University of Texas Bulletin

No. 2907: February 15, 1929

OSTRACODA OF THE CRETACEOUS OF NORTH TEXAS

By

CHARLES IVAN ALEXANDER

Bureau of Economic Geology

J. A. Udden, Director E. H. Sellards, Associate Director

PUBLISHED BY
THE UNIVERSITY OF TEXAS
AUSTIN

University of Texas Bulletin

No. 2907: February 15, 1929

OSTRACODA OF THE CRETACEOUS OF NORTH TEXAS

By

CHARLES IVAN ALEXANDER

Bureau of Economic Geology

J. A. Udden, Director E. H. Sellards, Associate Director

PUBLISHED BY
THE UNIVERSITY OF TEXAS
AUSTIN

Publications of the University of Texas

The University publishes bulletins four times a month, so numbered that the first two digits of the number show the year of issue and the last two the position in the yearly series. (For example, No. 2901 is the first bulletin of the year 1929.) These bulletins comprise the official publications of the University, publications on humanistic and scientific subjects, and bulletins issued from time to time by various divisions of the University. The following bureaus and divisions distribute bulletins issued by them; communications concerning bulletins in these fields should be addressed to the University of Texas, Austin, Texas, care of the bureau or division issuing the bulletin: Bureau of Business Research, Bureau of Economic Geology, Bureau of Engineering Research, Interscholastic League Bureau, and Division of Extension. Communications concerning all other publications of the University should be addressed to University Publications, University of Texas, Austin.

Additional copies of this publication may be procured from the
Bureau of Economic Geology, University of Texas,
Austin, Texas
at
75 cents per copy

UNIVERSITY OF TEXAS PRESS, AUSTIN

University of Texas Bulletin

No. 2907: February 15, 1929

OSTRACODA OF THE CRETACEOUS OF NORTH TEXAS

By

CHARLES IVAN ALEXANDER

Bureau of Economic Geology

J. A. Udden, Director E. H. Sellards, Associate Director

PUBLISHED BY THE UNIVERSITY FOUR TIMES A MONTH, AND ENTERED AS SECOND-CLASS MATTER AT THE POSTOFFICE AT AUSTIN, TEXAS, UNDER THE ACT OF AUGUST 24, 1912

The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

CONTENTS

ILLUSTRATIONS

OSTRACODA OF THE CRETACEOUS OF NORTH TEXAS

By

CHARLES IVAN ALEXANDER

INTRODUCTION

The study of the ostracods of the Cretaceous formations of north Texas has had a twofold object: to establish in the Cretaceous sediments of north Texas a series of fossil zones based on the occurrence of the commoner species of its ostracods, and to demonstrate that ostracods are as useful as any other group of fossils for solving the broader problems of stratigraphy and correlation. Since its primary purpose is the description of fossil zones that may be of value in correlation by means of well samples from the Cretaceous sediments, the paper is arranged in such a way as to have as practical an application as possible.

Much work has been done on the zoning and correlation of the Cretaceous sediments of north Texas. The zoning has been based for the most part on the macrofossils, although within the past few years several papers dealing with the micropaleontology have been published, and some of them include mention or description of ostracods.

The field and laboratory work preliminary to the preparation of this paper has been carried on by the author during the past four years, and all the samples from the Cretaceous clays, shales, and marls used in the studies, with the exception of a number which were presented by Mrs. Helen Jeanne Plummer, were collected and prepared by him. He fortunately had the opportunity at the outset of his work to make a foot-by-foot study of a series of cores from wells drilled by the Tarrant County Water Improvement District No. 1. These cores were from formations ranging from the base of the Upper Cretaceous downward through the entire Lower Cretaceous as it is developed in this region. They have proved especially valuable because they made possible a close check of the surface samples against the carefully measured stratigraphic columns.

The first part of this work was done in the two years during which the author was a graduate student in the Department of Geology of Texas Christian University, and a preliminary paper, the content of which is included in the present work, was prepared as a thesis to fulfill the requirements for the degree of Master of Science at that institution. During the next two years, these studies were completed and accepted as a thesis for the degree of Doctor of Philosophy in the Department of Geology of Princeton University.

The subjects considered in this paper and the order of their presentation, are as follows: first, a brief review of the literature on the paleontology and stratigraphy of the Cretaceous of Texas and of the literature on Cretaceous ostracods in general; second, descriptions of the sediments of each of the formations studied in this investigation and accounts of a few of the more important collecting localities in the Cretaceous of north Texas; third, descriptions of the species of the ostracods which have been found most useful in correlating the north Texas Cretaceous, with information concerning their known stratigraphic ranges; and fourth, a summary, presenting evidence that the ostracods may be used as successfully as any other fossils in solving the broader problems of Cretaceous stratigraphy and correlation.

The author wishes to acknowledge, with expressions of sincerest gratitude, Dr. Joseph A. Cushman's kindness and generosity in allowing him the privilege of working during a portion of the fall of 1927 in the Cushman Laboratory for Foraminiferal Research, and of comparing his Texas Cretaceous ostracods with some from Cretaceous formations of Europe. To Mrs. Helen Jeanne Plummer, the author's thanks are equally due for much excellent material from the Upper Cretaceous formations of Texas. The writer wishes also to express his gratitude to Professor W. M. Winton, of the Department of Biology and Geology

of Texas Christian University, who frequently assisted him, and who at all times showed an inspiring interest in the field and laboratory work, and to Professor B. F. Howell of the Department of Geology of Princeton University, who gave invaluable advice in the preparation of this manuscript. Mr. W. L. Moreman, of Clarendon, Texas, has kindly supplied the samples of Eagle Ford shale used in the author's studies. Finally, the author wishes to express to Miss Margaret Moore, of Sharon, Massachusetts, his appreciation of her coöperation in the preparation of the illustrations for this paper.

Ninety species and three varieties are described and figured in this paper. Fifty-six of the species and one of the varieties are described as new.

One new genus, *Cytherelloidea,* is proposed to receive a number of forms, fossil and Recent, which have previously been regarded as members of the genus *Cytherella* Jones, but which differ in many respects from the original generic description. The type species of this new genus is *Cytherelloidea williamsoniana* (Jones).

The types of the new species described in this paper have been deposited in the Bureau of Economic Geology of the University of Texas.

PREVIOUS WORK AND LITERATURE

The formations considered in this paper, listed from above downward, are as follows:

		Formations
Upper Cretaceous Series		Navarro Taylor Austin Eagle Ford Woodbine
Lower Cretaceous series	Washita division	Grayson Main Street Pawpaw Weno Denton Fort Worth Duck Creek
	Fredericksburg division	Kiamichi Goodland Walnut

These formations stretch in a broad belt across north-central Texas, from Red River on the north to Brazos River on the south. They are bordered on the west by the basal, Trinity, division of the Lower Cretaceous, and on the east by the basal Midway formation of Eocene age.

The average regional dip is forty to fifty feet per mile, except in the region of the Preston anticline along Red River, where the beds locally attain a dip of 7 to 8 degrees. The direction of dip is somewhat south of east.

The rocks of this belt contain a rich and varied fauna, which, since the first researches on the Texas Cretaceous by Ferdinand von Roemer, in 1846, have been the subject of a great amount of study and literature, the leading titles of which have been included in the accompanying bibliography.

Dr. R. T. Hill's work **(28)**, Geology of the Black and Grand Prairies of Texas, is undoubtedly the fundamental contribution to our knowledge of the Cretaceous of Texas. It not only summarizes all the work of those pioneer geologists of the Texas region, Roemer, Marcou, White, Cragin, Shumard, and others, but added an amount of information from careful personal study and observation that is all the more remarkable when one considers that Dr. Hill did his work before the days when transportation was facilitated by automobiles and our modern network of railways and good roads. The accuracy of his observations and the correctness of his conclusions are attested by the way in which his work has withstood the subsequent years of minute scrutiny.

The excellent work of Mr. W. S. Adkins and Professor W. M. Winton **(3)** on the paleontology of the Fredericksburg and Washita formations of north Texas constituted another distinct advance in the progress of investigation in the Texas Cretaceous, for it was the first attempt to establish a definite succession of fossil zones in the Cretaceous strata of north Texas.

Professor Gayle Scott's doctor's dissertation on the stratigraphy and paleontology of the Cretaceous of Texas **(52)** is the first serious attempt to make a careful correlation of the entire Texas Cretaceous section with the classic European Cretaceous column. Certain unorthodox views presented in this publication have been a stimulus to further and more detailed researches.

Dr. L. W. Stephenson's contributions have been mainly toward a solution of the difficult and obscure stratigraphic problems of the rather neglected Upper Cretaceous formations of the Arkansas-Oklahoma-Texas region.

Most comprehensive works dealing with the Texas Cretaceous section have considered only the macrofossils in establishing their zones and in making their correlations. Within the past few years, however, the marvelously rich microfaunas have been made the subject of numerous investigations. So far these investigations have dealt largely, if not entirely, with the foraminifera.

Dr. Joseph A. Cushman has contributed several short papers on some of the more interesting and important foraminifera of the Cretaceous sediments of the Gulf Coast region. Other contributions have been made by Mrs. Helen Jeanne Plummer **(43)** who in her paper on the foraminifera of the Midway formation figures and describes several species from the Cretaceous Navarro clays; by Thomas and Rice **(58)** who are making an interesting study of the evolution of the genus *Guembelina;* by Mrs. Dorothy Ogden Carsey **(12)** whose paper on the foraminifera of the Cretaceous of central Texas contains frequent references to ostracods in her samples; and by Mr. W. L. Moreman **(41)** who in his paper on the Eagle Ford formation describes and figures two species of ostracods, along with several species of foraminifera and macrofossils.

The ostracods have been chosen as the basis for the present study for several reasons. First, fossil ostracods are fairly common and in some Cretaceous clays, shales, and marls they are quite abundant. A few samples have been examined in which the ostracods actually outnumbered the foraminifera in number of individuals. Second, most ostracods are larger than most foraminifera and are, therefore, not only more conspicuous in the washed samples but are also easier to mount and examine. Third, most ostracods are easily identified, since the species are based on conspicuous external features, such as the amount by which one valve overlaps the other along the margins, the amount of convexity of the valves, and the arrangement of such surface ornaments as tubercles, spines, ridges, pits, and reticulations. In Cretaceous formations the genera *Cythere* and *Cythereis* are the most important ostracod genera, because their variously sculptured shells make their numerous species readily identifiable, because these genera present the greatest numbers of individuals, and because most of their highly ornate species are relatively short lived and therefore valuable as guide fossils.

Although the ostracods have for nearly a century attracted the interest of students of micropaleontology throughout the world and have been the subject of numerous publications, the present paper, so far as the author is able to determine, is the first attempt that has been made to establish definite fossil zones throughout any extensive series of Cretaceous sediments on the basis of the occurrence of species of the Order Ostracoda. This paper does not pretend to be monographic in its scope. Only those species are included which are common enough and striking enough in appearance to make good horizon markers and to be easily recognized.

The writer has tried to make his collections and studies as comprehensive as possible, but the area and the stratigraphic column considered are both so extensive as to make detailed studies of each formation throughout its long belt of outcrop in north Texas impracticable for preliminary treatise. The Upper Cretaceous formations are mainly clays and marls that weather into broad, level, soil-covered plains, where good exposures are few and widely scattered. This paper must, then, be regarded as forming merely a basis for more detailed studies which should be made, formation by formation, through the Cretaceous column.

The first paper presenting descriptions of species of Cretaceous ostracods was by Frederick Münster **(42)** in

1830. In it Münster described fourteen species collected from various Cretaceous and Tertiary localities in France and Germany. His descriptions are brief and unaccompanied by figures. Later workers must have had access to his type specimens or to his collections, since all his species are recognized; they certainly could not have been identified from his brief characterizations.

The work begun by Münster was continued by Roemer, Reuss, Cornuel, Bosquet, Egger, Jones, Hinde, Sherborn, Frederick Chapman, and others. Most of the papers published by these early investigators are merely descriptions of fossil species collected from the outcrops of some Cretaceous formation at a single locality or group of neighboring localities. The specific definitions are very broad, and the stratigraphic ranges as recorded are therefore very great.

Jones' and Hinde's **(33)** monograph of the Cretaceous ostracods of England and Ireland is doubtless the best single paper that has been published on Cretaceous Ostracoda. The monograph is a compilation of all the important works in that field of investigation up to 1889, it clears up synonomy and demonstrates by means of numerous tables the vertical and horizontal distribution of the various species throughout the Cretaceous of Europe.

The special value and interest of the works of Mr. Frederick Chapman lie in the geographic extent of his researches which include South Africa and Australia. They serve admirably to demonstrate the wide distribution and cosmopolitan character of the various species of Cretaceous ostracods and their value for making world-wide correlations. His papers record the occurrence of many identical species, in the Cretaceous of Europe, South Africa, and Australia.

Only three papers have yet been published containing descriptions of ostracods from the Cretaceous rocks of North America. One of these, by E. Willard Berry **(7)**, describes and figures thirteen new species from the Upper Cretaceous Monmouth formation of Maryland. Unfortunately, most of the figures are not so good as could be desired, and the descriptions frequently confuse the anterior and posterior ends of the carapaces. Through the courtesy of Dr. John R. Sandidge, lately a graduate student at Johns Hopkins University, the author had the opportunity of examining some material from the Monmouth formation of Maryland, and has thus definitely established the occurrence of several of Berry's species in the Navarro formation of Texas. This confirms the correlation of the Navarro of Texas with the Monmouth of Maryland which had previously been made on the basis of the macrofossils.[1] The second of the three papers is by Mr. W. L. Moreman **(41)** on the fossils of the Eagle Ford formation, in which two species of ostracods are described and figured. The third is a brief paper by the present author **(5)** in which the species, *Bairdia subdeltoidea* (Münster), recorded by a number of authors as ranging through the entire Upper Cretaceous and Tertiary, is divided into a number of distinct species and varieties that have relatively restricted stratigraphic ranges.

