties: Johnson, Hill, McLennan, Bell, Williamson, Travis, Hays, Comal, Guadalupe and Bexar. Beginning at the northern part of this area where the formation is estimated from surface exposures and well logs to be three hundred feet in thickness the formation gradually thins to the south, being one hundred and eighty feet at Waco, one hundred and twenty feet at Belton, forty-two feet at Austin and thirty-five feet at San Antonio. Despite this thinning the formation preserves its lithology in a general way. The bottom member, where ever it can be observed on a fresh exposure or in a stream bed, consists of blue-black shale to the vicinity of Austin in Travis County. At least three notable exceptions are found in Johnson County, along the Hillsboro-Fort Worth road. This road crosses the Eagle Ford-Woodbine contact at a

number of places near Grand View and in this vicinity the lower Eagle Ford is composed of arenaceous light colored shales. West of Grand View on the Grand View-Cleburne road the same conditions are noted, as the following section will illustrate:[5]

SECTION ON GRANDVIEW-CLEBURNE ROAD, ONE MILE WEST OF GRAND VIEW. SECTION TAKEN ALONG NORTH SIDE OF ROAD

Eagle Ford:	Feet
Light-colored shales, compressed, laminated ...	10
Pale yellow and white sandy clays containing thin ledges of sandstone and many white rounded concretions	5
Soft yellow sandy shale	26

It should be noted that locally this bottom member, in a number of places, contains sand or sandstone layers of varying thickness, but none over fifteen inches. South of Austin between Austin and the Blanco river this shale gives way to yellow clay, which contains small lime concretions. The lower member continues as clay to a point beyond San Marcos, but it changes in character south of this town and becomes more calcareous. In Bexar County the lithology of the bottom

[5]Winton, W. M. and Scott, Gayle: The Geology of Johnson County. Univ. of Texas Bull. No. 2229, p. 32.

member is the same as the upper members and it can not be differentiated.

The middle flag member persists as a definite horizon throughout this area, becoming more sharply defined near the vicinity of the Brazos where it reaches a thickness of twenty-one feet on the South Bosque escarpment where this member is well exposed. The following section was measured along this escarpment:

EAGLE FORD FORMATION IN BRICK YARD PIT SOUTHEAST OF ST. LOUIS AND SOUTHWESTERN RAILWAY, AND ABOUT ONE MILE EAST OF SOUTH BOSQUE STATION

	Feet
EagleFord (Middle Flag Member):	
Slate-colored shale, weathering light brownish-yellow	6.0
Very calcareous sandstone	0.2
Shale	1.0
Calcareous sandstone	0.3
Slate-colored laminated shale	2.0
Calcareous sandstone	0.25
Slate-colored laminated shale	1.8
Indurated grayish shale	0.35
Laminated shale, thin bentonite seam at base	3.4
Calcareous sandstone	0.3
Laminated, slate-colored shale, with thin bentonite seams	1.9
Calcareous sandstone	0.35
Laminated slate-colored shale with bentonite seams	0.5
Hard gray calcareous sandstone	0.3

[6]Adkins, W. S.: "Geology and Mineral Resources of McLennan County," Univ. of Texas Bull. No. 2340, 1923, p. 73.

Basal Shale Member:	Feet
Blue, thinly laminated shale	15.0
Very calcareous sandstone	0.15
Blue laminated shale, exposed	12.0

Locally included in this middle member, both above and below the flags are found thin seams of sandstone and sandy limestone. These flags have shale partings in almost all cases, the exceptions being where the partings are bentonitic, notably in the Austin section.

What was said of the lower member holds equally true for the upper one. In the northern part of this area this upper member consists of thinly laminated black shale about one hundred feet in thickness, as illustrated by the following section of the top of the Eagle Ford:[7]

Section of Upper and Middle Eagle Ford on Bosque Escarpment near the Fish Pond about 4 miles south of west of Waco. (Prather, 1902)

Austin:	Feet
Limestone	60
Eagle Ford (Upper Shale):	
Marl of clay-yellow color, with gypsum, selenite crystals and limonite. Fossils: Inoceramus, etc.	107

[7] Adkins, W. S.: "Geology and Mineral Resources of McLennan County," Univ. of Texas Bull. No. 2340, 1923, p. 71

(Middle Flags):	
Argillaceous limestone	2
Marl	4
Argillaceous limestone	1
Marl	3
Argillaceous limestone, in bands	2
Marl	15
Argillaceous limestone; Inoceramus, Ostrea	6
Total EagleFord	140

This shale facies persists to some point south of the southern line of Travis County, but somewhere between that point and the Blanco river section in Hays County the upper shale changes to a yellowish sandy shale with some thin sand-stone layers. At San Marcos the upper shale is eroded, but in Bexar County on the Blanco road this upper member can scarcely be distinguished from the middle one. There the upper member is represented by thin limestone flags with marl partings.

Southwest Texas Area

This area comprises the counties of Medina, Uvalde, Kinney and Val Verde. The writer did not have the opportunity to examine this area in detail and the facts herein noted are taken from the works of Hill[8]

[8]Hill, R. T.: "The Geology of the Black and Grand Prairies," Twenty-first Ann. Rept. U. S. G. S., pp. 323-328.

Vaughan,[9] Liddle,[10] and Böse.[11-12]

Passing westward from San Antonio, the Eagle Ford is exposed in the Balcones fault area. In this region the formation is not lithologically divisable into upper, middle, and lower members, as the formation preserves an almost identical lithology throughout. Arenaceous limestone flags are separated by sand shale partings throughout the formation. These shale partings are slightly argillaceous in the bottom portion, passing upward into calcareous shales in the top of the formation. In Medina County the formation averages about thirty-five feet in thickness,[13] but on passing westward into Uvalde County the formation begins to thicken rapidly[14] and continues to thicken beyond the Rio Grande in Mexico.[15] At Brackettville in Kinney County, Hill[16] estimates that the formation has a thickness of two hundred and fifty feet and

[9]Vaughan, T.W.: "Uvalde Quadrangle." Folio No. 64, U.S.G.S. pp.2.

[10]Liddle, R.A.: "The Geology of Medina County", Univ. of Texas Bull. #1860, pp. 43-45.

[11]Böse, Emil, and Cavins, O.A.: "The Cretaceous and Tertiary of Southern Texas and Northern Mexico." Univ. of Texas Bull. No. 2748, pp. 28-31.

[12]Böse, Emil, Udden, J.A. and Baker, C.L.: "Review of the Geol. of Texas," Univ. of Texas Bull. No. 44, pp. 79-80.

[13]Ibid., p. 44.

where it crosses the Rio Grande in Val Verde and Kinney Counties the thickness is estimated to be in excess of three hundred feet. In Kinney County the formation is disconformable on the Buda but grades conformably into the Austin Chalk. The top of the section here is a chalk limestone that can only be distinguished paleontologically from the Austin.

Macro-paleontology of the Eagle Ford Formation

Contrary to the popular notion prevailing among geologists, the Eagle Ford carries a rich and varied fauna of both vertebrates and invertebrates.

The basal member of the formation is a fossiliferous zone which is immediately overlain by a more or less barren zone; this in turn being overlain by the middle flag member which is profusely fossiliferous. The upper shale member also carries an abundant fauna. The lower part of the basal member of the formation has fossils with a Cenomanian aspect, but the upper part of the basal member in North Texas along with all of the overlying beds, of the formation is Turonian in age.

[14]Böse, Emil, Udden, J.A. and Baker, C.L.: "Review of the Geol. of Texas," Univ.of Texas Bull. No. 44, pp. 79-80.

[15]Ibid, p. 80

[16]Ibid, p. 324.

List of Fossils

Molluscoidea

Plicatula sp. ind.

Lingula sp. ind.

Mollusca

Ostrea lugubris, Conrad (Same as O. belliplicata, Shumard)

Ostrea congesta, Conrad

Ostrea blackii, White

Ostrea sp. ind.

Ostrea sp. ind

Ostrea alifera Cragin

Exogyra columbella, Cragin

Exogyra aff laeviuscula (?) Roemer

Mactridea

Mactra, sp. ind.