DESCRIPTIONS OF FORMATIONS AND LOCALITIES

An abundance of sand or pyrite, echinoid or molluscan fragments, or some other such mineral or organic material may greatly aid in establishing the level from which a sample is taken, especially when ostracods and foraminifera are rare or are represented only by long-lived species. In this chapter, therefore, the author proposes, first, to describe briefly the lithologic features and thicknesses of the Cretaceous formations in north Texas; second, to present such an account of the general appearance and content of the washed samples, concentrated from the clay, shale, and marl layers of these formations as may be of assistance to the micropaleontologist in determining his position in the column; and third, to describe as an aid to other workers and collectors those localities which have yielded the best

[1]Clark, Wm. B., **19**, p. 329.

material, some of which have been chosen as the type localities for the ostracod species here described. As a further aid to the collector, road maps showing the exact location of some of the type localities have been included.

Besides the surface exposures described in this chapter, and numerous others not specifically mentioned, the author made detailed examinations of the cores from wells of the Tarrant County Water Improvement District No. 1, which were drilled at widely separated stations in Tarrant County and cut through the entire Lower Cretaceous column. Through the kindness of Dr. Joseph A. Cushman, samples from the Taylor and Navarro formations of the Upper Cretaceous from wells at Mexia, Texas, were also studied.

LOWER CRETACEOUS (COMANCHE SERIES)

FREDERICKSBURG DIVISION

WALNUT FORMATION

The Walnut formation is composed in north Texas of a series of unconsolidated sands, clays, and shales, capped by a thick agglomerate of shells of the fossil oyster, *Gryphea marcoui* Hill and Vaughan. This "shell-agglomerate" is itself a most excellent horizon marker and is unmistakable in appearance even in well cores. The occurrence of this agglomerate has been recorded from Red River southward as far as Lampasas River (**28,** p. 206).

In the Cretaceous column of north Texas four of these shell agglomerates occur, each formed by a separate species of oyster. The four agglomerates in upward succession are as follows; first, that of the Walnut, composed of *Gryphea marcoui* Hill and Vaughan; second, one at the top of the Kiamichi, formed by *Gryphea navia* Hall; third, one at the top of the Denton, formed by *Gryphea washitaensis* Hill; fourth, and least important in a few Grayson localities agglomerates formed by *Gryphea mucronata* Gabb. All three upper agglomerates are strictly local in extent[2] (**64,** p. 17), and are easily distinguished from that of

[2]Winton, W. M., 64, p. 17.

the Walnut on the basis of thickness alone. Wherever exposed in north Texas, the Walnut shell agglomerate is from 15 to 20 feet thick; the others are in no place more than 2 to 3 feet thick and are in most outcrops much less.

The lower Walnut sands are devoid of fossil remains. Samples from the clay and shale members of the upper Walnut contain much sand, considerable pyrite, and a microfauna resembling that of the lower Goodland formation.

Because only the upper Walnut clays have proved fossiliferous, and because the microfauna of these clays has been found to be identical with that of the lower Goodland formation, no localities from the Walnut have been recorded. The samples for the writer's studies of the Walnut formation have been taken from two of the wells drilled by the Tarrant County Water Improvement District No. 1. One of these wells was located near Plover in southwestern Tarrant County, and the other was on Clear Fork of Trinity River near Lake Worth dam. The cores from these wells are stored in the laboratories of the Department of Geology of Texas Christian University.

The following species of ostracods occur in the Walnut strata:

Cytheridea oliverensis n. sp.
Cythere concentrica (Reuss)
Cythereis carpenterae n. sp.
Cythereis fredericksburgensis n. sp.
Cythereis mahonae n. sp.

GOODLAND FORMATION

The Goodland formation has a thickness of about 20 feet at Red River and rapidly increases in thickness southward to about 140 feet on Brazos River. Two lithologic divisions are recognizable within the Goodland formation, which, south of Brazos River, are regarded as separate formations. The upper harder portion, composed largely of hard, white limestone, alternating with seams of yellow clay or marl, correlates with the Edwards formation. The lower portion, consisting largely of dark, laminated clays and shales, with a few seams of yellowish marl and several ledges of chalky-white, soft limestone, correlates with the Comanche Peak formation.

Many species of echinoids have long been used as horizon markers in the Goodland (**3**, p. 16), especially in the upper portion of the formation. It is important to note that 75 per cent or more of all organic remains contained in washed samples from the upper Goodland clays and marls are fragments of tests or spines of these echinoderms.

Concentrates of the lower clay, shale, and marl members of the Goodland contain large quantities of pyrite.

The following species of ostracods have been found in Goodland strata:

Cytherella ovata (Römer)
Cytherella scotti n. sp.
Bythocypris goodlandensis n. sp.
Paracypris siliqua Jones and Hinde
Cytheridea oliverensis n. sp.
Cytheridea goodlandensis n. sp.
Cytheridea amygdaloides var. brevis (Cornuel)
Cythere concentrica (Reuss)
Cythereis carpenterae n. sp.
Cythereis fredericksburgensis n. sp.
Cythereis mahonae n. sp.
Cytheropteron howelli n. sp.

LOCALITIES

Station 1. (Tarrant County.)—An excellent outcrop of the Goodland formation occurs at the Lake Worth dam. Below the dam black basal shales of the Goodland lie on the uppermost ledges of the Walnut shell agglomerate. Just above, and north of the dam, a steep bluff exposes almost the entire formation. This is the type locality for *Cythereis carpenterae* n. sp.

Station 2. (Tarrant County.)—Rich upper Goodland material occurs at "Cragin Knobs," on the "Stove Foundry Road," 3 miles southwest of the new Texas & Pacific Railroad shops at Fort Worth. The "Knobs," are two low, rounded hills on the north side of the road and are truncated by the road cut. Limestone ledges alternate with thick marl seams. All the marl layers produce excellent material (fig. 1). This is the type locality for *Cytherella scotti* n. sp., *Bythocypris goodlandensis* n. sp., *Cytheridea goodlandensis* n. sp., *Cythereis fredericksburgensis* n. sp., and *Cytheropteron howelli* n. sp. This is also the type locality for the foraminifer, *Flabellammina alexanderi* Cushman.

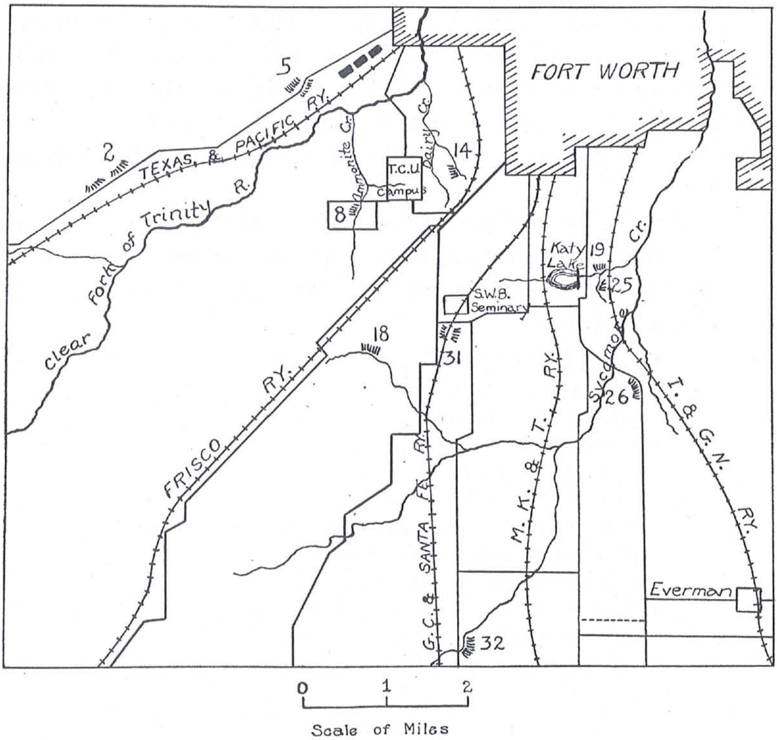


Fig. 1. Sketch map of a portion of southern Tarrant County, showing location of stations 2, 5, 8, 14, 19, 25, 26, 31, and 32.

Station 3. (Tarrant County.)—An excellent exposure of upper Goodland occurs in a low bluff on the east bank of North Fork of Mary's Creek, at the concrete bridge on the Fort Worth-Weatherford road about 11½ miles west of Fort Worth.

Station 4. (Denton County.)—An exposure of upper Goodland occurs in a low, northward-facing bluff on the south bank of Clear Creek, 0.2 mile west of the bridge that crosses Clear Creek on the main highway about 4½ miles west of Sanger. The exposure is about 150 feet north of the road at this point. This outcrop is the type locality for *Cythereis mahonae* n. sp.

KIAMICHI FORMATION

The Kiamichi formation consists of dark, compactly laminated shales, containing a few ledges of grayish-white, sandy, limestone which stains yellow on exposure. The formation is remarkably uniform in composition throughout its areal extent. Unlike the Goodland, the Kiamichi thins southward from about 50 feet thick at Red River to 35 feet at Fort Worth, and it is absent south of Brazos River.

Most concentrates of the Kiamichi shales and clays, like those of the upper Goodland, contain an abundance of pyrite and a considerable quantity of sand. Ostracods are very numerous, and in most places outnumber the foraminifera.

The Kiamichi formation was placed by Hill (**28,** pp. 115, 256) in the Washita division of the Lower Cretaceous and was regarded by most later workers as the basal formation of that division. Winton and Adkins (**30,** p. 37), however, in 1919 called attention to the discrepancies of this classification, stating that, "Although the Kiamichi formation has been placed in the Washita division, it has strong paleontological affinities with the Fredericksburg . . . ." Dr. Scott (**52,** p. 41) definitely places the Kiamichi in the Fredericksburg division with the underlying Goodland and Walnut formations.

This conclusion, suggested by Winton and Adkins and definitely adopted by Scott, seems further established by the writer's studies of the ostracods. The ostracods of the Kiamichi are distinctly Fredericksburg in character. Many species that make their appearance in the upper Goodland extend on upward through the Kiamichi, whereas only three Fredericksburg species are shared with the post-Kiamichi Duck Creek formation, where they are very rare.

To obtain further evidence on this problem, the author requested the opinion of Dr. Joseph A. Cushman based on the foraminiferal evidence in these same samples. This eminent authority agrees that the Kiamichi should be classified with the Goodland in the Fredericksburg Division.[4]

The following species of ostracods have been found in the Kiamichi formation:

Cytherella ovata (Römer)
Bairdia gracilis n. sp.
Paracypris siliqua Jones and Hinde
Cytheridea oliverensis n. sp.
Cytheridea amygdaloides (Cornuel)
Cytheridea amygdaloides var. brevis (Cornuel)
Cytheridea bairdioides n. sp.
Cythere concentrica (Reuss)
Cythereis fredericksburgensis n. sp.
Cythereis mahonae n. sp.
Cytheropteron howelli n. sp.
Cytheropteron tumidum n. sp.

LOCALITIES

Station 5. (Tarrant County.)—The entire Kiamichi formation is exposed in the deep road cut on the "Stove Foundry Road," just north of the new Texas & Pacific Railroad shops, Fort Worth (fig. 1). At this locality the formation grades from black shales at the bottom of the exposure to yellow clays at the top. The entire formation as exposed here is very rich in ostracods. This is the type locality for *Bairdia gracilis* n. sp., *Cytheridea bairdioides* n. sp., and *Cytheropteron tumidum* n. sp.

Station 6. (Wise County.)—Upper Kiamichi, in contact with basal Duck Creek, with thin beds of *Gryphea navia* Hall at the plane of contact, is exposed in a small tributary creek which runs northward into Oliver Creek, just within the eastern edge of Wise County. The exposure is in a low, eastward-facing cliff. The Kiamichi shales below the line of contact are black, compactly laminated and bituminous. The overlying Duck Creek clays are yellow, and the change in color at the line of contact is abrupt. Concentrates from both the upper Kiamichi and the basal Duck Creek at this locality are excellent. (fig. 2). This is the type locality for *Cytheridea oliverensis* n. sp.

Station 7. (Johnson County.)—The upper one foot of the Kiamichi shales is exposed in the east fork of Mustang Creek, about 8¼ miles northeast of Godley. The shales outcrop in the low banks of the creek just above the level of the creek channel. A thin bed with great numbers of individuals of *Exogyra plexa* Cragin occurs at the plane of contact with the basal Duck Creek clays.

[4]Personal communication.

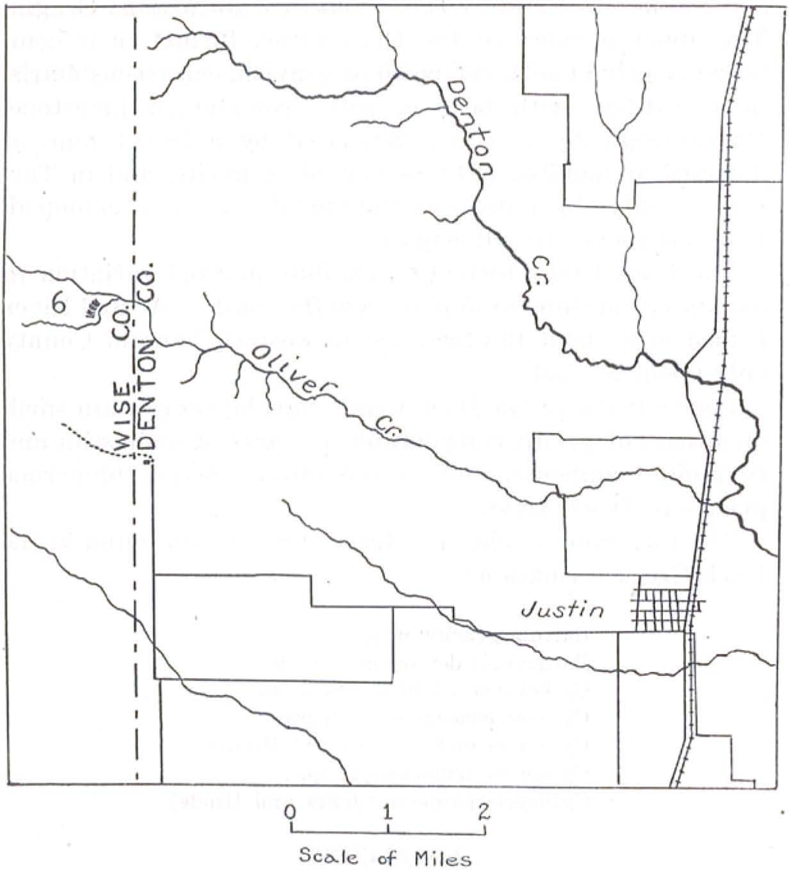


Fig. 2. Sketch map of a portion of western Denton County, showing the location of station 6.

WASHITA DIVISION

DUCK CREEK FORMATION

In north Texas two distinct members of the Duck Creek formation are recognizable on both lithologic and paleontological characters. The lower member is composed of soft, impure limestone beds, interstratified with thinner layers of yellowish or brownish calcareous marls. Paleontologically it is characterized by ammonites of the genera *Hamites* and *Desmoceras,* and by *Inoceramus comancheanus* Cragin. The upper member of the Duck Creek formation is composed largely of soft, yellowish or grayish, calcareous marls, interstratified with beds of soft, iron-stained limestone. Paleontologically it is characterized by a broad zone of dwarfed ammonites **(51)** preserved in pyrite, and in Tarrant County, by numerous individuals of the brachiopod, *Kingena wacoensis* (Roemer).

The Duck Creek formation exhibits marked variation in thickness and thins rapidly toward the south. At Red River it measures about 193 feet, and in western Tarrant County only about 65 feet.

Concentrates of the Duck Creek marl layers contain small quantities of pyrite, considerable amounts of molluscan and echinoid fragments, and in the lower portion numerous prisms of *Inoceramus.*

The following species of ostracods have been found in the Duck Creek formation:

Bairdia gracilis n. sp.
Paracypris dentonensis n. sp.
Cytheridea washitaensis n. sp.
Cythere concentrica (Reuss)
Cythereis nuda (Jones and Hinde)
Cythereis krumensis n. sp.
Cythereis paupera (Jones and Hinde)

LOCALITIES

Station 8. (Tarrant County.)—On the Municipal Golf Course southwest of Fort Worth, lower Duck Creek is exposed in a high, eastward-facing bluff on the west side of Ammonite Creek and just about 500 feet south of the road that marks the northern boundary of the golf course (fig. 1).

Station 9. (Tarrant County.)—The upper Duck Creek has been exposed at the northern end of Rogers Avenue, 0.38 mile north of the campus of Texas Christian University, in a long, shallow pit 30 feet east of the road at the top of the hill through which the northern extension of Rogers Avenue is cut. Recent house construction and grading has obliterated the outcrop.

Station 10. (Grayson County.)—Lower (not basal) Duck Creek is exposed in a low, northward-facing cliff on the south bank of a small creek about 15 feet north of the road, about one mile east of Fink. The marl layers are mostly thin and occur between harder beds of limestone. This locality is an excellent collecting place for the large ammonite *Desmoceras brazoense* (Shumard).

Station 11. (Johnson County.)—The lower Duck Creek is exposed in a low, eastward-facing cliff on the west bank of the east fork of Mustang Creek, about 7½ miles northeast of Godley, and about ½ mile south along the creek, from Station 7.

Station 12. (Grayson County.)—All except the uppermost part of the Duck Creek formation is exposed on a steep slope that lies just below and east of the Missouri, Kansas & Texas Railroad tracks, about 3 miles north of Denison. The lowermost beds of the formation outcrop in the westward-facing bank of a small stream about 75 feet east of the main slope.

Station 13. (Denton County.)—An excellent exposure of uppermost Duck Creek occurs where the road leading northwest from Krum to Trinity Farms crosses Hickory Creek, 8 miles from Krum. The exposure is in a low, northward-facing cliff that forms the south bank of Hickory Creek, about 150 feet north of the road. This exposure is the type locality for *Paracypris dentonensis* n. sp.

Basal Duck Creek is also exposed at Stations 6 and 7.

FORT WORTH FORMATION

The Fort Worth formation, forming a broad dip-slope of many thousand square miles extent, is the most uniform of all the Comanche formations in thickness and composition.

The formation is composed of an alternating series of limestone beds about six inches to one foot in thickness and laminated, calcareous marl beds from two to six inches thick. In stream cuts the limestone layers form a series of projecting ledges.

The abundance of the large and diagnostic echinoids, *Holaster simplex* Shumard and *Macraster elegans* (Shumard) contributes to the high percentage of plates and spines in the washed samples from the marl layers. Fragments of these forms comprise from 50 to 75 per cent of the total bulk of organic remains in any of the concentrated residues.

The following species of ostracods have been found in the Fort Worth formation:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Cytherelloidea williamsoniana var. stricta (Jones and Hinde)
Bairdia harrisiana Jones
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.
Cythere concentrica (Reuss)
Cythereis nuda (Jones and Hinde)
Cythereis krumensis n. sp.
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis wintoni n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)

LOCALITIES

Station 14. (Tarrant County.)—The lower part of the Fort Worth formation is well exposed in a small, eastward-facing cliff that forms the west bank of the east branch of Dairy Creek, 0.7 mile east of the southeast corner of the campus of Texas Christian University. Thin seams of yellowish or grayish calcareous marl lie between projecting ledges of the Fort Worth limestone. Microfossils are abundant and well preserved in marl samples from this locality (fig. 1).

Station 15. (Denton County.)—The upper two-thirds of the Fort Worth formation is exposed in a westward-facing cliff that forms the east bank of Wolf Branch, 2.25 miles by road north of the railroad station at Ponder, along the Ponder-Krum road. The exposure lies about 450 feet east of the highway.

Station 16. (Denton County.)—An exposure of the Fort Worth formation, which is very rich and produces excellent material, lies about 1¼ miles northwest of Krum, just north of the small concrete bridge where the road crosses a tributary of Hickory Creek. This is the type locality for *Cythereis krumensis* n. sp. and *C. worthensis* n. sp.

Station 17. (Johnson County.)—Lower Fort Worth is exposed about one-half mile southwest of Godley, in a low, northward-facing cliff that forms the south bank of the southern branch of Noland's River. A road that leaves the main Godley-Cresson highway and turns directly south across the tracks of the Gulf, Colorado & Santa Fe Railroad, leads to within 250 feet of the exposure, where it turns westward. Material from this locality is excellent. This is the type locality for *Cythereis wintoni* n. sp.

The Fort Worth formation is exposed also at Station 21.

DENTON FORMATION

The Denton formation is composed, throughout the greater part of its extent in north Texas, of laminated clays, which are in most places dark, blue, or black but are locally gray. These strata contain enormous numbers of shells of *Gryphea washitaensis* Hill, especially in the upper part of the formation, which is in places capped by a thin, slabby agglomerate of these shells.

The Denton formation thins very gradually in thickness from about 35 feet in Denton County to about 20 feet in Johnson County.

Concentrates of the Denton clays are characterized most strikingly by great numbers of fragments and shells of juveniles of *Gyphea washitaensis.* A few echinoid fragments are also present, and the number of these decreases upward through the formation, as the numbers of *Gryphea* shells and fragments increase.

The following species of ostracods have been found in the Denton formation:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Cytherelloidea williamsoniana var. stricta (Jones and Hinde)
Cytherelloidea reticulata n. sp.
Bairdia harrisiana Jones
Bairdia comanchensis n. sp.
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.
Cythere concentrica (Reuss)
Cythere subconcentrica n. sp.
Cythereis nuda (Jones and Hinde)
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)
Cythereis hawleyi n. sp.

LOCALITIES

Station 18. (Tarrant County.)—The lower and middle Denton beds are exposed southwest of Fort Worth on the low, north bank of a small tributary of Sycamore Creek, about one-half mile directly east of underpass at the intersection of the Fort Worth-Primrose road and the tracks of the Frisco Railroad. The banks of the stream, just before reaching the Denton exposure, consist of low, steep cliffs with the projecting ledges characteristic of the Fort Worth limestone. This is an excellent collecting locality for both Denton and Fort Worth marl samples (fig. 1).

Station 19. (Tarrant County.)—The uppermost three feet of the Denton formation, which consist of dark bluish clay, bearing innumerable shells of adults and juveniles of the oyster *Gryphea washitaensis* Hill and also a fairly rich and well-preserved upper Denton microfauna, are exposed on the north bank of the tributary of Sycamore Creek which has been dammed to form Katy Lake, at a point a quarter of a mile east of and below the Katy Lake dam (fig. 1).

Station 20. (Grayson County.)—The upper Denton is well exposed in a much-dissected slope below, and just west of, the high-banked tracks of the Missouri, Kansas & Texas Railroad, at a point about 1½ miles northeast of Denison. Samples from this station contain considerable sand and some pyrite and limonite. The microfauna is not rich but is characteristic for this horizon.

Station 21. (Grayson County.)—The basal Denton is exposed at the foot of the high "Flag Pole Hill" overlooking Red River and about 3¼ miles northeast of Denison. The dark, basal clays of the Denton formation are found overlying the uppermost ledge of the Fort Worth limestone near the base of the east slope of this knob-like hill. Samples from this locality present a very characteristic lower Denton microfauna, although they are not rich in individuals.

Station 22. (Grayson County.)—The middle portion of the Denton formation is exposed in a deep railroad cut of the Missouri, Kansas and Texas Railroad, 5 miles west of Denison and about 30 feet south of the automobile road between Denison and Pottsboro.

Station 23. (Johnson County.)—The upper two-thirds of the Denton formation is exposed along the steep, west bank of the north fork of Noland's River, about 100 feet south of the bridge on the Godley-Joshua road, 1¼ miles east-northeast of Godley. The dark, bluish clays exposed here contain the richest, most characteristic, and best preserved Denton microfauna that the author has discovered, and this is the type locality for *Cythereis dentonensis* n. sp.

Station 24. (Johnson County.)—The uppermost two feet of the Denton formation are exposed in a roadside ditch, 1 mile south of the garage and filling station near the eastern edge of the town of Rio Vista. The upper Denton clays lie just beneath a ledge of limestone which marks the base of the Weno formation. The clay is seen in a ditch on the east side of the road, just at the point where the main southerly road gives off a somewhat less-traveled, easterly branch road. Samples from both the Denton and the overlying Weno yield an abundance of well preserved specimens. This is the type locality for *Cytherelloidea reticulata* n. sp. and *Bairdia comanchensis* n. sp. from the Denton strata in this outcrop.

WENO FORMATION

The Weno formation exhibits a most varied lithology, with many changes. In Cooke and Grayson counties the formation is composed of dark, blue-gray shales capped by a series of hard, calcareous ledges that contain large numbers of shells of *Gryphea washitaensis* Hill and *Ostrea carinata* Lamarck and comprise what is known as the "Quarry Limestone." Southward these upper, limy members thicken and gradually replace the lower shale member. In Tarrant County they form a series of massive limestone strata that comprise the entire upper one-third of the formation. South of Brazos River the entire formation is calcareous. South of Denton County, however, the limestone members are not characterized by an abundance of shells.

The Weno thins rapidly southward from about 100 feet in northern Denton County to about 65 feet in Tarrant County and about 4 feet on Brazos River.

Most concentrates of the Weno marls contain a variety of materials. Washed samples from this formation from exposures in those counties bordering on Red River are very arenaceous, and some contain quantities of pyrite. Farther south these minerals are negligible, and the samples are characterized by numerous molluscan and echinoid fragments, bits of teeth, and what has been regarded as vertebrae and bones of small fish.

The following species of ostracods have been found in samples from the Weno formation:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Cytherelloidea reticulata n. sp.
Bairdia harrisiana Jones
Bairdia comanchensis n. sp.
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.

Cythere concentrica (Reuss)
Cythere subconcentrica n. sp.
Cythereis nuda (Jones and Hinde)
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)
Cythereis hawleyi n. sp.
Cythereis sandidgei n. sp.
Cytheropteron rugosalatum n. sp.
Cytheropteron bilobatum n. sp.
Cytheropteron acutolatum n. sp.

LOCALITIES

Station 25. (Tarrant County.)—The lower part of the Weno formation occurs in an excellent exposure about 300 feet directly south of Station 19 (fig. 1). The outcrop here consists of yellowish and brownish clays exposed on the sloping bank of the small stream. These clays yield a rich and beautifully preserved microfauna, and this station has been chosen as the type locality for *Cythereis hawleyi* n. sp. and *Cytheropteron rugosalatum* n. sp.

Station 26. (Tarrant County.)—The upper part of the Weno and the lower and middle parts of the Pawpaw formations are exposed southeast of Fort Worth, along a tributary of Sycamore Creek one-quarter of a mile southeast of the point where the Fort Worth-Everman road turns from the Fort Worth-Burleson highway. Samples have been taken from the banks of the small stream, 300 feet east of the road, but the best material has been procured from the ditch along the west side of the highway, just where it swings southward near the top of the hill. In the ditch, ledges of upper Weno limestone are interstratified with layers of yellowish or grayish calcareous marl. Above these ledges are the brownish clays of the Pawpaw. By working southward along the road, which is sloping uphill in that direction, successively higher strata are encountered. All samples collected from this station have yielded excellent material (fig. 1). From this locality have been described *Cythere subconcentrica* n. sp. and *Cytheropteron acutolatum* n. sp. from Pawpaw beds and *Cythereis sandidgei* n. sp. from Weno beds.

Station 27. (Johnson County.)—The upper Weno is exposed in a roadside ditch on the south side of the Godley-Cleburne highway at the top of the hill just west of Concord, a town about 2¼ miles southeast of Godley along the highway. The exposure at this locality consists of alternating beds of grayish, calcareous marl and ledges of upper Weno limestone. The samples are moderately rich in fossils and contain a typical middle Washita fauna.

Station 28. (Denton County.)—The upper portion of the Weno and the basal portion of the Pawpaw formations are exposed in a roadside ditch on the north side of the Fort Worth-Denton highway, 2¾ miles northeast of Roanoke and just 0.1 mile up the hill northwest of the bridge over Denton Creek. Material from this locality contains considerable sand and is only moderately fossiliferous.

Station 29. (Grayson County.)—The dark-blue shales of the lower and middle Weno are well exposed in "Blue Cut," a deep railroad cut on the Missouri, Kansas & Texas Railroad, about 1 mile northeast of Denison. Concentrates of samples from this locality contain considerable sand and are only moderately fossiliferous. This is the type locality for *Cytheropteron bilobatum* n. sp.