Aviculidae

Avicula planiscula, Roemer

Gervilliopsis invaginata (?) White

Inoceramus confertim-annulatus, Roemer

Inoceramus mytiloides, Mantell

Inoceramus mytilopsis, Conrad

Inoceramus problematicus (?) Schlotheim

Inoceramus fragilis, Hall and Meek

Inoceramus labiatus, Schlotheim

Nuculidae

Nucula bellastriata, Shumard

Nucula haydeni, Shumard

Trigonidae

Trigonia aliformis, Goldfuss

Astartidae

Astarte lineolata, Roemer

Lucinadae

Lucina sublenticularis, Shumard

Lucina sp. ind.

Cardidae

Cardium choctawense, Shumard

Veneridae

Cyprineria Crassa, Meek

Tellinidae.

Tellina sp. ind.

Myidae

Corbula tuomeyi

Corbula sp. aff tuomeyi (?)

Vermetidae

Serpula plana, Conrad

Turritellidae

Turritella sp. ind

Aporrhaidae

Anchura ruida (?) White

Mautelliceras(?)(Eucalycoceras) aff Couloni d'Orbigny

Mautelliceras(?) (Eucalycoceras) sp.

Acanthoceras swallovii, Shumard

Acanthoceras n. sp.

Acanthoceras aff turneri White

Acanthoceras n. sp.

Acanthoceras/cfr. Cunningtoni Var Cornutum Kossmat

Prionotropis aff. woolgari, Mantell

Prionotropis sp.

Prionotropis n. sp.

Prionotropis n. sp

Prionocylus n. sp.

Metoicoceras whitei, Hyatt

Metoicoceras irwini, Moreman

Metoicoceras gibbosum (?)

Helicoceras pariense, White

Engonoceras planum, Hyatt

Placenticeras pseudoplacenta Hyatt

Placenticeras pseudoplacenta, var occidentale, Hyatt

Baculites gracilis, Shumard

Scaphites vermiformis, Meek

Scaphites texanus, Roemer

Acanthoceras (?) knabense, Stanton (This is a new genus, and should be named, as it is clearly not an Acanthoceras)

Turrilites aff desnoyers d'Orbigny

Turrilites aff tuberculatus d'Orbigny

Turrilites n. sp.

Large "cart-wheel" ammonites reported from Johnson and McLennan counties, near Austin, Travis County and near Brackett, County, Texas.

Schloenbachia n. sp.

Mortoniceras n. sp.

Pachydiscus n. sp.

Adkinsia sp.

Baculites sp.

Ptychoceras sp.

Hamulina(?) sp.

Lytoceras (?) sp.

Hamites sp.

Vertebrates

Pisces

Ptychodus whipplei, Marcou

Ptychodus whipplei, Marcou var. (?)

Portheus n. sp.

J. K. Prather[17] recognized the following species:*

*Clidates

*Ichthyodectes

*Protosphyraena penetrans

*Oxyrhina extenta

*Xiphactinus audax

*Squalodonts

*Cestracidont sharks

Pycnodus commimiens Hay

Typodus valens Hay

Holcolepis pulchellus Cockrell

Many other genera and species as yet unnamed are also found here. Fish remains are abundant throughout the formation.

Reptilia:

Mososaurus

Plesiosaurus

Cimoliasaurus (?)

Flora:

Wood fragments are common throughout the formation, At Austin, Travis County, at the Bouldin Creek locality a tree has been preserved. So far as known no flora has been described from the Eagle Ford.

[17]Prather, J.K.: Trans. Texas Acad. Sci. IV, 1901, 85-87.

Microscopic fauna:

Globigerina cretacea, d'Orbigny

Globigerina dubia, Egger

Globotruncana arca, Cushman

Guembelina globulosa, Ehrenberg

Robulus cultratas, Montfort

Quinqueloculina stelligera, Schlumberger

Verneuiliana sp.

Frondicularia alata d'Orbigny

Frondicularia hebronensis, Moreman

Vaginulina simondsi, Carsey

Vaginulina webbervillensis, Carsey

Anomalina Eaglefordensis, Moreman

Anomalina sp.

Nodosaria communis d'Orbigny

Gaudryina filiformis, Berthelin.

Ostracoda:

Cytherella Muensteri, Roemer
Bairdia subdeltoidea, Munster
Cythereis Ornatissima, Reuss
} Synonyms

Conodont teeth, bryozoa, sponge spicules, small fish teeth and *Inoceramus* prisms are also found in microscopic samples.

Fossil Zones

Attempts have been made to establish fossil zones in the Eagle Ford, of which Moreman[18] cites six and Scott[19] three. While it is possible to establish fossil zones, the writer does not believe that these zones are practicable for long distance correlation in the Eagle Ford formation. Due to erosion and diastems within the formation, some of these fossils have been destroyed if they were ever present and others never existed in certain regions. In a general way certain fossils can be used for markers. For example, Ostrea lugubris and O. alifera when present mark the upper part of the formation. Prionotropis or Prionocyclus marks the middle. Innoceramus labiatus marks the Turonian portion and Acanthoceras marks the lower Cenomanian part of the formation.

Bentonite

The Eagle Ford formation contains several distinct bentonitic layers which are continuous over large areas. In North Texas where the formation is

[18]Moreman, W.L.: "Fossil Zones in the Eagle Ford of North Texas", Journ. of Palentology, Vol. I, No. 1, pp. 89-101.

[19]Scott, Gayle: "Etudes Stratigrahique et Paleontologique sur les Terrains cretaces du Texas." These Doctorat, Grenoble, 1925, pp. 48.

thick the number of bentonitic layers is not known. At Austin, in Travis County, there are eight such layers, one of which is six inches in thickness. At San Marcos in the flag member above the basal clay there are six such layers as illustrated by the following section measured by Professor F. L. Whitney.

Section of basal Eagle Ford at Southwest Entrance of Cemetery one and one-half miles southwest of San Marcos.

a. Yellow clay with small lime nodules .....8'

b. Flags 3/4" to 2 1/2" with yellow sandy shale partings, containing bentonitic layers .....6'.5"

Buda limestone

First Bentonite layer was on top of clay.

Second Bentonite layer was 20" above top of clay.

Third Bentonite layer was 31" above top of clay.

Fourth Bentonite layer was 45" above top of clay.

Fifth Bentonite layer was 57" above top of clay.

Sixth Bentonite layer was 64" above top of clay.

The top of the formation, however, is eroded in the San Marcos section and it is possible that two of the eight layers noted at Austin have been carried away. These bentonitic layers have been used

for correlation purposes, but it seems to the writer that they could only locally be used for reliable correlation. Such layers are widespread, having been reported from the Boquillas Flags of Udden [20] and from the Turonian of Mexico.[21]

Cause of the Variation in Thickness of the Eagle Ford Formation

As has been noted, the Eagle Ford reaches its maximum thickness in the North Texas area. In this area the formation appears to overlie conformably the Woodbine formation and to be overlain conformably by the Austin. In the upper fifty feet or so of the formation the small fluted oyster, Ostrea lugubris is found. This fossil is not found in the vicinity of Dallas except in the contact zone with the Austin where it is found reworked in the bottom chalk ledge. This indicates that about fifty feet of the formation as known in North Texas is missing at Dallas. This eroded condition of the top of the formation is noted all through Central and South Texas to Kinney County showing that the withdrawal of the sea at the end of Eagle Ford time was general over this area. In the

[20] Udden, J.A., Baker, C.L. and Böse, Emil: "Review of the Geology of Texas", Univ. of Texas Bull. No. 44, p. 85.

[21] Baker, C.L. "Panuco Oil Field", A.A.P.G. Bull. Vol. 12, No. 4, p. 403.