The Weno formation is exposed also at Station 24.

PAWPAW FORMATION

The Pawpaw formation exhibits even greater and more striking lithologic changes than the Weno. In the region of Red River, and as far south as northern Denton County, it is composed of reddish, arenaceous clays interbedded with thin ironstone and sandstone slabs, and its appearance is deceptively like that of the Woodbine sand of the Upper Cretaceous series. Southward the clays of the Pawpaw become less sandy, and the ironstone and sandstone slabs fewer and thinner. From Tarrant County southward to Brazos River, the formation consists of reddish-brown, slightly arenaceous clays, which contain a rich, dwarfed fauna,[5] preserved in pyrite.

The Pawpaw formation, like the Weno, thins rapidly southward. It is 55 feet thick at Red River, 25 feet thick at Fort Worth, and only 12 feet thick in northern Johnson County.

Concentrates from the Pawpaw clays vary in content according to the region from which they are collected. Samples from the more northern exposures are very sparsely fossiliferous and contain mainly sand and bits of iron-cemented, sandstone slabs. Farther south the clays bear a rich microfauna and contain also considerable quantities of sand and some molluscan, echinoid and

[5]Adkins, W. S., 1.

crustacean fragments. Some pyrite is present in most samples, and in certain layers minute ammonites, snails and clams, preserved in this material, are quite abundant.

The following species of ostracods have been found in the Pawpaw formation of north Texas:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Bairdia harrisiana Jones
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.
Cythere concentrica (Reuss)
Cythere subconcentrica n. sp.
Cythereis nuda (Jones and Hinde)
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)
Cythereis sandidgei n. sp.
Cytheropteron rugosalatum n. sp.
Cytheropteron acutolatum n. sp.

LOCALITIES

Station 30. (Denton County.)—The uppermost part of the Pawpaw formation is exposed in a shallow ditch on the south side of the Sanger-Pilot Point road, 4¾ miles east of Sanger and 0.65 mile west of the bridge over Elm Fork of Trinity River. These dark reddish-brown, somewhat arenaceous clays contain a fairly rich microfauna.

The Pawpaw formation is also exposed at Stations 26 and 28.

MAIN STREET FORMATION

The Main Street is typically a limestone formation throughout its areal extent, and in north Texas it so closely resembles the Fort Worth limestone, that only a close observation of the fossils serves to distinguish the two. The formation is composed of regularly alternating layers of grayish limestones and compact, laminated, calcareous marls.

Southward the Main Street formation thickens gradually from about 20 feet at Red River to about 50 feet in Johnson County.

Concentrates of the Main Street marl layers contain large amounts of molluscan fragments, some bits of echinoid and crustacean tests, and small quantities of pyrite and limonite. Molluscan fragments make up the bulk of the material.

The following species of ostracods have been found in the Main Street formation:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Bairdia harrisiana Jones
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.
Cythereis nuda (Jones and Hinde)
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)

LOCALITIES

Station 31. (Tarrant County.)—A good exposure of the Main Street limestone occurs southwest of Fort Worth, in a railroad cut on the Santa Fe Railroad, about 200 feet south of the point where the road to the Baptist Seminary from the west crosses the tracks about 300 feet west of the Seminary campus. Projecting ledges of limestone alternate with seams of dark yellowish or brownish marl (fig. 2).

Station 32. (Tarrant County.)—The Main Street limestone is exposed along the banks of the south fork of Sycamore Creek, 4¼ miles south of the southwestern edge of the Baptist Seminary campus, on the Fort Worth-Crowley road. Yellowish and grayish seams of calcareous marl alternate with the typical, projecting ledges of Main Street limestone (fig. 2).

Station 33. (Johnson County.)—A rather poor exposure for the collection of marl samples occurs at the northern edge of the city of Cleburne, just east of the City Ball Park, where the highway leading into the city from Fort Worth parallels the tracks of the North Texas Traction Company. The marl layers are thin, calcareous, and hard, but unweathered samples contain a fairly rich microfauna.

GRAYSON FORMATION

The Grayson formation in north Texas is composed of a series of soft, yellowish or grayish marls, except for the upper one-third, which contains several ledges of hard, crystalline limestone. This upper part of the formation, with its limestone ledges, corresponds to the Buda limestone of central and south Texas. The lower, clay member of the Grayson formation is correlated with the south Texas, Del Rio formation. Hill (**28**, pp. 283, 288) correlated the Main Street formation with the Del Rio, and the entire Grayson with the Buda. Later workers, however, regarded the Main Street and Grayson formations as correlative with the Del Rio, and the lower portion of the Woodbine formation[6] of north Texas with the Buda.

Extensive studies of the macrofossils and of thin sections of the limestones from both the north Texas and south Texas areas have confirmed the conclusions published by Winton (**64**, p. 28) that the Main Street formation correlates with the upper member of the Georgetown limestone of south Texas, that the lower Grayson is the equivalent of the Del Rio, and that approximately the upper one-third of the Grayson corresponds to the Buda.

The Grayson formation thickens southward from 50 feet thick at Red River to 75 feet thick in southern Denton County. No exposures of the complete thickness occur in Tarrant or Johnson counties, so the thickness in these two regions can be only estimated. Winton and Scott (**66**, p. 28) give the thickness as about 100 feet for Johnson County.

The marls of this formation are extremely rich in both ostracods and foraminifera. The foraminiferal fauna, particularly, has a markedly Upper Cretaceous aspect. The concentrates contain small amounts of sand, fragments of echinoid tests and spines, and fragments of molluscan shells, particularly *Inoceramus* prisms. The lower layers in most places contain considerable quantities of pyrite, and dwarfed molluscan faunas preserved in pyrite are common. In the upper and middle layers varying amounts of gypsum and smaller amounts of pyrite and limonite are present.

[6]Udden, J. A., Baker, C. L., and Böse, E., **60**.

The following species of ostracods have been found in the Grayson formation:

Cytherella comanchensis n. sp.
Cytherella obovata Jones and Hinde
Cytherelloidea granulosa (Jones)
Cytherelloidea obliquirugata (Jones and Hinde)
Macrocypris graysonensis n. sp.
Bairdia harrisiana Jones
Bairdia parallela n. sp.
Paracypris alta n. sp.
Cytheridea washitaensis n. sp.
Cytheridea graysonensis n. sp.
Cythere triplicata (Römer)
Cythereis nuda (Jones and Hinde)
Cythereis paupera (Jones and Hinde)
Cythereis worthensis n. sp.
Cythereis dentonensis n. sp.
Cythereis ornatissima (Reuss)
Cythereis sandidgei n. sp.
Cythereis subovata n. sp.
Cythereis roanokensis n. sp.
Cythereis burlesonensis n. sp.

LOCALITIES

Station 34. (Denton County.)—The most complete outcrop of the Grayson in north Texas, in which the entire 75 feet of thickness of the formation are exposed, occurs in a high, southward-facing bluff on Denton Creek, 2 miles by road, east of the Fort Worth-Denton highway, at a point 3½ miles in a straight line northeast of Roanoke. This bluff can be seen from any point along the highway north of Roanoke. Samples collected up the entire face of this escarpment are very rich in microfossils. This is one of the finest collecting localities in all the north Texas Cretaceous area and is the type locality for *Cytherella comanchensis* n. sp., *Macrocypris graysonensis* n. sp., *Bairdia parallela* n. sp., *Paracypris alta* n. sp., *Cytheridea washitaensis* n. sp., *C. graysonensis* n. sp., *Cythereis subovata* n. sp., and *C. roanokensis*, n. sp.

Station 35. (Johnson County.)—An excellent exposure of upper Grayson that has produced concentrates rich in microfossils occurs in a steep, northwestward-facing slope three-quarters of a mile almost due east of Burleson and about 0.2 mile northeast of the Burleson-Alvarado road. This is the type locality for *Cythereis burlesonensis* n. sp.

Station 36. (Denton County.)—The lower portion of the Grayson formation is exposed in a deep road cut, 0.1 mile south of the intersection of the Denton-Aubrey road and Clear Creek, 4.8 miles by road northeast of the Denton courthouse square. Concentrates of samples from this locality vary greatly with the level in the cut. Some are almost completely devoid of microfossils, whereas others contain a fairly good number of species and individuals.

Station 37. (Grayson County.)—A small exposure of upper Grayson occurs in a low, northward-facing cliff that forms the south bank of a small stream, about 50 feet west of the Pottsboro-Fink road, about 3 miles north of Pottsboro. Samples from this locality contain a rich and characteristic Grayson microfauna.

UPPER CRETACEOUS (GULF SERIES)

WOODBINE FORMATION

The Woodbine formation consists largely of a series of ferruginous, argillaceous sands and sandstones that weather mostly a deep, reddish-brown in outcrops. A few seams or lenses of arenaceous or lignitic clays are interbedded with the sands. The base of the formation seems in most places to consist of a series of dark, black or blue, compactly laminated clays or shales. These basal beds are rarely well exposed. They, as well as the underlying Grayson clays, are at most places obscured by the detrital slopes of red Woodbine sands.

Changes in thickness of the Woodbine formation are great and rapid. At Red River, the formation measures about 500 feet in thickness, in Tarrant County about 300 feet, and it is entirely absent south of Brazos River. Stephenson (**57**, p. 3), on rather meager evidence, describes and refers to the Woodbine formation a thin series of non-calcareous, non-arenaceous clays, reported to extend from Brazos River southward to about the region of the city of Austin.

For the most part, the Woodbine is paleontologically an extremely impoverished formation. A few molluscan fossils have been recorded from the basal shales[7] and from the upper sand and clay members.[8] Until recently

[7]Scott, Gayle, **54**, p. 616.
[8]Hill, R. T., **28**, p. 314.

these, with several species of fossil plants,[9] constitute all that has been known of fossil remains from the Woodbine formation. The author's studies have added a number of species of ostracods from samples of the basal clay and shale members of the formation in the core of the Tarrant County Water Improvement District's well at Arlington, Texas. All species of ostracods found in these basal Woodbine shales at Arlington have also been recognized in the upper beds of the underlying Grayson formation. It is important to note, further, that many species of foraminifera, too, are common to the two formations.

The compact, black, laminated shales from which the above-mentioned samples were taken, agree exactly with numerous descriptions of the shales that have been regarded by various authors as the basal beds of the Woodbine at other localities and differ radically from any Grayson clays that the writer has ever seen, or of which he has been able to find descriptions. In the cores they are easily differentiated from the yellowish clays of the Grayson.

The lack of faunal breaks in the meager amount of material available for study suggests that in Tarrant County, at least, sedimentation must have been almost, if not quite, continuous through the time period during which the upper Grayson clays and these basal black shales of the Woodbine were deposited. On account of the paucity of the macrofauna, the solution of the problem of the origin and time relationships of the Woodbine formation throughout its areal extent will perhaps be reached through a careful study of the microfossils. The author plans to make a series of careful collections along this much-disputed contact of the Woodbine with the Comanche formations. in an attempt to gather evidence which will establish whether the Woodbine is actually transgressive in Oklahoma and Arkansas, or whether the regression postulated by Scott simply began

[9]Knowlton, F. H., **37**, p. 314; Berry, E. W., **6**.

earlier in that area. Collections from several arenaceous and lignitic clay layers throughout the Woodbine formation have so far failed to produce any microfossils.

Concentrates from the basal shale layers from the Arlington drill core contained, besides numerous ostracods and foraminiferans, a quantity of molluscan fragments, a small amount of echinoid material, some sand, and varying quantities of pyrite.

The following species of ostracods have been found in the Woodbine formation:

Bairdia harrisiana Jones
Cytheridea graysonensis n. sp.
Cythere triplicata (Römer)
Cythereis worthensis n. sp.
Cythereis roanokensis n. sp.
Cythereis burlesonensis n. sp.

LOCALITIES

Samples collected from many of the clay and lignitic shale layers of the Woodbine formation have not as yet yielded any microfossils. The high mineral content of the waters which deposited the sediments of this formation, as evidenced by the nature of the sediments, was evidently not favorable to the growth of animal life. Since the basal shale members of the formation are rarely or never well exposed, no localities for surface samples from this formation are recorded.

EAGLE FORD FORMATION

The Eagle Ford formation in north Texas is composed of a thick series of compactly laminated, black, bituminous shales, including a few thin slabs of argillaceous limestone, and at some localities, more or less abundant nodular limestone concretions.

The base of the Eagle Ford formation is marked throughout north Texas, and as far south as Austin at least, by a thin bed composed of numerous teeth and bones of fish, coarse sands, and quartz pebbles, which are in some places cemented into a true conglomerate.

The formation thins rapidly southward from about 600 feet at Red River to about 500 feet at Dallas, 350 feet at

Midlothian, and 30 feet at Austin. This thinning is always at the expense of the lower beds, so that fossil zones, which in the region of Dallas occur in the upper part of the formation, at Austin lie at the base and in contact with the Buda limestone, since the Woodbine sand is not developed so far south. Fossil zones that occur at the base of the Eagle Ford in contact with the Woodbine in the Dallas area are totally absent at Austin. Thus, it must be recognized that the Eagle Ford is transgressive toward the south, first over the Woodbine sand, and farther southward over the statigraphically lower Buda limestone.

Concentrates of some samples of the Eagle Ford shales are extremely difficult to make. The bituminous shales break down only under prolonged and vigorous treatment. The concentrates contain a large quantity of sand and other mineral matter, and in certain zones, molluscan fragments in moderate abundance, foraminifera in considerable numbers, and occasional ostracods.

Microfossils have been found to occur in number only in two zones in the Eagle Ford formation, namely, the horizons of the two ammonite species *Metoicoceras whitei* Hyatt and *Metoicoceras irwini* Moreman. Both the macro- and microfaunas of the Eagle Ford, as well as its stratigraphic relations, are described in considerable detail in Moreman's recent paper **(41)** on that formation.

The following species of ostracods have been found in the Eagle Ford formation:

Cytherella münsteri (Römer)
Bairdia subdeltoidea (Münster)
Cythereis eaglefordensis n. sp.

LOCALITIES

Station 38. (Denton County.)—The zone of *Metoicoceras whitei* Hyatt of the Eagle Ford formation is exposed on Indian Creek, 6½ miles east of the railroad crossing at the town of Lewisville. There are a number of exposures along Indian Creek. The one from which the writer's collections were made is a steep, eastward-facing slope, about 400 feet east of the road, which runs north and south at this point. Concentrates of samples taken from the shales along this slope contain considerable sand and some foraminifera. Ostracods, which are nowhere common in Eagle Ford samples, are present in some of the concentrates and absent in others.

Station 39. (Ellis County.)—The *Metoicoceras whitei* zone of the Eagle Ford is exposed also in a northwestward-facing cliff on a tributary of Mountain Creek, one-quarter mile east of the concrete bridge on the Fort Worth-Midlothian highway about 3 miles north of Midlothian. Concentrates contain some sand, and whereas they are not rich in microfossils they contain a characteristic assortment of species.

Station 40. (Dallas County.)—The zone of *Metoicoceras irwini* Moreman of the Eagle Ford formation is exposed in a small tributary of the Elm Fork of Trinity River, where the Irving-Coppell road crosses the stream, about 6 miles northwest of Irving. Samples from this locality contain a fairly rich and well preserved foraminiferal fauna and a few ostracods. This is the type locality for *Cythereis eaglefordensis* n. sp.

Station 41. (Dallas County.)—The contact zone of the Eagle Ford and the overlying Austin formation is exposed on Chalk Hill, 3 miles west of Dallas, on the Fort Worth-Dallas highway. Concentrates of the topmost beds of the Eagle Ford at this locality contain an abundance of quartz sand and numerous foraminifera. Ostracods are extremely rare, and only one or two poorly preserved specimens have been found in the examination of many samples from this zone.

AUSTIN FORMATION

Lithologically, the Austin chalk is the most distinctive and easily recognizable formation in the entire Texas Cretaceous column. It is a massive chalk, or chalky limestone containing a few thin seas of grayish calcareous marl. The chalk is a faint blue color in fresh cuts and a glaring white in weathered exposures. It forms a steep and prominent westward-facing escarpment all along its line of contact with the underlying Eagle Ford, and eastward it passes imperceptibly into the flat plains underlain by the Taylor formation.

The Austin chalk reaches a maximum thickness of about 800 or 900 feet at Red River, measures between 600 and 700 feet at Dallas, and is only about 400 feet or slightly more at Austin.

Stephenson (**57**, p. 7) suggests that the increase in thickness of the Austin chalk from Dallas toward Red

River, is at the expense of the lower Taylor marls, so that the top of the chalk in northeastern Texas may correspond to the middle of the Taylor formation as exposed at the type locality in Williamson County. Evidence from the present studies of the ostracods favors this conclusion. Species that in Dallas County occur in the middle of the Taylor have been found in the top of the Austin in the region of Red River.

Stephenson also postulates a minor unconformity between the Austin and the overlying Taylor, extending probably from Hill County southward to Comal County.

The base of the Austin formation consists of a thin bed of dark colored, arenaceous clays, usually regarded as belonging to the Eagle Ford formation (see Station 41) and commonly known as the "Fish Bed Conglomerate." Concentrates of these clays contain numerous foraminifera and a great abundance of feldspathic quartz sand. Fragments of teeth and scales of fish are also common, and it is from these that the beds have derived their name.

It is generally admitted that an unconformity separates the Eagle Ford and Austin formations, at least along the greater part of their line of contact, and that the "Fish Bed Conglomerates" mark the transgressive movement of the seas that deposited the Austin calcareous muds.

Certain large representatives of the genus *Inoceramus* are known to be important markers of the Austin chalk, and samples concentrated from any of the occasional marl seams of the formation are usually composed very largely of the prisms from the shells of members of this genus.

The following species of ostracods have been found in the Austin formation:

Cytherella parallela (Reuss)
Cytherella obesa n. sp.
Cytherella austinensis n. sp.
Bairdia rotunda (Alexander)
Paracypris pulchella n. sp.
Krithe cushmani n. sp.
Cythere semiplicata (Reuss)
Cythere sphenoides Reuss

Cythere taylorensis n. sp.
Cythere ponderosana (Israelsky)
Cythere cornuta var, gulfensis n. var.
Cythereis austinensis n. sp.
Cythereis dallasensis n. sp.

LOCALITIES

Station 42. (Dallas County.)—The upper Austin is exposed northeast of Dallas on the southern bank of a small stream that runs into White Rock Reservoir, 3.4 miles by road northeast of the White Rock dam, on the Dallas-Garland road. The exposure lies to the west of the concrete bridge that crosses the stream. A thin marl seam between massive chalk ledges occurs about 10 feet below road level. Concentrates from this marl seam contain a rich microfauna. This is the type locality for *Cytherella obesa* n. sp., *C. austinensis* n. sp., *Paracypris pulchella* n. sp., *Cythereis austinensis* n. sp., and *C. dallasensis.*

Station 43. (Dallas County.)—A good exposure of the top of the Austin occurs 1 mile east of Garland, on the Garland-Rockwall road, in a small tributary of Rowlett Creek, about 30 feet south of the road.

Station 44. (Dallas County.)—The upper Austin is exposed in a roadside ditch on the Lancaster-Waxahachie road, 0.5 mile south of the bridge across Ten Mile Creek.

Station 45. (Dallas County.)—The middle portion of the Austin is exposed on the Lancaster-Cedar Hill road, just west of the Ten Mile Creek bridge, 7 miles east of Cedar Hill .

Station 46. (Dallas County.)—The basal members of the Austin are exposed on the Fort Worth-Dallas highway, at Chalk Hill, about 300 feet east and up the hill from Station 41.

Station 47. (Fannin County.)—The top of the Austin is exposed in a creek bed, 7¾ miles north of Ladonia. This is the locality from which the author has obtained ostracod species that occur in the middle of the Taylor formation in Dallas County.

Station 48. (Ellis County.)—The uppermost part of the Austin occurs in a roadside ditch north of the road, at a point 1 mile northwest of the crossing of the Midlothian-Waxahachie highway with the Houston & Texas Central Railway at the northwestern edge of the city of Waxahachie.

The Austin chalk occurs also at Station 41.

TAYLOR FORMATION

The Taylor formation consists largely of calcareous clays and marls, in most places yellowish or grayish in color but in some exposures bluish and somewhat bituminous. These clays weather so rapidly into a regolith of thin, black soil that exposures of any extent are extremely rare, and estimates of thickness, and faunal sequence, are very difficult to make.

The thickness of the formation was estimated by Hill (**28**, p. 337) as varying from about 650 feet at Austin to somewhat less than 1,000 feet at Corsicana.

Stephenson (**56**, pp. 155–156) in 1918 described two distinct and adjacent members within the Taylor formation: the lower one, the Wolfe City sand is an argillaceous sand; the upper one, the Pecan Gap chalk is an argillaceous chalk. Recently Dane and Stephenson (**22**) described southerly continuations of these two units, the Wolfe City sand being recognizable as far south as the city of Hubbard, Hill County, and the Pecan Gap chalk being recorded as far south as Rockwall County. They describe also three less extensive, new member units within the Taylor from the region of Brazos River. These authors show that about 500 feet of marl immediately overlying the Pecan Gap chalk in north Texas, and heretofore regarded as the lower beds of the Navarro formation, bear closer faunal affinities with the Taylor than with the Navarro and should be regarded as the upper part of the Taylor. The writer has made collections from these upper clays in southeastern Collin County, in southwestern Hunt County, and in Kaufman County and has classified them, on the basis of their microfaunas, as Taylor.

Most concentrates of typical Taylor clays contain an extremely rich foraminiferal fauna, an abundance of ostracods, a few molluscan and echinoid fragments, and a small amount of sand.

Samples from the Wolfe City sand member of the Taylor consist principally of a fine-grained quartz sand, but they contain many more microfossils than do samples from most sand formations.

Concentrates of the Pecan Gap chalk do not differ markedly in general appearance and content from those of the typical Taylor marls.

The following species of ostracods have been found in the Taylor formation:

Cytherella parallela (Reuss)
Cytherella obesa n. sp.
Cytherella austinensis n. sp.
Bairdia rotunda (Alexander)
Paracypris angusta n. sp.
Krithe cushmani n. sp.
Cytheridea perforata (Römer)
Cytheridea plummeri n. sp.
Cythere semiplicata (Reuss)
Cythere sphenoides Reuss
Cythere taylorensis n. sp.
Cythere foersteriana (Bosquet)
Cythere ponderosana (Israelsky)
Cythere gapensis n. sp.
Cythere cornuta var. gulfensis n. var.
Cythereis dallasensis n. sp.
Cythereis bicornis Israelsky
Cythereis rugosissima n. sp.

LOCALITIES

Station 49. (Dallas County.)—An exposure of lower Taylor marl, very near the base of the formation, occurs on the Garland-Rockwall road, 0.7 mile east of Rowlett, where the highway runs beneath the tracks of the Missouri, Kansas & Texas Railroad. The exposure is in a low slope just north of the road and just west of the railroad trestle. The clays are yellowish in color and contain a rich lower Taylor microfauna. This is the type locality for *Paracypris angusta* n. sp., and *Krithe cushmani* n. sp.

Station 50. (Collin County.)—The Pecan Gap member of the Taylor formation is exposed in a deep railroad cut on the Santa Fe Railroad in the town of Farmersville. The exposure is in the steep banks of the cut about 500 feet north of a high, wooden viaduct over the railroad tracks.

Station 51. (Collin County.)—The Wolfe City sand member of the Taylor formation, in contact with typical Taylor clays below, occurs on the east bank of a railroad cut on the Santa Fe Railroad, 0.6 miles north of the railroad station at Copeville.

Station 52. (Collin County.)—The Wolfe City sand occurs in a shallow roadside ditch, on the east side of the Copeville-Farmersville road, 0.4 mile north of the Copeville station. The sands in this exposure are slightly cemented, forming a soft, argillaceaus sandstone. The sands contain a fairly rich and well preserved microfauna.

Station 53. (Collin County.)—Upper Taylor clays, overlying the Wolfe City and Pecan Gap members of the formation, are exposed in a deep roadside ditch on the east side of the Copeville-Garland road, 2 miles by road south of Copeville.

Station 54. (Hunt County.)—The uppermost beds of the Taylor formation are exposed in a deep roadside ditch on the west side of the Caddo Mills-Greenville road, and just north of the small concrete bridge, 4.8 miles northeast of the station at Caddo Mills. The exposure consists of dark, yellowish clays which contain a fairly rich and well-preserved microfauna. These clays lies 400 to 500 feet above the top of the Pecan Gap chalk.

Station 55. (Kaufman County.)—The southernmost known exposure of Pecan Gap chalk occurs in a roadside ditch on the north side of the Forney-Mesquite road, 0.7 mile west of a large garage in the edge of Forney. The exposure consists of a slightly chalky, yellowish clay and contains a fairly abundant, typical Pecan Gap microfauna. This is the type locality for *Cythere gapensis* n. sp.

Station 56. (Kaufman County).—Yellow clays, stratigraphically slightly above the Pecan Gap member of the Taylor formation and containing a rich and typical middle Taylor microfauna, are exposed in a shallow roadside ditch on the north side of the Forney-Rockwall road, 2.3 miles northwest of Forney.

Station 57. (Rockwall County.)—A highly argillaceous chalk that lies in the top of the Pecan Gap member of the Taylor formation occurs in ditches on both sides of the Rockwall-Greenville road, 1.8 miles northeast of the Rockwall courthouse. The sample used in this report was collected from the ditch south of the highway. This is the type locality for the foraminifera *Pseudouvigerina plummerae* Cushman and *Bolivinita planata* Cushman.

Station 58. (Ellis County.)—Lower middle Taylor is exposed in a roadside ditch on the north side of the Garret-Boyce road, 2.8 miles by road east of the railroad station in the town of Boyce. This is the type locality for *Cythere taylorensis* n. sp.

Station 59. (Williamson County.)—Lower Taylor marls are exposed in a roadside ditch on the Granger-Bartlett road, 2.8 miles by road north of the Granger railroad station. This locality is outside the area covered by this report, but samples of the marls from this locality were examined for the purpose of comparison with the writer's north Texas material. This is the type locality for *Cytheridea plummeri* n. sp., *Cythere cornuta* (F. A. Roemer) var. *gulfensis* n. var., and *Cythereis rugosissima* n. sp.

NAVARRO FORMATION

The Navarro is, like the underlying Taylor, typically a clay formation. Its clays are in most places somewhat sandy, especially in the lower part and in many places compactly laminated and shaly. The division between Taylor and Navarro is rather difficult to make. Although no physical evidence of unconformity is recognized between these two formations, Dane and Stephenson (**22,** p. 56) postulate such a break south of Navarro County on the basis of a gradual thinning of the Navarro formation southward through Fall and Milam counties and on the disappearance in these counties of a zone marked by the oyster *Exogyra cancellata* Stephenson, which occurs at the base of the Navarro in Navarro County and as far southward as northern Milam County.

The argillaceous and calcareous sand member in the lower part of the Navarro formation is regarded as the southward extension of the Nacatoch sand of Arkansas.[10]

The Navarro formation probably attains a thickness of 600 or 700 feet in north Texas. As is true of the underlying Taylor formation, exposures are few and poor, and estimates of thickness therefore difficult.

The relationship of the Navarro of north Texas to the Escondido formation of south Texas has for a long time been one of the interesting problems of Texas Cretaceous stratigraphy, and recently the question of the length of the time-break between the top of the Navarro and the overlying Midway formation (Eocene) has attracted considerable attention.

The writer has had the opportunity of examining only one sample from the Escondido, collected from the vicinity of Eagle Pass, Texas. Although ostracods are very rare in this sample, those which occur indicate a correlation of the Escondido with the upper part of the Navarro, as that formation is developed in north Texas.

Dr. Scott (**52,** p. 114) in his recent publication on the Cretaceous stratigraphy of Texas, correlates the lower part of the Midway formation with the Danian of Europe and states his belief that the hiatus between the Navarro and Midway formations represents not nearly so long a time

[10]Stephenson, L. W., **57.**

period as has been commonly supposed. His work has been severely criticized by Stephenson **(57,** p. 16) and Gardner **(27),** who do not agree with his correlation of the lower Midway with the Danian, nor with his estimate of the time interval represented by the unconformity between the upper Navarro and the basal Midway.