Dallas area the sands of the Woodbine are abruptly over-lain by the shales of the Eagle Ford indicating a disconformity. Both formations thin rapidly to the south and in the northern part of McLennan County the sands of the Woodbine appear to be absent and here the Eagle Ford (?) is in contact with the Del Rio, as seen in the following section:[22]

Section on Eagle Ford Escarpment, 0.2 mile south of iron bridge across Aquilla Creek, 2 miles west of Tokio (Locality 953) (after Adkins)

Eagleford:

	Feet
Blue shale with ironstone concretions	5.0
Sandstone, yellow to red, and gray locally concretionary	0.1
Blue shale	10.0
Platy light yellow sandstone	0.1
Slate-colored lustrous flaky, finely laminated, non-fossiliferous shale	1.5
Coarse platy gray sandstone, sparsely fossiliferous	0.1
Sandstone, gypsiferous, red, soft, iron-stained	0.1

Del Rio:

White to gray chalky, fossiliferous, nodular limestone; high Washita fossils	0.4-0.6
Grayish, light colored, limonite stained, fossiliferous, plastic limy clay interiorly bluish and jointed. Fossils: Exogyra arietina, Gryphaea mucronata, Gryphaea sp., Pecten texanus, Plicatula sp. Nucula sp. Turritella sp., Turrilites sp., exposed in gullies	15.0

[22] Adkins, W.S.: "Geology and Mineral Resources of McLennan County," Univ. of Texas. Bull. 2340, 1923, p. 54.

In Central McLennan County .8 of a mile north of the iron bridge over the South Bosque river near the town of Bosqueville the Eagle Ford is in contact with a sand formation that contains fossils of Woodbine age. This sand formation overlies a two foot ledge of sandy limestone which contains fossils of both Woodbine and Buda age.[23]

Section in Keyes' Branch, Bosqueville, Texas
(after Adkins)

Woodbine (?):	Feet
Sandstone, gray, fossiliferous	0.5
Sandstone, yellow, soft, receding exposure	0.6
Sandstone, yellow, locally red, fossiliferous, harder than preceding, of variable thickness; about	0.3
Sandy shale, yellowish-brown, variable thickness; about	0.5

The foregoing strata have variable bedding; locally are consolidated, or cross-bedded, or contain "cannon-ball" concretions. The strata mainly weather to a dark red-brown color. Fossils: oysters of Woodbine aspect.

Buda:	
Hard crystalline massive limestone variable in color, texture and microscopic appearance; top indurated, mostly red stained, slightly sandy, bedding planes obscure; grading down into chalky, softer fossiliferous limestone below; one ledge thickness variable, maximum seen about	2.5

[23]Adkins, W.S.: "Geology and Mineral Resources of McLennan County," Univ. of Texas. Bull. No. 2340, p. 59.

Top 2 feet is: Hard, obscurely bedded, locally sandy, ironstained limestone, at places sub-oolitic and almost pure lime at other places composed almost entirely of organic debris; coarsely crystalline, blue-gray interiorly, on fresh exposure weathers to brown-yellow with red splotches; local cavities of iron oxides; irregularly shaped circular to triangular, mainly iron-stained inclusions, some of them the casts of various pelecypoda (Protocardia, etc). Fossils: Exogyra arietina (?) Exogyra sp. (a Buda species,) Spondylus hilli (?) Gryphaea mucronata, Pecten (Vola) roemeri, and oysters of Woodbine aspect. Ostrea cf. carica, and others.

Lower 0.5 foot is: Soft, whitish, locally limonite-stained fossiliferous limestone with high Washita fossils: Gryphaea mucronata, Pecten subalpinus, Pecten cf. texanus, Acanthoceras (?) sp., Lima sp., Protocardia vaughani, Plicatula sp., Pyrina (?) sp. This stratum is probably of Del Rio age.

Del Rio:

Clay, bluish, calcareous, weathering yellow-gray; jointed fossiliferous. Fossils: Pecten subalpinus, Pecten texanus, Plicatula sp., Gryphaea mucronata; Protocardia vaughani, Cardita sp., Hemiaster calvini, etc. 0.75

Limestone, white, chalky, limonite stained Fossils: Pecten texanus, Pecten subalpinus, Plicatula sp., Gryphaea mucronata, Gryphaea sp.; the pectens are abundant 1.0

Clay, calcareous; Del Rio fossils 2.0

The writer visited this area to see if he could agree as to the Woodbine and Buda age of the rock. Conditions were found just as described except that no Pecten roemeri could be found. Gryphaea mucronata

was noted and a small Exogyra that somewhat resembled the Exogyra found in the top of the Buda on Bouldin creek. These fossils were stratigraphically lower than the Ostrea carica of Woodbine age but in the same rock. It is hard to say just what is the exact age of this rock. In some respects it appears to be older than Woodbine but younger than Buda. It may represent a time interval between the Woodbine and Buda. At any rate both the Buda and Woodbine appear to be preserved here and this rock seems to represent an erosional remnant. At Axtel in McLennan County twelve feet of Buda is reported in the Shelton well.[24] Here the Eagle Ford appears to be resting on Buda, the Woodbine, if present, not being recognized. This also appears to represent an outlier, the nearest Buda outcrop being at Prairie Dell, sixty eight miles away. From these outcrops to Prairie Dell the Eagle Ford is in contact with the Del Rio.

Eagle Ford-Del Rio contact east of Santa Fe track, 4.5 miles south of McGregor (Locality 966).[25]

Eagle Ford (basal shale): Feet

[24] Adkins, W.S.: "Geology and Mineral Resources of McLennan County," Univ. of Texas Bull. No. 2340, p. 63.

[25] Ibid., p. 57.

Shale, blackish when fresh, blue on exposure. Calcareous flags containing Inoceramus have fallen down the slope of the hill from the Middle Flag Member 22.5

Red, iron-stained oyster breccia; yellow and red incrustations; Ostrea sp. (apparently Upper Cretaceous forms) 0.2

Del Rio:

Light gray calcareous clay; pyrite fossils abundant; Exogyra arietina rare..... 11.5

From Prairie Del south into Mexico the Eagle Ford is in contact with the Buda.[26] According to Whitney[27] and others the Buda has undergone erosion.. The observations of the writer on the surface of the Buda tends to confirm these observations.

The Hartman #1 Warrick Well in Bell County penetrated Pre-Cambrian at 2258 feet; the Georgetown City well in Williamson County penetrated the Pre-Cambrian at 1260 feet; the Camp Bullis Reservation well in Bexar County penetrated the Pre-Cambrian at 1710 feet. This shows an ancient land mass which probably existed during most of geologic time.

According to these observations a structural high existed in the Central Texas area which was

[26]Adkins, W.S., has informed the writer that there are localities in Terrel County where the Eagle Ford is in contact with the Georgetown.

[27]Personal communication.

flanked on both sides by a structural low. This appears to have affected the deposition of the Cretaceous deposits beginning with the Washita.[28] (See Plate 18). This structure appears to have begun to rise at the beginning of Washita time and continued until Eagle Ford time when it reached its culmination. During Eagle Ford time there appears to have been a land mass to the west of the Austin area. This was probably the Central Mineral Region. Fossil ice crystals are found in the region around Austin and have been noted as far south and west as the Shafter Mine in Brewster County,[29] indicating a general emergent condition. Schuchert[30] has shown that in shallow seas a subsurface disconformity can result due to wave action. He calls these subsurface disconformities diastems. The writer suggests that there are several diastems in the Eagle Ford of Central Texas. The Austin section in particular shows abundant evidence in the form of shell breccia, "fish" beds, ice crystals, fossil trees and phosphate nodules, that shallow waters prevailed there. It should be

[28]Thicknesses for the Washita series taken from the Master of Arts Thesis of Robert H. Cuyler, University of Texas, 1927.

[29]Udden, J.A. "Fossil Ice Crystals", University of Texas Bulletin No. 1821.

[30]Schuchert, Charles: "Unconformities as seen in Disconformities and Diastems. (Separate from Amer. Journ. of Science. Vol. XIII, March, 1927).

noted also that fossils which are separated in North Texas by many feet of sediments are present in the same layer or separated by only a few inches of sediments in the Austin region. (See Plate 6) The logical conclusion is that in Central Texas the Eagle Ford is represented by a compressed section; that shallow waters were caused by a rising geanticline, and these shallow waters caused diastems and prevented the deposition of sediments while allowing life to exist. At the end of Eagle Ford time there was a withdrawal of the sea from the Central Texas area and a period of erosion before the deposition of the Austin. Evidence of this is seen in the reworked material at the bottom of the Chalk. Underneath this reworked zone and extending downward into the shale sometimes as far as eighteen inches a number of marine gastropod borings were noted, on the Fort Worth-Dallas pike exposure at White Rock Cuesta, at Brushy Creek near Round Rock in Williamson County, at Watters Park and Bouldin creek in Travis County, and at a contact locality two miles southwest of Kyle in Hays County. These borings were filled with typical chalk material and contained grains of glauconite, a further evidence of disconformity.