Dr. Gardner states that so sharply separated are the Navarro and Midway foraminiferal faunas that with the "crudest sort of knowledge of these groups," she has been able to make correct age determinations in the field.

Mrs. Plummer **(43,** p. 20) however, in her paper on the Midway foraminifera, which is obviously the result of long and careful studies, states that "the occurrence in the late Navarro sea of several Midway species, some of which in varying forms are typical of the Texas Tertiary strata in general, and the corresponding weakening of the dominant Cretaceous faunal characteristics in these topmost strata may indicate that the hiatus represented by the unconformity is not so tremendous as has been previously assumed."

The ostracods throw a little additional light on this subject. Though the many differences between the ostracod fauna of the upper Navarro and that of the lower Midway are sufficiently marked to make each faunal group distinguishable, a few species are present in both formations. Further, many species in the Midway show clear relationship with upper Navarro species, and exhibit but few changes from their Navarro precursors in the direction that would be expected from a study of the evolution of these groups. Thus, the micropaleontogical evidence seems to justify Dr. Scott's suggestion that the hiatus between the upper Navarro and the basal Midway is not so great as has been commonly supposed. A definite correlation of the lower Midway with the Danian must await more detailed comparative studies in all branches of paleontologic work.

The following species of ostracods have been found in the Navarro formation:

Cytherella tuberculifera n. sp.
Cytherella navarroensis n. sp.
Cytherella moremani n. sp.
Cytherella ovoidea n. sp.
Cytherelloidea williamsoniana (Jones)
Bairdia magna Alexander
Cytheridea everetti Berry
Cytheridea monmouthensis Berry
Cytheridea truncata Berry
Cytherdea globosa n. sp.
Cytheridea fabaformis (Berry)
Cytheridea micropunctata n. sp.
Cytheridea macropora n. sp.
Cythere parallelopora n. sp.
Cythere cornuta var. gulfensis n. var.
Cythere rhomboidalis Berry
Cythere ovata (Berry)
Cythere acutocaudata n. sp.
Cythere huntensis n. sp.
Cythereis communis Israelsky
Cythereis hazardi Israelsky
Cytheropteron navarroense n. sp.
Cytheropteron hannai (Israelsky)

LOCALITIES

Station 60. (Navarro County.)—Lower Navarro clays, bearing an extremely rich and well preserved microfauna are exposed in the clay pits 2 miles, by road, south of Corsicana, along the tracks of the Houston & Texas Central Railroad. The clays at this locality lie about 50 feet above the Nacatoch sand member of the Navarro formation. This is the type locality for *Cytherella tuberculifera* n. sp., *C. navarroensis* n. sp., *C. moremani* n. sp., *C. ovoidea* n. sp., *Cytheridea globosa* n. sp., *C. micropunctata* n. sp., *Cythere parallelopora* n. sp., and *Cytheropteron navarroense* n. sp. From this same outcrop has been described the foraminifer, *Cristellaria navarroensis* Plummer.

Station 61. (Hunt County.)—An exposure at the Navarro-Midway contact is found 3 miles by road northwest of Lone Oak, in a shallow gully, in a field 200 feet north of the road. Both formations at this locality are somewhat arenaceous, and the Midway clays are highly glauconitic. The upper Navarro microfauna is not rich, but contains a characteristic assemblage of species. This is the type locality for *Cythere huntensis* n. sp. and *Cytheridea macropora* n. sp.

Station 62. (Navarro County.)—Upper Navarro clays, about half-way between the Nacatoch sand member of the formation and the

Navarro-Midway contact, were sampled 4 miles southeast of Chatfield. This exposure is in a deep roadside ditch on the east side of the road, 0.3 mile from the point where a road turns southward from the main road between Chatfield and Montfort.

DESCRIPTION OF GENERA AND SPECIES

Sub-Order PLATYCOPA

Family CYTHERELLIDAE

Genus CYTHERELLA Jones, 1849

Cytherella, T. R. Jones, Mon. Entomos. Cret. England, 1849, Mon. Paleontogr. Soc. London, p. 28.

Carapace in side view ovate or subovate; compressed, especially in front; greatest width or convexity of shell varies in different species from about the middle backward to the posterior extremity. Right valve conspicuously larger than left and overlapping it around entire margin. Hinge structure consists of a simple groove along the dorsal margin of the larger right valve, into which fits a simple flange-like ridge of the left valve. Surface smooth or punctate, never roughly sculptured.

Specific determination within the genus *Cytherella* is difficult, since differentiation must be based on such characters as (1) position of greatest convexity, (2) amount of curvature of dorsal, ventral, anterior, and posterior margins in lateral view, (3) proportion of height of carapace to length, (4) amount of overlap of right valve over left, along the different parts of the periphery, (5) appearance of anterior and posterior ends in dorsal view.

Genotype: *Cythere compressa* Münster.

CYTHERELLA OVATA (F. A. Roemer)

Pl. I. figs. 1 and 2

Cytherina ovata F. A. Roemer, 1840, Verstein. norddeutsch. Kreidegeb., p. 104, pl. 16, fig. 21.

Cytherina complanata Reuss, 1845, Verstein. böhm. Kreideform., pt. 1, p. 16, pl. 5, fig. 35.

Cythere reniformis Bosquet, 1847, Mém. Soc. Roy. Sci., Liége, vol. 4, p. 356, pl. 1, figs. 1a–f.

Cytherella ovata Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 28, pl. 7, figs. 24a–i.

Cytherella complanata Reuss., 1854, Denkschr. K. Akad. Wiss., Wien, vol. 7, p. 140, pl. 28, fig. 9.

Carapace in side view ovate, greatest height slightly behind middle. Dorsal margin arched, with long, rather flat anterior slope, and with shorter, slightly steeper and rounder posterior slope. Ventral margin very gently and evenly convex downward. Anterior margin broadly and evenly rounded. Posterior end obliquely rounded, obscurely angled slightly below middle. Right valve larger, and overlapping left, with strongest overlap along dorsal margin. In dorsal view, carapace elongate-ovate, widest behind middle; anterior end subacute, posterior roundly truncated. Surface smooth.

Length, 0.78 mm.; height, 0.6 mm.; width, 0.43 mm.

This species ranges through the Goodland and Kiamichi formations but is common only in the upper and middle portions of the Goodland. It is extremely rare in the Kiamichi.

Plesiotypes selected from Stations 2 and 4, Goodland formation.

CYTHERELLA SCOTTI n. sp.

Pl. I, figs. 12, 15

Carapace in dorsal view oblong-ovate, highest at anterior and posterior ends, constricted in the middle. Dorsal and ventral margins sinuate. Anterior end broadly rounded. Posterior end rounded and only slightly less broad than anterior. In dorsal view, carapace lanceolate; widest at posterior end which is truncated, with sides sloping flatly toward acute anterior end. Right valve overlapping left slightly around entire margin.

Length, 0.85 mm.; height, 0.45 mm.; width, 0.34 mm.

This species has been found only in the upper quarter of the Goodland formation where it is not common.

Holotype from Station 2, Goodland formation.

CYTHERELLA COMANCHENSIS n. sp.

Pl. I, figs. 7, 8

Carapace in side view ovate, highest at middle. Dorsal margin gently arched. Ventral margin gently convex downward, with slight sinuosity slightly behind middle. Anterior end broadly rounded. Posterior end low, narrower than anterior, and obliquely rounded. Right valve overlapping left, with strongest overlap along anterior portions of dorsal and ventral margins. Carapace in dorsal view with greatest width at posterior end; anterior end acute, posterior end roundly truncated. Surface smooth.

Length, 0.7 mm.; height, 0.42 mm.; width, 0.3 mm.

This species ranges from the Fort Worth formation upward to the top of the Grayson. It is rare in the Fort Worth and reaches its greatest abundance in the upper part of the Grayson.

Holotype from Station 34, upper Grayson.

CYTHERELLA OBOVATA Jones and Hinde

Pl. II, figs. 5, 9

Cytherella obovata Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 46, pl. 3, figs. 46, 47.

Carapace in side view obovate, with greatest height anterior to middle. Dorsal margin gently arched. Ventral margin gently sinuate slightly behind middle. Anterior end broadly rounded. Posterior end narrow, low, acuminately rounded. In dorsal view, valves gently and evenly convex; anterior end acute, posterior end blunt.

Length, 0.72 mm.; height, 0.42 mm.; width, 0.25 mm.

This species is common only in the Grayson, although it occurs rarely from the Fort Worth formation upward to the top of the Washita division.

Plesiotype selected from Station 34, Grayson formation.

CYTHERELLA MUENSTERI (F. A. Roemer)

Pl. I, figs. 9, 10

Cytherina muensteri Roemer, 1838, Neues Jahrb. f. Min. etc., p. 516, pl. 6, fig. 13.
Cytherella muensteri Bosquet, 1852, Mém. Cour. Acad. Roy. Sci., Belg., vol. 24, p. 13, pl. 1, figs. 2a–d.

Carapace in side view oblong, height equal to slightly more than one-half the length. Dorsal and ventral margins straight, parallel. Anterior end broadly rounded. Posterior end broadly and somewhat obliquely rounded, and slightly lower than anterior end. Right valve overlapping left slightly around entire periphery. Carapace in dorsal view, widest posteriorly; anterior end acute, posterior end roundly truncated. Surface minutely punctate, granular in appearance.

Length, 0.6 mm.; height, 0.33 mm.; width, 0.24 mm.

This species occurs only in the Eagle Ford formation, where it is nowhere very common.

Plesiotype selected from Station 39, Eagle Ford formation.

CYTHERELLA PARALLELA (Reuss)

Pl. I, figs. 13, 16

Cytherina parallela Reuss, 1845, Verstein, böhm. Kreidef., pt. 1, p. 16, pl. 5, fig. 33.
Cythere truncata Bosquet, 1847, Mém. Soc. Roy. Sci. Liége, vol. 4, p. 357, pl. 1, figs. 2a–e.
Cytherella truncata Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 30, pl. 7, figs. 25a–e.
Cytherella parallela Reuss, 1854, Denkschr. K. Akad. Wiss. Wien, vol. 7, p. 40.

Carapace in side view subovate, height equal to about two-thirds length. Dorsal and ventral margins straight and parallel. Anterior and posterior ends rounded, posterior slightly narrower than anterior. Right valve overlapping left slightly around entire margin. Carapace in dorsal view widest posteriorly; anterior end acute, posterior roundly truncated. Surface smooth.

Length, 0.7 mm.; height, 0.48 mm.; width, 0.31 mm.

This species is very similar in general appearance to *Cytherella muensteri* but is readily differentiated by its smooth surface.

C. parallela has been found commonly in the Taylor marls, both below and above the Wolfe City sand member of the formation. No examples of the species have been found within this sand member, however. This species also occurs rarely in the upper part of the Austin chalk.

Plesiotype selected from Station 49, Taylor formation.

CYTHERELLA OBESA n. sp.

Pl. I, figs. 3, 6

Carapace in side view ovate, highest at middle. Dorsal margin gently and evenly arched. Ventral margin gently and evenly convex downward. Anterior end broadly rounded. Posterior end rounded, slightly less broad than anterior. Right valve overlapping left, with overlap slightly stronger along dorsal and ventral borders than along anterior margin. Valves strongly convex with greatest width near posterior end. In dorsal view, anterior end subacute, posterior blunt, rounded. Surface smooth.

Length, 0.82 mm.; height, 0.54 mm.; width, 0.4 mm.

This species occurs from the upper part of the Austin formation to the top of the Pecan Gap chalk member of the Taylor. It is nowhere abundant, although it is fairly common in the upper Austin chalk and in the Pecan Gap chalk. It has not been found in the Wolfe City sand member of the Taylor.

Holotype from Station 42, Austin formation.

CYTHERELLA AUSTINENSIS n. sp.

Pl. II, figs. 4, 6

Carapace in side view oblong-ovate; highest slightly anterior to middle. Dorsal margin gently arched. Ventral margin gently convex downward. Anterior end broad, evenly rounded. Posterior end low, considerably narrower than anterior, obliquely rounded. Right valve larger than left, overlapping it around entire periphery; overlap increases anteriorly along ventral margin diminishing slightly at antero-ventral angle and continues evenly around anterior margin and backward to middle of dorsal margin, where it conspicuously decreases and remains very slight around posterior end. Carapace gently convex, with greatest width at about middle. In dorsal view, anterior and posterior ends subacute, with posterior somewhat blunter than anterior. Surface smooth.

Length, 0.8 mm.; height, 0.48 mm.; width, 0.32 mm.

This species ranges from the upper Austin chalk, where it is fairly common, up to the top of the Pecan Gap chalk member of the Taylor formation, where it is again common. It is a rare form in the intervening Taylor marls and in the Wolfe City sand member of the Taylor.

Holotype from Station 42, upper Austin chalk.

CYTHERELLA TUBERCULIFERA n. sp

Pl. II, fig. 3

Carapace in side view oblong-ovate, highest at middle. Dorsal margin gently arched. Ventral margin gently convex downward. Dorsal and ventral margins subparallel, converging slightly anteriorly. Anterior and posterior margins rounded, posterior margin of right valve bearing a short, blunt, posterior projection at middle. Right valve overlapping left, with strongest overlap along middle of dorsal, ventral and posterior margins. Carapace moderately convex, widest posteriorly; anterior end subacute, posterior blunt, with slight projection from right valve. Surface smooth.

Length, 0.92 mm.; height, 0.54 mm.; width, 0.37 mm.

This species ranges from the Nacotoch sand member of the Navarro formation upward to the Navarro-Midway contact. It is fairly common throughout most of its range.

Holotype from Station 60, lower Navarro clays.

CYTHERELLA NAVARROENSIS n. sp.

Pl. II, figs. 1, 2

Carapace in side view oblong-ovate. Highest at, or slightly in front of, middle. Dorsal margin gently arched, sloping more strongly posteriorly than anteriorly. Ventral margin gently convex downward. Anterior end broadly and obliquely rounded. Posterior low, considerably narrower than anterior and obliquely rounded. Right valve larger; strongest overlap along anterior portion of dorsal and ventral margins. Carapace of moderate convexity, with greatest width at or slightly behind middle. In dorsal view, sides of valves slope flatly toward either end; anterior end subacute, posterior end slightly blunter. Surface smooth.