Extent of the Eagle Ford

The westward extent of the Eagle Ford in Texas is not known as the formation has been removed west of the Balcones fault. To the east, in North Texas, it extends to the eastern side of Lamar County. To the southeast in Central Texas it is apparently continuous into Louisiana for fossils of Eagle Ford age have been found in a deep well in De Soto Parish.[31] The nearest Eagle Ford known is at Boggy Creek salt dome in Cherokee County where the salt plug has lifted it up 5000 feet above its normal position.[32] The southern extension toward the Gulf is not known as no wells have penetrated through the Tertiary in the Gulf Coast region. On the south it passes into Mexico, loses its distinctive lithology and becomes a limestone formation.

Basal Shale in Central Texas

It has been suggested by R. T. Cannon, Dr. L. W. Stephenson, Professor F. L. Whitney and others

[31] Matson, A. C.: "The De Soto-Red River Oil and Gas field." La. U. S. G. S. Bull. 661, 1917, p. 115.

[32] Renick, B. C.: "Recently discovered Salt Domes in East Texas." A.A.P.G. Bull. Vol. 12, No. 5, May, 1928.

that the basal shales of the Eagle Ford found at Aquilla, Hill County and extending south into Travis County are of Woodbine age. A study of this section to establish or disprove this theory was made on the suggestion of Professor Whitney.

The section at the brickyard near Aquilla in Hill County yielded no microscopic fossils, but the following Macro fossils were noted:

Yoldia sp.

Corbula sp.

Mantelliceras (?) sp.

Plants

The ammonite Mantelliceras (?) (It may be Eucalycoceras) establishes this shale as Cenomanian. This section is in contact with brown sandstone, which looks like Woodbine.

A section 3 miles south of Temple in Bell County 1 mile east of the Belton-Temple highway carries a profuse ammonite fauna of which the following genera have been recognized:

Mantelliceras (Eucalycoceras) aff Couloni d'Orbigny. (See Plate 7)

Acanthoceras sp. cunningtoni var Cornutum Kossmat. (See Plate 8)

Acanthoceras aff turneri White (See Plate 9).

Acanthoceras n. sp. (See Plate 7)

Turrilites aff desnoyers d'Orbigny (See Plate 10).

Turrilites aff tuberculatus d'Orbigny (See Plate 10).

Turrilites n. sp. (See Plate 10)

These are all Upper Cenomanian fossils.

The section at Brushy Creek, near Round Rock, in Williamson County contained two Acanthoceras (See Plate 7) of undetermined sp. establishing the Cenomanian age of the basal shale there.

The basal shale in the Walnut Creek section near Watters Park, Travis County, failed to yield any fossils.

The Bouldin Creek section near Austin, Travis County yielded the following fauna: (See Plate 11)

Macro fauna:

Exogyra columbella (?) Cragin

Anchura sp.

Ostrea sp.

Lucina sp.

Mactra sp.

Plicatula sp.

Anomia sp.

Turritella sp.

Turrilites (?) sp.

Micrabacia (?) sp.

Micro fauna:

Sponge spicules; 2 sp.

Globigerina cretacea Roemer

Globotruncana arca, Cushman

Marginulina sp.

Frondicularia sp.

Pulvinulina sp.

Guembelina sp.

Pseudotextularia sp.

Bairdia sp.

The Macro fauna is distinctive. The fossils are so poorly preserved that the species could not be accurately determined. All of these genera have been described from the Colorado formation by T. W. Stanton[33] and the species of Stanton bear a great similarity to the forms found in the shales at Bouldin Creek. The Exogyra is not an Exogyra columbella but a new species. Cragin's original Exogyra columbella is not a true columbella as has been noted by Professor Whitney, L. W. Stephenson and others. This Bouldin

[38]Stanton, T. W.: "Colorado Formation and its Invertebrate fauna", U.S.G.S. Bull. 106, 1899.

Creek Exogyra bears a great resemblance to Exogyra laeviuscula Roemer, but is distinctly a new species. Professor Whitney called the writer's attention to a difference between the species of Exogyra found in the shales and those found in the flags at Bouldin Creek and further study may show that two species are represented there, which would not be surprising considering the Cenomanian age of the shale and the high Turonian age of the flags.

The microfauna contains species which are common to the Eagle Ford. The sponge spicules, or very similar forms are found in the upper shale at this locality and also at Brushy Creek. The ostrocod Bairdia ranges upward from the Washita.

This shale is evidently of Conomanian age. The flags immediately overlying this shale carry a high Turonian fauna. Between the shale and the flags there is a "fish bed" containing Ostrea sp., Exogyra n. sp. (?) fish teeth and phosphate nodules. (See Plate 2). This is three inches thick on fresh exposures. It seems absurd to assume that this "fish bed" represents all of lower Turonian. There is scant evidence of erosional unconformity at the top of the shale. The shales undulate somewhat at the contact with the flags, but not enough to be certain that they have undergone erosion.

The sudden and unaccountable change, however, from a Cenomanian fauna to a high Turonian fauna shows that a distinct disconformity exists in this section. The entire section at Bouldin Creek is given below:

	Feet
Austin:	
White chalky limestone	10.
Eagle Ford Shales:	
Thinly laminated shales with thin bentonitic layers. Fossils: Inoceramus sp. and Ostrea lugubris; thin "fish bed" occurs 10 ft. below contact	14.5
Sandy shales containing Ostrea sp. and Corbula sp.	4.25
Thinly laminated sandy limestone flag with Ostrea lugubris (?) and Inoceramus labiatus	.25
Thinly laminated sandy shales with phosphate nodules and wood fragments	2.00
Sandy limestone ledge with Inoceramus labiatus and Inoceramus sp.	.83
Sandy shale with bentonite layer	.66
Sandy limestone ledge with Inoceramus sp...	.5
A layer of almost pure bentonite containing an abundance of fish teeth	.55
Sandy limestone flag with Inoceramus labiatus	.33
Bentonite layers with numerous fish teeth ..	.33
Thinly laminated black bituminous shales with limestone concretions around wood fragments and bentonitic layers. Fossil tree	4.00
Hard sandy limestone ledge with Metoicoceras sp., Prionotropis or Prionocyclus n. sp. a new genus of ammonite, Inoceramus labiatus,	

Ostrea sp. Helicoceras pariaense and Exogyra columbella (?) Cragin	4.16
"Fish bed" conglomerate with Ostrea sp., Ostrea lugubris (?), Exogyra columbella (?) Cragin, numerous fish teeth and phosphate nodules	.25
Heavy conchoidal fracture shales, with Exogyra columbella (?) Cragin, and the Colorado (?) fauna listed above	8.25
(Pleistocene stream gravels covering shale ..	4.00)
Thinly laminated shales containing no micro or macrofaunas	2.33

Buda:

Hard yellow limestone with uneven upper surface	2.33

The shale in the Aquilla section contains no $CaCo_3$ and does not effervesce upon application of HCl. The shale in this section contains a high percentage of $CaCo_3$ and effervesces freely upon application of HCl.

This bottom shale layer has nowhere yielded any typical Woodbine fossils. It does, however, contain a high Cenomanian fauna, in the area from Aquilla to Round Rock. At Austin the fauna has a decidedly Coloradoan aspect which would place these shales stratigraphically higher than the Woodbine. The Eagle Ford in North Texas has deposits of high Cenomanian age in the lower portion. These facts

lead the writer tentatively to assign with some doubt, this basal shale to the Eagle Ford as nothing diagnostic of Woodbine age was found, but, on the other hand it represents a deposit which does not resemble Eagle Ford except in lithology.