Length, 0.95 mm.; height, 0.56 mm.; width, 0.37 mm.

This species is very similar in appearance to *C. austinensis* of the upper Austin formation. It may be distinguished, however, by the following differences: (1) dorsal and ventral overlap in this species notably stronger than anterior; and (2) in dorsal view, the sides of the valves in this species slope flatly toward each end, whereas in *C. austinensis* they are gently and evenly convex.

Cytherella navarroensis is common in the upper Navarro, but has been found to occur rarely through the lower clays downward into the upper part of the Taylor formation.

Holotype from Station 60, lower Navarro clays.

CYTHERELLA MOREMANI n. sp.

Pl. I, figs. 4, 5

Carapace in side view ovate; greatest height at or slightly anterior to middle. Dorsal margin arched, with short, rather flat anterior slope, and with longer, slightly steeper, and more rounded posterior slope. Ventral margin evenly convex downward. Anterior end broadly rounded. Posterior end low, narrow and obscurely angled below middle. Right valve overlapping left, with strongest overlap along ventral margin and anterior portion of dorsal margin. Carapace in dorsal view, elongate-ovate, widest slightly behind middle. Surface of valves slopes flatly toward each end; anterior end subacute, posterior end blunt. Surface smooth.

Length, 0.92 mm.; height, 0.62 mm.; width, 0.41 mm.

This species closely resembles *C. ovata* and *C. obesa.* It is easily distinguished from the former by the position of the highest point on the dorsal margin which occurs at or slightly in front of the middle, giving a short flat anterior slope and a long rounded posterior slope; whereas in *C. ovata* the highest point on the dorsal margin is posterior to the middle and gives a long flat anterior slope and a short rounded posterior slope. It may be differentiated from *C. obesa* by the shape of its posterior margin, which is narrow and obliquely rounded; whereas in *C. obesa* the posterior margin is only slightly less broad than the anterior and is evenly rounded.

Cytherella moremani occurs quite commonly through the upper two-thirds of the Navarro formation but is rarer in the upper part of its range and does not occur at all in the few feet of glauconitic clays just below the Navarro-Midway contact.

Holotype from Station 60, lower Navarro clays.

CYTHERELLA OVOIDEA n. sp.

Pl. I, figs. 11, 14

Carapace in side view an almost perfect oval; highest at middle. Dorsal margin moderately and evenly arched. Ventral margin evenly convex downward. Anterior end rounded; posterior slightly narrower than anterior, rounded. Right valve overlapping left, with strongest overlap along dorsal and ventral margins. Carapace in dorsal view oblong-ovate, widest somewhat behind middle; anterior end subacute, posterior roundly truncated. Surface smooth.

Length, 0.74 mm.; height, 0.5 mm.; width, 0.3 mm.

This species ranges through the upper two-thirds of the Navarro formation. It is fairly common toward the lower part of its stratigraphic range and becomes rarer upward.

Holotype from Station 60, lower Navarro clays.

Genus CYTHERELLOIDEA new genus

This new genus is proposed for a number of forms both fossil and recent, which until now have been regarded as members of the genus *Cytherella,* although differing greatly in many respects in their shell characters from the original description of that genus as outlined by Jones (**29,** p. 28) in 1849. In spite of the obvious differences, Jones placed these forms in his genus *Cytherella.*

Carapace in side view, roughly oblong-ovate or subquadrangular. Carapace compressed, especially in front; internal cavity shallow. Greatest width of carapace at posterior end. The two valves are subequal, the right valve being very slightly larger than the left, and never overlapping it strongly or extending beyond it for more than a very short distance along the periphery. The hinge structure, as in *Cytherella,* consists of a groove in the right and a flange in the left valve. Surface always more or less sculptured, bearing tubercles, ridges, and pits, and usually with a narrow, convex, marginal ridge extending around the periphery of the valves.

Genotype: *Cytherella williamsoniana* Jones, 1849.

CYTHERELLOIDEA WILLIAMSONIANA (Jones)

Pl. II, fig. 12

Cytherella williamsoniana Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 31, pl. 7, figs. 26a–i.

Cypridina leioptycha Reuss, 1851, Haidinger's Naturwiss. Abhandl., vol. 4, pt. 1, p. 49, pl. 6, fig. 11.

Carapace in side view oblong, subquadrangular. Valves flat, with very shallow internal cavity. Dorsal and ventral margins straight, parallel. Anterior and posterior ends rounded, sub-equal. A narrow ridge near the anterior border dies out dorsally and ventrally. Two longitudinal ridges, one near the dorsal and the other near the ventral edge of the valves, beginning at the anterior third of the valves, free of the anterior marginal rim and within it, run backward to the posterior end of the valves where they terminate in two large, rounded, smooth tubercles. These two tubercles are connected by a short, low, vertical ridge. Surface of carapace otherwise smooth.

Length, 0.7 mm.; height, 0.4 mm.; width, 0.28 mm.

This species occurs throughout the Navarro formation, and although it is nowhere very common, it is found in most samples anywhere within its formational boundaries, except from the Nacotoch sand member.

Plesiotypes selected from Station 60, Navarro formation.

CYTHERELLOIDEA WILLIAMSONIANA var. STRICTA (Jones and Hinde)

Pl. II, fig. 10

Cytherella williamsoniana var. *stricta* Jones and Hinde, 1889, Suppl. Monogr. Entom. Cret. Eng. Irel., Paleontogr. Soc. London, p. 48, pl. 3, fig. 71.

Carapace in side view oblong. Dorsal margin straight. Ventral margin slightly sinuate at middle. Anterior and posterior ends rounded, subequal. Valves flat, with very shallow internal cavity. A narrow ridge runs along the rounded anterior margin and continues backward along the dorsal margin dying out near the posterior end; this anterior marginal ridge ends abruptly ventrally at the antero-ventral angle. Just dorsal to this termination, another narrow ridge arises, and after bending downward to the ventral margin it continues backward as the ventral marginal ridge. Near the dorsal edge of the valves, free of the marginal ridge and within it, runs a convex, longitudinal ridge that begins in the anterior third of the valve and extends backward to the posterior end where it terminates in a prominent, rounded tubercle. Ventral to this there is a similar tubercle, which is the posterior termination of a short longitudinal ridge that lies within the ventral margin. Surface otherwise smooth.

Length, 0.57 mm.; height, 0.37 mm.; width, 0.23 mm.

This species occurs fairly commonly in the Fort Worth formation but is less frequent in the upper and lower strata of the formation. A single individual has been found in the upper part of the Denton formation at Station 24.

Plesiotype selected from Stations 14, 15, and 16, Fort Worth formation.

CYTHERELLOIDEA RETICULATA n. sp.

Pl. II, fig. 11

Carapace in side view oblong. Valves flat, with very shallow internal cavity. Dorsal margin gently arched. Ventral margin slightly sinuate. A narrow, convex ridge extends along the rounded anterior margin and continues, somewhat diminished in strength, along the dorsal and ventral borders of the valves. Two longitudinal ridges, one near the dorsal and the other near the ventral edge, begin near the anterior third of the valves and terminate at the posterior end in prominent, rounded tubercles, which are connected by a low, vertical cross-ridge. Between these two longitudinal ridges is a prominent, subcentral depression. Surface of carapace finely and reticulately pitted.

Length, 0.57 mm.; height, 0.32 mm.; width, 0.22 mm.

This species, which is nowhere common, occurs through the entire Weno formation and has been found very rarely in the upper part of the Denton.

Holotype from Station 24, upper Denton.

CYTHERELLOIDEA GRANULOSA (Jones)

Pl. II, fig. 7

Cytherella williamsoniana var. *granulosa*, Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 31, pl. 7, fig. 26i.

Cytherella williamsoniana Bosquet, 1854, Mém. Comm. géol. Carte Neerlande, vol. 2, 1854, p. 61, pl. 5, figs. 2a–d.

Cytherella williamsoniana var. *bosqueti,* Marsson, 1880, Mittheil., p. 31, pl. 2, figs. 8d, e.

Carapace in side view oblong, subquadrangular. Dorsal margin straight or gently arched. Ventral margin slightly sinuate. Anterior and posterior ends rounded. Anterior and dorsal and ventral borders bear a narrow, convex marginal ridge. Two longitudinal ridges, one near the dorsal and the other near the ventral edge of the valves and within the marginal ridges, terminate posteriorly in prominent, rounded tubercles, which are connected by a low cross-ridge. The longer, dorsal ridge begins at about the anterior third of the valves; the ventral ridge is terminated anteriorly at about the middle of the valves by a marked depression, which lies well below the center of the valve. Surface granular in appearance, bearing small pits and numerous small rounded tubercles.

Length, 0.55 mm.; height, 0.31 mm.; width, 0.24 mm.

This species is confined to the Grayson formation, where it is nowhere very common.

Plesiotype selected from Station 34, Grayson formation.

CYTHERELLOIDEA OBLIQUIRUGATA (Jones and Hinde)

Pl. II, fig. 8

Cytherella obliquirugata Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 50, pl. 3, fig. 73.

Carapace in side view oblong-ovate. Dorsal margin straight or slightly sinuate. Anterior end broadly rounded; posterior end narrower and obliquely rounded. Anterior margin with narrow peripheral rim. Surface with several oblique, parallel costae, and small subcentral pit.

Length, 0.51 mm.; height, 0.28 mm.; width, 0.18 mm.

This species has been found only in the upper part of the Grayson formation. It is not common but can usually be found in any sample taken within its stratigraphic range.

Plesiotype from Station 34, Grayson formation.

Sub-Order PODOCOPA

Family CYPRIDAE

Genus MACROCYPRIS Brady, 1867

Carapace in side view elongate, narrow at both ends; posterior end narrower than anterior, and tapering to a point. Right valve slightly larger than left and overlapping it along dorsal margin. Surface of valves smooth. Hinge structure simple, without hinge teeth of any kind.

Genotype, *Macrocypris minna* Baird.

MACROCYPRIS GRAYSONENSIS n. sp.

Pl. II, figs. 13, 14

Carapace in side view elongate, siliquose, highest at middle. Height equal to slightly more than one-third the length. Dorsal margin gently arched. Ventral margin straight or very slightly sinuate at middle. Anterior end roundly and obliquely truncated. Posterior tapering to an acute postero-ventral angle. Right valve overlapping left slightly along dorsal margin. Carapace in dorsal view, lanceolate, widest at middle; ends acute. Surface smooth.

Length, 0.91 mm.; height, 0.31 mm.; width, 0.27 mm.

This species is very similar to *M. simplex* Chapman **(13,** p. 333), but differs in several details. First, the side view of the present species shows a much more acute posterior end than Chapman's figure and description indicate for his species. Also, in dorsal view, Chapman's figure shows the maximum width or convexity of *M. simplex* to be well in front of the middle and the anterior end to be strongly compressed; whereas in the present species the greatest width is at the middle, and the anterior end is only moderately compressed.

Macrocypris graysonensis occurs fairly commonly in the lower third of the Grayson formation.

Holotype from Station 34, Grayson formation.

Genus BAIRDIA McCoy, 1844

Carapace usually triangular or rhomboidal in shape. Left valve conspicuously larger than right, and overlapping it both dorsally and ventrally. Surface smooth or punctate. Hinge structure simple, without hinge teeth, and consisting of the overlapping edge of the hinge margin of the left valve over that of the right valve.

Genotype, *Bairdia curta* McCoy.

BAIRDIA GRACILIS n. sp.

Pl. II, figs. 16, 17

Carapace in side view oblong, subquadrate, greatest height at middle. Height equal to slightly more than half the length. Dorsal margin arched, sloping flatly anteriorly from the heighest point on the margin. Ventral margin straight. Anterior end rounded. Posterior end obliquely and roundly truncated. Left valve larger than, and overlapping right valve slightly around entire margin. Carapace in dorsal view lanceolate, widest at middle; ends bluntly angled, anterior slightly blunter than posterior. Surface smooth.

Length, 0.65 mm.; height, 0.35 mm.; width, 0.27 mm.

This species is fairly common in the upper Kiamichi and has been found very rarely in the basal part of the Duck Creek. This is one of the very few species which occurs in both the Washita and Fredericksburg divisions.

Holotype from Station 5, Kiamichi formation.

BAIRDIA HARRISIANA Jones

Pl. II, figs. 18, 19

Bairdia harrisiana Jones, 1849 Monogr. Entom. Cret. Eng., Paleontogr. Soc., London, p. 25, pl. 6, figs. 17a–f.

Carapace in side view elongate, subrhomboid, highest at middle. Height equal to slightly more than one-third the length. Dorsal margin gently arched. Ventral margin sinuate. Anterior end obliquely rounded, curving postero-ventrally from an obscure antero-dorsal angle. Posterior end low, obscurely angled. Left valve slightly larger than right, and overlapping it except at posterior angle. Carapace in dorsal view, lanceolate, widest at middle; ends subacute. Surface of valves smooth.

Length, 0.62 mm.; height, 0.26 mm.; width, 0.2 mm.

This species has a very wide stratigraphic range, occurring from the upper part of the Fort Worth formation upward through the Washita Division and into the basal shales of the Woodbine formation. It is very common in the middle of its stratigraphic range, through the Denton, Weno, and Pawpaw formations, although even here it varies in abundance in different strata and becomes rarer as the limits of its zone of occurrence are approached.

Plesiotype selected from Station 23, Denton formation.

BAIRDIA PARALLELA n. sp.

Pl. III, figs. 1, 3

Carapace elongate, highest at middle. Height equal to about half the length. Dorsal and ventral margins straight or very slightly sinuate, parallel. Anterior end broadly rounded. Posterior end obliquely and roundly truncated, obscurely angled at postero-ventral angle. Left valve larger than and overlapping right valve except at posterior angle. Carapace moderately and evenly convex; in dorsal view, widest at middle. Surface of valves minutely and obscurely punctate.

Length, 0.71 mm.; height, 0.36 mm.; width, 0.3 mm.

This species has been found only in the middle third of the Grayson formation.

Holotype from Station 34, Grayson formation.