In the rapid reconnaisance work of early geologists, lithology instead of paleontology was used as a basis for subdividing formations. A formation which is continuous over an area covering hundreds of miles, can and sometimes does change in lithology several times. It seems to the writer that faunal breaks should take precedence over lithological breaks, since a change in conditions that bring about a complete faunal break is known to be world-wide in application. In the light of this knowledge, paleontology instead of lithology should be used as the basis for subdividing a series, and the subdivision should be placed where the faunal break occurs, even if there is a similar lithology both above and below this break. The Cenomanian-Turonian contact in the Eagle Ford should be worked out and the shales of Cenomanian age should be given a separate formational name. This is a paleontological and field problem and requires more time than the writer has to do field work plus a better knowledge of paleontology. The writer hopes, however, that the formation will soon be subdivided.

BIBLIOGRAPHY

Adkins, W.S.: "The Geology and Mineral Resources of the Ft. Stockton Quadrangle", Univ. of Texas Bull. No. 2378, 1923.

_____: "Geol. and Mineral Resources of McLennan County", Univ. of Texas Bull. No. 2340, 1923.

_____ and Winton, W. M.: "Geology of Tarrant County", Univ. of Texas Bull. No. 1931, 1919.

Baker, C. L.: "Geol. of Panuco Oil Field, Mexico", A.A.P.G. Bull. Vol. 12, No. 4, 1928.

_____; Udden, J.A. and Böse, Emil: "Review of the Geol. of Texas, Univ. of Texas Bull. No. 44, 1914.

Böse, Emil: "On a new Exogyra from the Del Rio Clay and Some Observations on the Evolution of the Exogyra in the Texas Cretaceous", Univ. of Texas Bull. No. 2748, 1927.

_____, and Cavins, O. A.: "The Cretaceous and Tertiary of Southern Texas and Northern Mexico", Univ. of Texas Bull. No. 2748, 1927.

_____, Udden, J.A. and Baker, C. L.: "Review of the Geol. of Texas, Univ. of Texas Bull. No.44, 1916.

Carsey, Dorothy Ogden: "Foraminifera of the Cretaceous of Central Texas", Univ. of Texas Bull. No. 2612, 1926.

Cavins, O. A. and Böse, Emil: "The Cretaceous and Tertiary of Southern Texas and Northern Mexico", Univ. of Texas Bull. No. 2748, 1927.

Cuyler, R. H.: Master of Arts Thesis, Univ. of Texas 1927.

Dumble, E. T.: "The Geol. of East Texas", Univ. of Texas Bull. No. 1869, 1918.

Hill, R. T.; "Annotated Check List of Cretaceous Fossils", Texas Geological Survey Publication, 1891.

_____: "The Geol. of the Black and Grand Prairies", U.S.G.S., Twenty-first Ann. Rept. Pt. VII, Wash. 1900.

Iddings, Arthur and Olsson, A. A.: "The Geol. of N.W. Peru" A.A.P.G. Bull. Vol. 12, No. 1, 1928.

Liddle, R. A.: "The Geol. and Mineral Resources of Medina County", Univ. of Texas Bull. No. 1860, 1918.

Matson, G. C.: "The De Soto Red River Oil and Gas Field", La. U.S.G. Survey Bull. 661, 1917.

Moreman, W.L.: "Fossil Zones in the Eagle Ford of North Texas", Journ. of Paleontology, Vol. 1, No. 1, 1928.

Olsson, A. A. and Iddings, Arthur: "The Geol. of N.W. Peru." A.A.P.G. Bull. Vol. 12, No. 1, 1928.

Prather, J. K.: "Cretaceous. Vertebrates." Trans. Texas Acad. of Science, IV, 1901.

Renick, B.C.: "Recently discovered Salt Domes in East Texas," A.A.P.G. Bull. Vol. 12, No. 5, 1928.

Schuchert, Charles, "Unconformities as seen in dis-Conformities in Diastems" (Separate) Published in Am. Journ. of Sci. Vol. XIII, 1927.

Scott, Gayle: "The Woodbine Sand of North Texas Interpretated as a Regressive Phenomenon." A.A.P.G. Bull. Vol. 10, No. 6, 1926.

_____: "Etudes Stratigraphiques et Paleontologique sur les Terrains Cretaces due Texas." These Doctorat, Grenoble, 1925.

_____and Winton, W.M.: "The Geology of Johnson County," Univ. of Texas Bull. No. 2229, 1922.

Sellards, E. H.: "The Geol. and Mineral Resources of Bexar County," Univ. of Texas Bull. No. 1932, 1919.

Shuler, E. W.: "The Geol. of Dallas County," Univ. of Texas Bull. No. 1818, 1918.

Stanton, T. W.; "The Colorado Formation and its Invertebrate Fauna," U.S.G.S.Bull. 106, 1893.

Stephenson, L.W.: "A Contribution to the Geol. of Northeastern Texas and Southern Okla," U.S.G.S. Prof. Paper 120H, 1918.

_____: "Notes on the Stratigraphy of the

of the Upper Cretaceous Formations of Texas and

Arkansas," A.A.P.G. Bull. Vol. 11, No. 1, 1927.

Taft, J.A.: "Report on the Cretaceous Area North of the Colorado River," Texas Geol. Survey, Fourth Ann. Rept., 1892.

Udden, J.A.: "Fossil Ice Crystals," Univ. of Texas Bull. No. 1821, 1918.

_____, Baker, C.L. and Bose, Emil: "A Review of the Geol. of Texas", Univ. of Texas Bull. No. 44, 1916.

Vaughn, T.W.: "Uvalde Quadrangle", U.S.G.S. Folio No. 64, 1900.

Winton, W.M.: "The Geol. of Denton County," Univ. of Texas Bull. No. 2544, 1925.

_____and Scott, Gayle: "The Geol. of Johnson County," Univ. of Texas Bull. No. 2229, 1922.

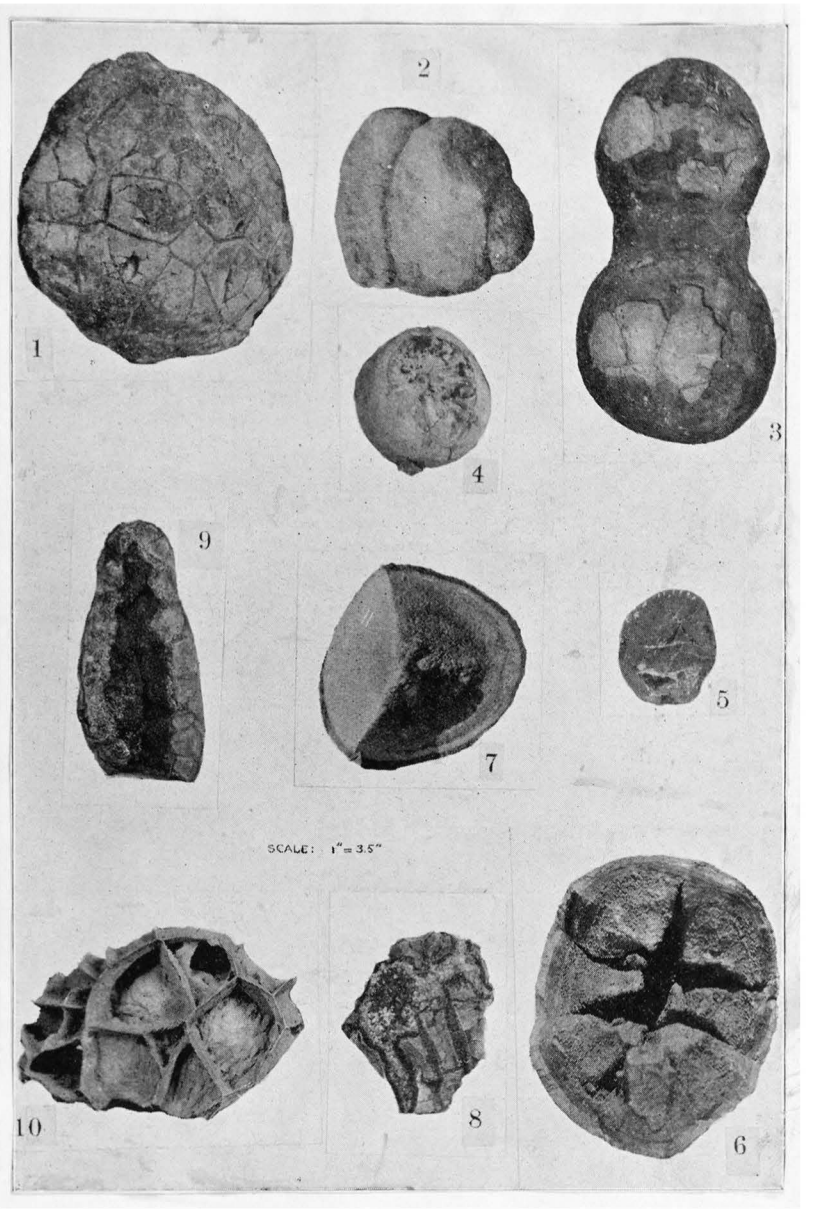
_____ and Adkins, W.S.: "The Geol. of Tarrant County," Univ. of Texas Bull. No. 1931, 1919.

PLATES

Outcrop showing Flags and Basal Shale on
Bouldin Creek, near Austin, Texas.

Outcrop showing Basal Shale, Boyd Falls
on Bouldin Creek, near Austin, Texas.

View showing "Fish Bed Conglomerate." This specimen was taken from Base of Flags at San Marcos, Texas.



Concretions from Eagle Ford near Dallas, Texas.

Ostrea lugubris from Oyster bed
in top of Eagle Ford on Post Oak Creek
near Sherman, Texas

Contact of Austin-Eagle Ford at White Rock
Cuesta on Dallas-Fort Worth Pike

Photograph of bottom flag from Watters Park, 10 miles North-west of Austin, Texas, showing *Prinotropis n.sp*, *Helicoceras pariaense* and *Inoceramus labiatus* in same horizon.

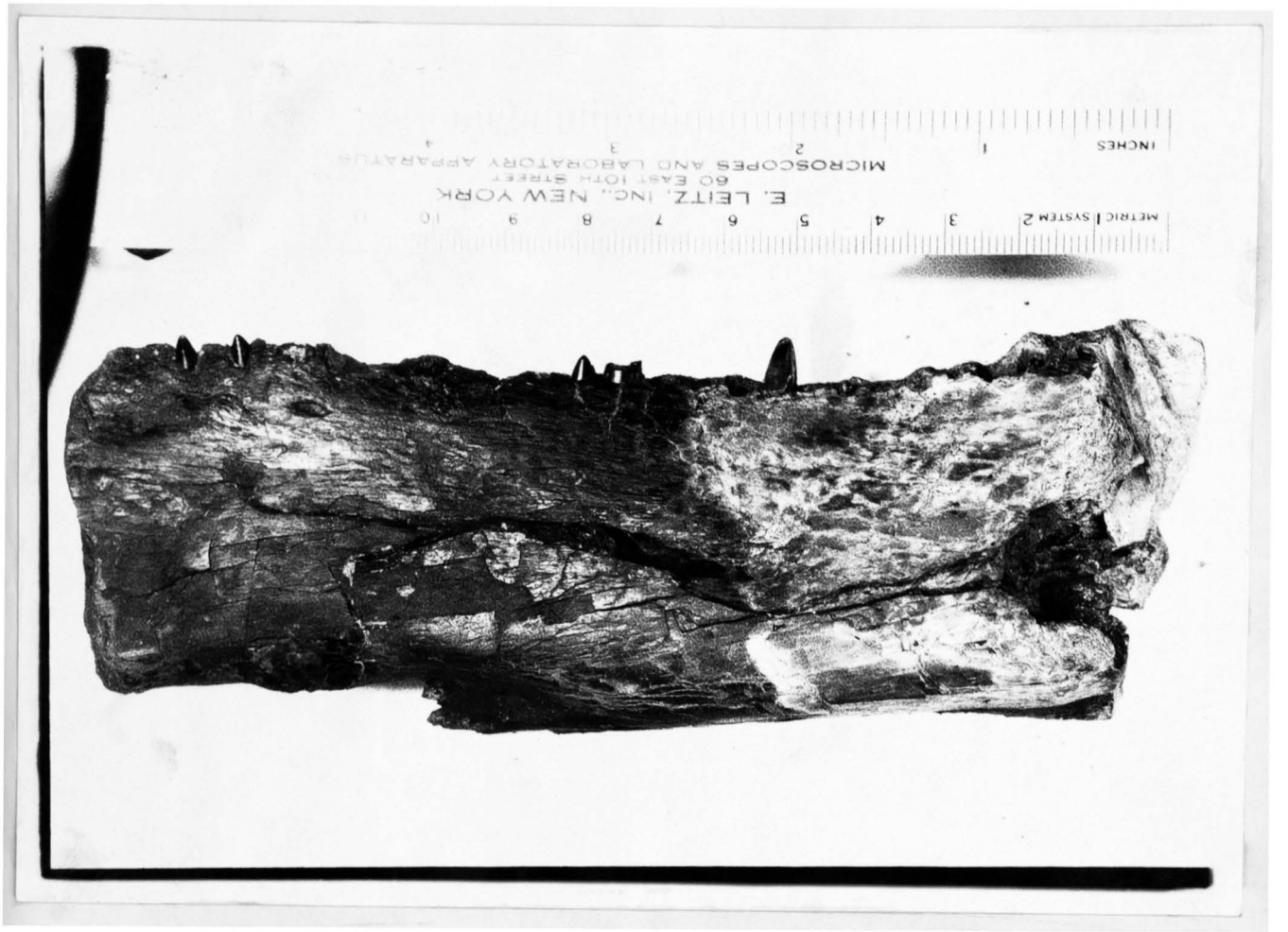
Acanthoceras from lower Member. No. 1 is from an exposure 3 miles south of Temple near Temple-Belton highway, and has been provisionally determined as Mantelliceras (Eucalycoceras ?) aff Couloni d'Orbigny. No. 2 is from the exposure on Brushy Creek, 1 mile east of Round Rock, and is Acanthoceras n. sp.

cfr.
Acanthoceras/cunningtoni Var cornutum Kossmat, from the lower shale exposure 3 miles south of Temple and 1 mile east of the Temple-Belton Road.

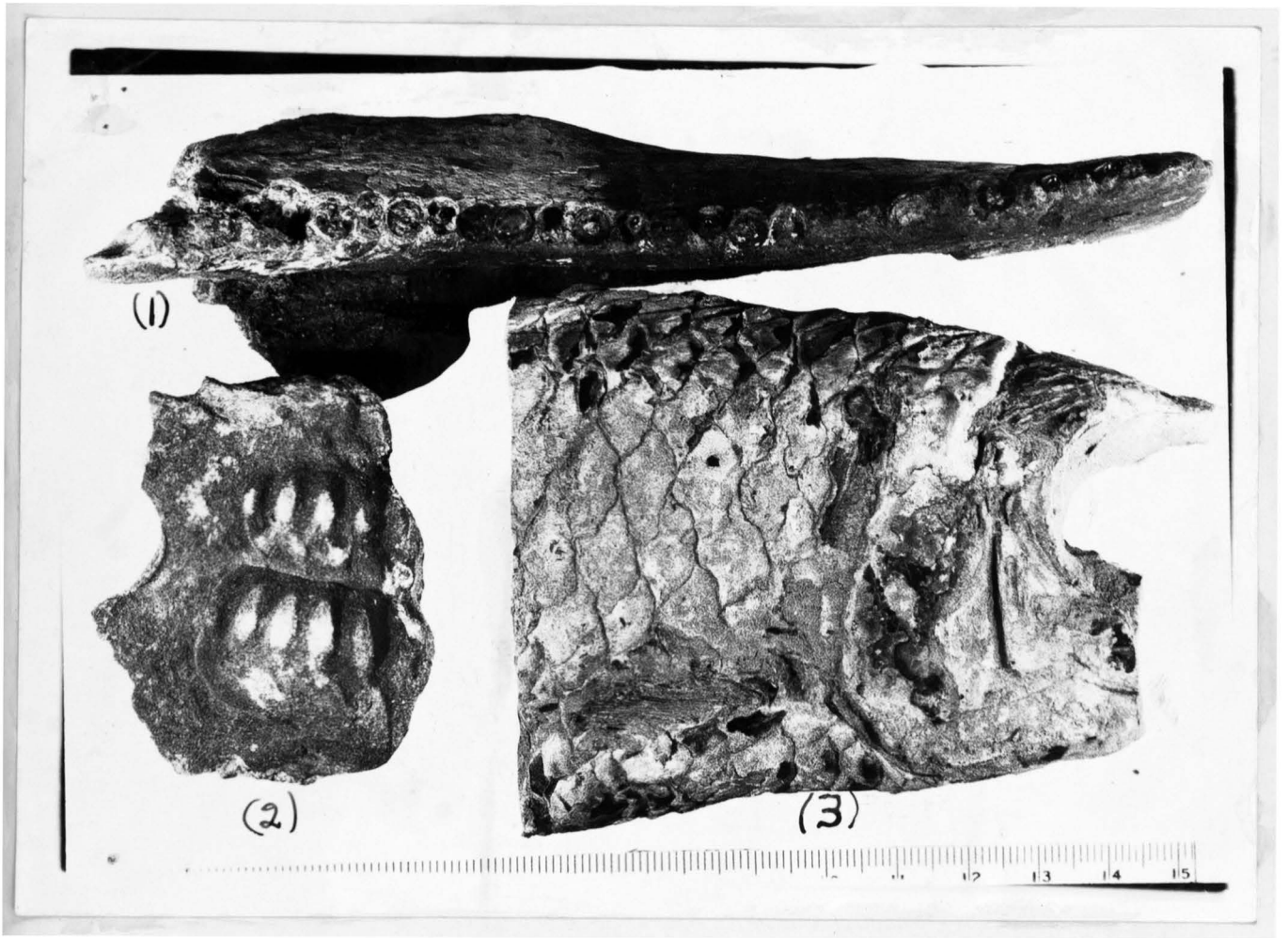
Acanthoceras aff *turneri* White from exposure in McLennan County, 2 miles north of Moody, on Moody-Waco road.

(1) Turrilites aff desnoyers d'Orbigny,
(2) Turrilites aff tuberculatus d'Orbigny, and
(3) Turrilites n. sp. from an exposure of lower Eagle Ford 3 miles south of Temple and 1 mile east of the Temple-Belton road.

Fossils from the lower shale of Bouldin Creek section near Austin, Texas.



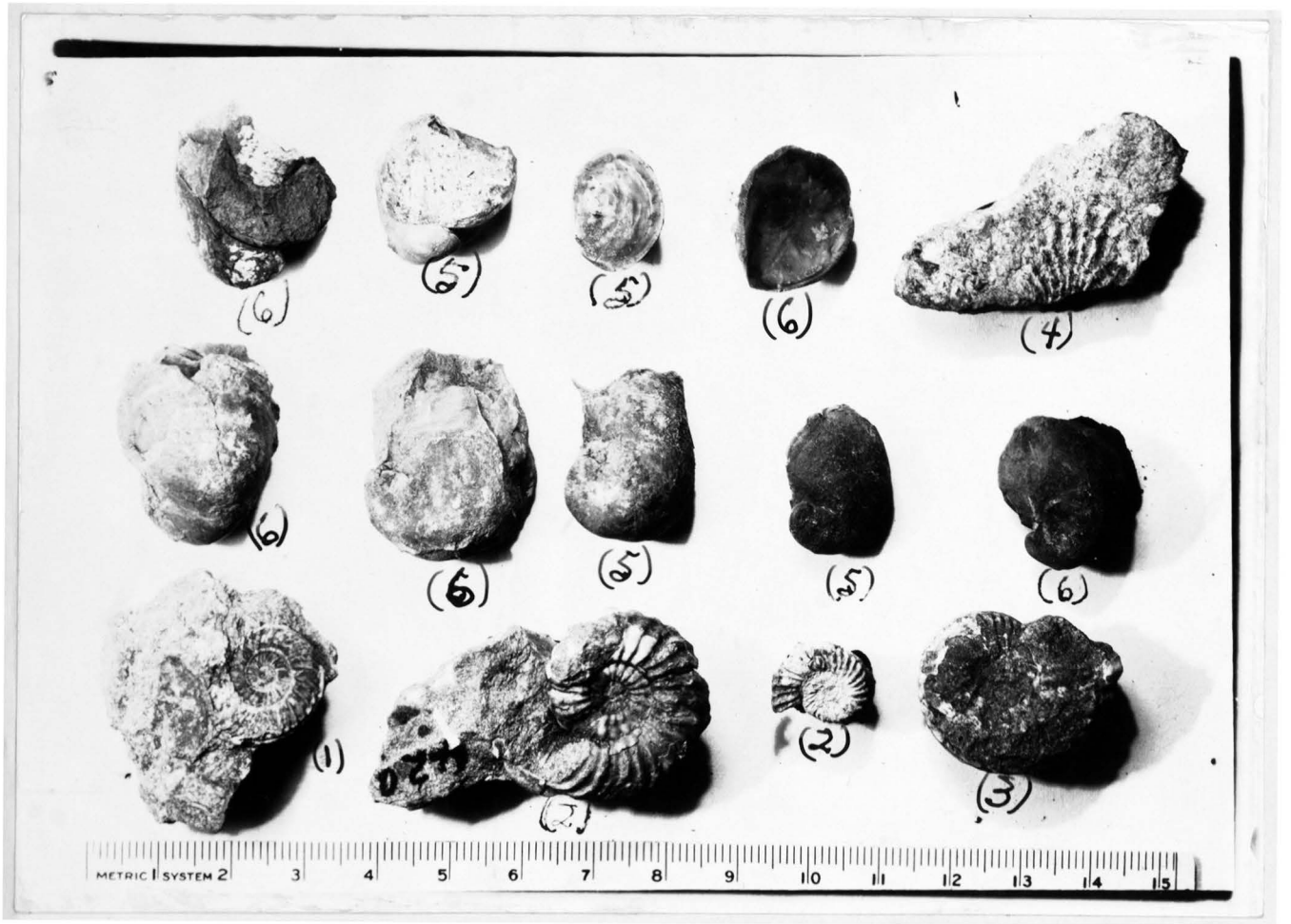
Fish jaw-bone found in bottom member of Eagle Ford at iron bridge over South Bosque River 1 mile south of Bosqueville, McLennan county, Texas. This specimen was identified by Gidley of the U. S. National Museum as Portheus sp.



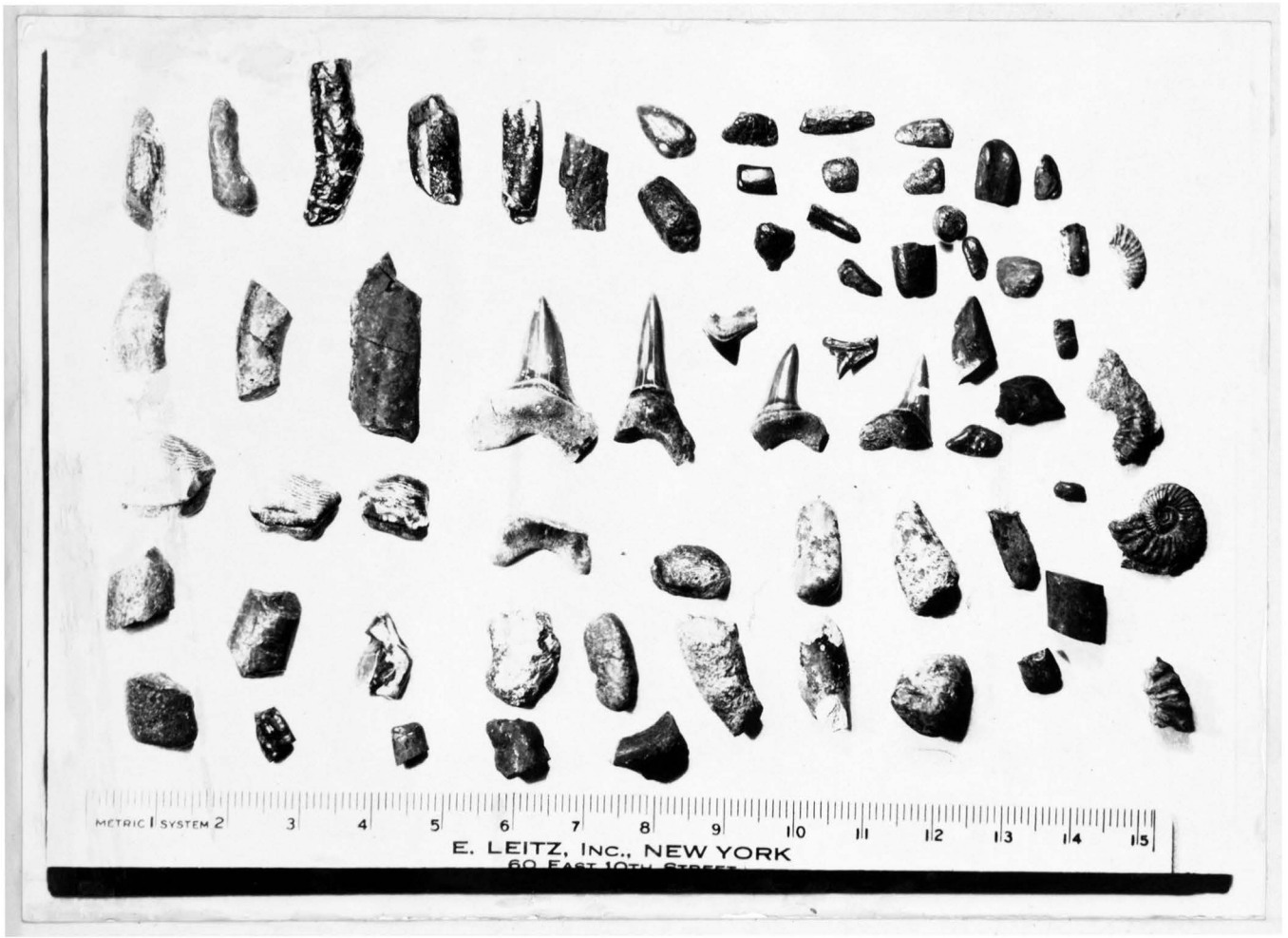
(1) Ventral view of Portheus sp. (2) Unidentified Turrilite from Bell County. (3) Fossil fish from Eagle Ford near Midlothian, Texas.

Plate 14

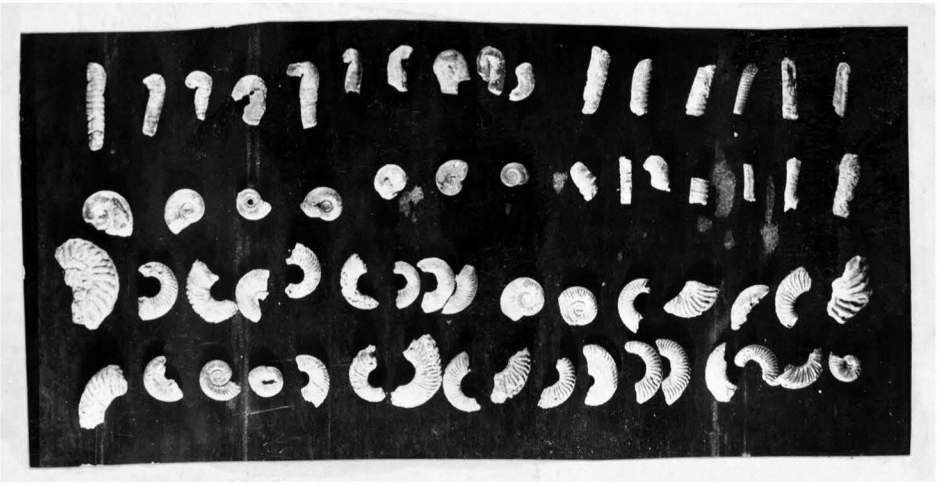
Inoceramus labiatus found in lowest flag in the exposure on Walnut Creek 2 miles east of Watters Park, Travis County, Texas.



(1) and (2) Species of Prionotropis. (3) A species of Prionocyclus. (4) Ostrea lugubris (?) This specimen is from lowest flag. (5) Exogyra sp. from flags at Bouldin Creek. (6) Exogyra from lower shale at Bouldin Creek.

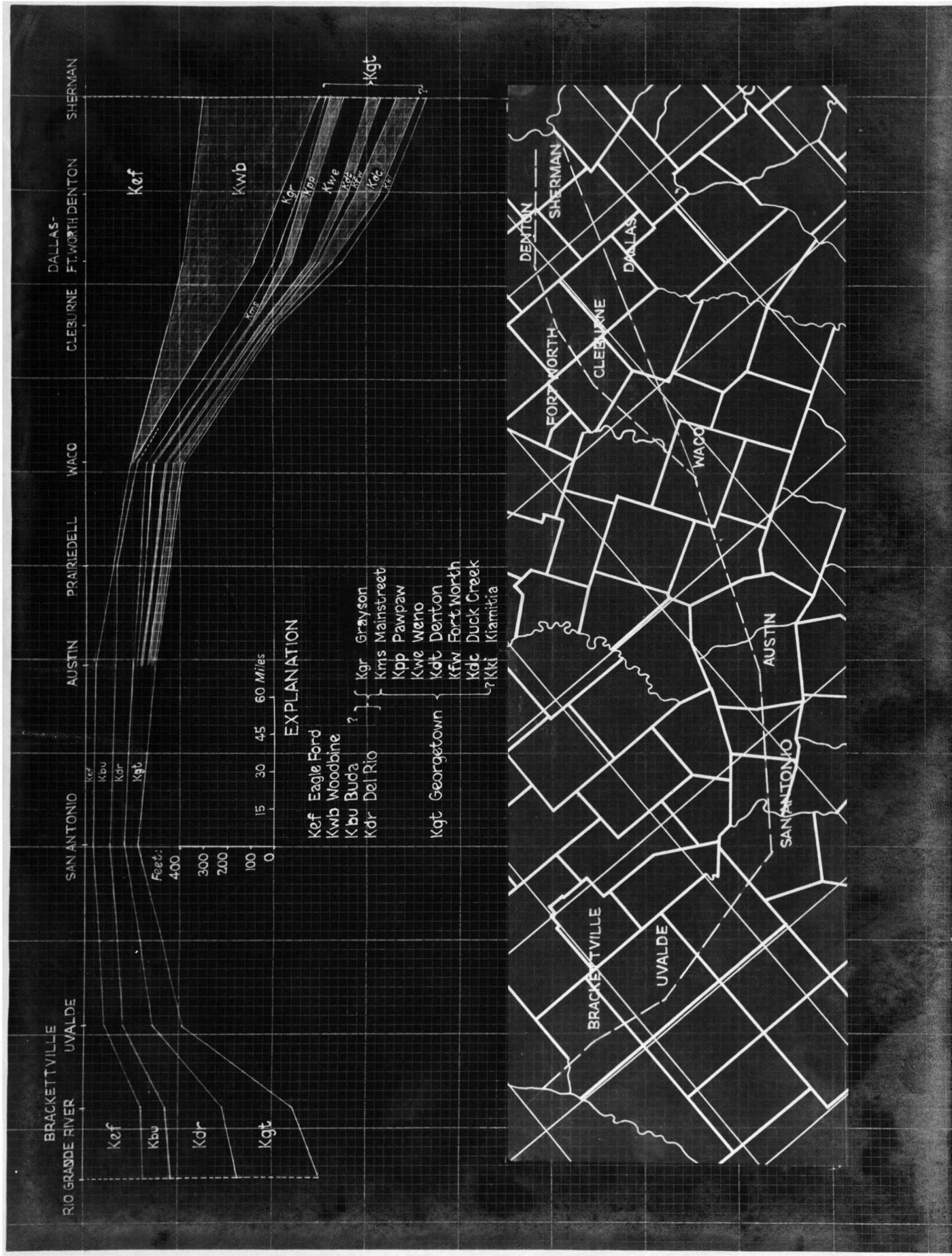


Pavement teeth, shark teeth. Squalodont shark teeth, Coprolites, phosphate nodules and some small Ammonites from the Eagle Ford near Austin, Texas.



A dwarf fauna from the flag member of the Eagle Ford in McLennan County, Texas. These specimens were collected from ant hills.

Plate 18.



North-South Section across Texas, showing variation of thicknesses of Cretaceous formations from Georgetown to Eagle Ford.