BAIRDIA SUBDELTOIDEA (Muenster)

Pl. III, fig. 5

Cythere subdeltoidea Münster, 1830, Neues Jahrb. f. Min., etc., p. 64.
Cytherina subdeltoidea F. A. Roemer, 1838, Neues Jahrb. f. Min., etc., p. 517, pl. 6, fig. 16.

Cytherina trigona Bosquet, 1847, Mém. Soc. Roy. Sci. Liège, vol. 4, p. 358, pl. 1, fig. 3.
Bairdia subdeltoidea Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 23, pl. 5, fig. 15a–f.
Cypris pristina Eichwald, 1853, Lethæa Rossica, vol. 3, 1853, pp. 316, 317, pl. 11, fig. 23.

Carapace in side view subtriangular; height equal to about two-thirds the length. Greatest height of carapace at about middle. Dorsal margin strongly arched, obscurely angled at highest point. Ventral margin convex downward. Anterior end obliquely rounded, obscurely angled at middle. Posterior end produced into short, subacute beak. Left valve larger than and overlapping right valve, especially along anterior and posterior one-third of the dorsal margin and the middle of the ventral margin. Valves strongly and evenly convex, widest at middle. Surface minutely punctate; in well preserved specimens, striated marginal areas visible anteriorly and posteriorly.

Length, 1.06 mm.; height, 0.7 mm.; width, 0.52 mm.

This species has been found to occur only in the Eagle Ford formation.

Plesiotypes selected from Stations 38 and 39, Eagle Ford formation.

BAIRDIA ROTUNDA Alexander

Pl. III, figs. 2, 6

Bairdia subdeltoidea, of authors, in part.
Bairdia subdeltoidea var. *rotunda* Alexander, 1927, Jour. Pal., vol. 1, p. 31, pl. 6, figs. 1, 3.

Carapace in side view subtriangular; height equal to slightly more than two-thirds the length. Greatest height at about middle. Dorsal margin strongly and evenly arched. Ventral margin convex downward. Anterior end somewhat obliquely rounded. Posterior end very slightly produced, subacute. Left valve larger than right valve, and overlapping it along dorsal and ventral margins, as in

B. subdeltoidea. Valves strongly and evenly convex. Surface minutely punctate.

Length, 1.2 mm.; height, 0.85 mm.; width, 0.7 mm.

This species has been found to range from the upper part of the Austin chalk upward through the lower three-quarters of the Taylor formation. Toward the upper part of its stratigraphic range this species exhibits an increasingly stronger arching of the dorsal margin.

Type locality, Taylor marls in an excavation exposed 2 miles by road west of Taylor on the south side of Taylor-Austin road.

BAIRDIA MAGNA Alexander

Pl. III, fig. 8

Bairdia subdeltoidea, of authors, in part.
Bairdia magna Alexander, 1927, Jour. Pal., vol. 1, p. 32, pl. 6, figs. 7, 8.

Carapace in side view subtriangular; height equal to slightly less than three-fourths the length. Greatest height at about middle. Dorsal margin strongly and evenly arched. Ventral margin convex downward. Anterior end broadly and somewhat obliquely rounded. Posterior end obtusely angled, not produced. Left valve larger than and overlapping right valve along dorsal and ventral margins. Valves strongly and evenly convex. Surface punctate.

Length, 1.44 mm.; height, 0.99 mm.; width, 0.78 mm.

This species is found throughout the Navarro formation.

Type locality, Navarro clays exposed on left bank of Colorado River near the ferry at Webberville, Travis County.

BAIRDIA COMANCHENSIS n. sp.

Pl. II, fig. 15; Pl. III, fig. 4

Carapace in side view, triangular ovate, somewhat elongate. Height equal to slightly more than half the length. Dorsal margin evenly arched, highest at middle. Ventral margin convex downward. Anterior end obliquely rounded, obscurely angled at middle. Posterior end produced into rather strong, subacute beak. Left valve larger and overlapping right, with strongest overlap along dorsal margin. Valves strongly convex, with greatest width at middle. Surface smooth.

Length, 0.85 mm.; height, 0.52 mm.; width 0.38 mm.

This rather rare species has been found only in the upper Denton and the lower Weno formations.

Holotype from Station 24, upper Denton formation.

Genus BYTHOCYPRIS Brady, 1880

Shell thin, fragile. Carapace in side view elongate, elliptical, reniform or sub-reniform. Left valve larger than and overlapping right valve both dorsally and ventrally. Surface smooth. Carapace compressed; in dorsal view valves are gently convex, with ends acute to subacute. Hinge simple, as in *Bairdia*.

Genotype, *Bythocypris reniformis* Brady.

BYTHOCYPRIS GOODLANDENSIS n. sp.

Pl. III, figs. 11, 13

Carapace in side view elongate, reniform, highest at middle. Height equal to slightly more than one-third of length. Dorsal margin gently and evenly arched. Ventral margin straight or slightly sinuate. Anterior and posterior ends sub-equal, low, narrow, rounded. Valves gently and evenly compressed, widest at middle. Surface smooth.

Length, 0.61 mm.; height, 0.24 mm.; width, 0.2 mm.

This species ranges throughout the Goodland formation. It is rather rare in the lower third of the formation, and again in the upper few feet, but elsewhere through its range it is fairly common.

Holotype from Station 2, Goodland formation.

Genus PARACYPRIS G. O. Sars, 1865

Carapace in side view elongate. Rounded anteriorly, produced posteriorly. Posterior end terminating in an acute angle. Valves sub-equal, the left being very slightly larger than the right. Shell in dorsal view, more or less compressed; ends subacute to acute. Hinge simple, devoid of hinge-teeth of any kind.

PARACYPRIS SILIQUA Jones and Hinde

Pl. III, figs. 7, 10; Pl. IV, fig. 5

Paracypris siliqua Jones and Hinde, 1889, Suppl. Monogr. Cret. Enton. Eng. Irel., Paleontogr. Soc. London, p. 2, pl. 2, figs. 48, 49, 51; pl. 3, figs. 33, 34.

Carapace in side view elongate, highest anterior to middle. Height equal to about two-fifths the length. Dorsal margin arched, slightly flattened at hinge line. Ventral margin slightly sinuate at middle. Anterior end narrow, rounded. Posterior end acute. Valves subequal, left valve overlapping the right slightly dorsally. Carapace in dorsal view lanceolate; ends acute. Surface smooth.

Length, 0.97 mm.; height, 0.4 mm.; width, 0.37 mm.

This species ranges through the upper two-thirds of the Goodland, with a zone of abundance in the middle of the formation. It has been found rarely in the Kiamichi, and three individuals, specifically indistinguishable from it, have been recorded in the middle of the Grayson formation at Station 35. It is common only in the Goodland, however.

Plesiotype selected from Station 2, Goodland formation.

PARACYPRIS DENTONENSIS n. sp.

Pl. IV, figs. 1, 4

Carapace in side view elongate; height equal to slightly more than one-third the length. Greatest height of carapace at anterior end. Dorsal margin gently arched, obscurely angled at each end of hinge line. Ventral margin sinuate at middle. Anterior end obliquely rounded. Posterior end long, tapering to an acute angle. Valves subequal, the left overlapping the right slightly dorsally. Carapace gently convex, widest slightly anterior to middle. Surface smooth.

Length, 0.9 mm.; height, 0.35 mm.; width, 0.27 mm.

This species occurs throughout the Duck Creek formation in Denton and Grayson counties. It is rare in the lower part of the formation but becomes quite common toward the top. A single specimen has been found in the uppermost Kiamichi clays at Station 5.

Holotype from Station 13, Duck Creek formation.

PARACYPRIS ALTA n. sp.

Pl. III, figs. 9, 12

Carapace in side view oblong, highest in front. Height equal to somewhat more than half of length. Dorsal margin arched, sloping strongly posteriorly. Ventral margin sinuate at middle. Anterior end obliquely rounded. Posterior end low, acute. Left valve overlapping right dorsally. Carapace gently and evenly convex, widest anterior to middle. Surface smooth.

Length, 0.8 mm.; height, 0.48 mm.; width, 0.27 mm.

This species occurs commonly throughout the Washita formations from the Denton upward to the top of the Grayson. It has been found occasionally in the uppermost part of the Fort Worth formation.

Holotype from Station 34, lower Grayson formation.

PARACYPRIS PULCHELLA n. sp.

Pl. IV, figs. 2, 8

Carapace in side view elongate, highest at or slightly in front of middle. Height equal to slightly more than one-third of length. Dorsal margin strongly and evenly arched. Ventral margin convex at either end, sinuate at middle. Anterior end quite narrow, obliquely rounded. Posterior end produced, acute. Valves of slight convexity; carapace in dorsal view lanceolate, widest at middle; ends similar, acute. Surface smooth.

Length, 0.95 mm.; height, 0.36 mm.; width, 0.29 mm.

This rather rare species has been found only in the upper part of the Austin formation.

Holotype from Station 42, Austin chalk.

PARACYPRIS ANGUSTA n. sp.

Pl. IV, figs. 3, 7

Carapace in side view elongate, highest somewhat anterior to middle. Height equal to about two-fifths of length. Dorsal margin a long, low arch. Ventral margin straight except for very slight sinuosity at middle. Anterior end narrow, evenly rounded. Posterior end produced, acute. Left valve slightly larger than right, and overlapping it dorsally. Carapace in dorsal view lanceolate, widest at middle, tapering more strongly posteriorly than anteriorly; ends similar, acute. Surface smooth.

Length, 0.77 mm.; height, 0.3 mm.; width, 0.25 mm.

This species has been found only in the lower fourth of the Taylor formation.

Holotype from Station 49, Taylor formation.

Family CYTHERIDAE

Genus KRITHE Brady, Crosskey, and Robertson, 1874

Carapace in side view oblong. Greatest height of carapace at or posterior to middle, anterior end being more or less narrowed. Dorsal margin arched. Anterior end rounded. Posterior obliquely truncated, with obscure postero-ventral angle. In dorsal view, carapace varies from medium to strongly tumid; anterior end subacute; posterior end blunt, and more or less incised at middle. Surface generally smooth, although sometimes bearing obscure tubercles. Hinge joint consisting of a slight projection in the left valve which is received into a corresponding depression on the hinge margin of the right valve.

KRITHE CUSHMANI n. sp.

Pl. IV, figs. 9, 11

Carapace in side view oblong, highest at middle. Height equal to slightly less than half the length. Dorsal margin gently arched, depressed anteriorly. Ventral margin very slightly convex downward. Anterior end narrowed, evenly rounded. Posterior end obliquely truncated, with subacute postero-ventral angle. Carapace in dorsal view, broadly lanceolate, widest behind middle; anterior end acute; posterior end narrowed, truncated, and slightly incised at middle. Surface smooth.

Length, 0.74 mm.; height, 0.34 mm.; width, 0.30 mm.

This species ranges from the upper Austin chalk upward through approximately the lower two-thirds of the Taylor formation. It is most common in the lower Taylor.

Holotype from Station 49, lower Taylor.

Genus CYTHERIDEA Bosquet, 1852

Carapace in side view subovate or subtriangular; highest at or in front of middle. Anterior end more or less broadly rounded, frequently bearing toothlike spines. Posterior end low, subacute. Valves unequal, the left usually the larger. Surface smooth or sculptured. Hinge structure consisting of terminal, short, crenulated crests in one valve, usually the left, which fit into corresponding depressions in the other valve.

CYTHERIDEA OLIVERENSIS n. sp.

Pl. IV, figs. 6, 10

Carapace in side view triangular-ovate, highest slightly in front of middle. Height equal to about two-thirds the length. Dorsal margin strongly arched, obscurely angled at highest point, and sloping abruptly toward each end. Ventral margin gently convex downward. Anterior end evenly rounded. Posterior low, and somewhat acuminate. Carapace in dorsal view elongate-ovate, widest posterior to middle; anterior end compressed and subacutely pointed; posterior end slightly blunter. Left valve larger than right and overlapping it around entire margin, especially along middle of ventral margin. Surface of valves minutely punctate.

Length, 0.68 mm.; height, 0.45 mm.; width, 0.33 mm.

This species has a wide stratigraphic range, occurring throughout the Fredericksburg division from the upper Walnut shales to the top of the Kiamichi. It is only moderately common through most of its stratigraphic range, with a zone of abundance in the upper part of the Goodland formation.

Holotype from Station 6, Kiamichi formation.

CYTHERIDEA GOODLANDENSIS n. sp.

Pl. IV, fig. 15

Carapace in side view oblong-ovate, highest slightly anterior to middle. Height equal to about half the length. Dorsal margin arched, sloping slightly more abruptly toward anterior than toward posterior end, from highest point. Ventral margin straight, or very slightly convex downward. Anterior end obliquely rounded. Posterior end slightly narrower than anterior, slightly lower, and rounded. Left valve overlapping right slightly around entire margin. Carapace in dorsal view gently and evenly convex, widest at middle. Surface smooth.

Length, 0.6 mm.; height, 0.35 mm.; width, 0.28 mm.

This species has been found only in the upper part of the Goodland formation, where it is very common.

Holotype from Station 2, Goodland formation.

CYTHERIDEA AMYGDALOIDES (Cornuel)

Pl. IV, figs. 16, 17

Cythere amygdaloides Cornuel, 1846, Mém. Soc. Géol. France, ser. 2, vol. 1, pt. 1, p. 197, pl. 7, figs. 1–9.

Carapace in side view elongate-ovate, highest slightly anterior to middle. Height equal to about two-thirds the length. Dorsal margin arched. Ventral margin gently convex downward. Anterior end broadly and evenly rounded. Posterior slightly lower than anterior, and somewhat less broadly rounded. Carapace in dorsal view evenly convex, with greatest width at middle. Left valve overlapping smaller right valve around entire margin. Surface of valves punctate.

Length, 0.75 mm.; height, 0.48 mm.; width, 0.37 mm.

This species occurs only in the upper part of the Kiamichi formation. It is one of the commonest species in its zone of occurrence.

Plesiotypes selected from Station 5, Kiamichi formation.

CYTHERIDEA AMYGDALOIDES var. BREVIS (Cornuel)

Pl. IV, fig. 13

Cythere amygdaloides var. *brevis* Cornuel, 1846, Mém. Soc. Géol. France, ser. 2, vol. 1, pt. 2, p. 199, pl. 8, fig. 12.

Carapace in side view ovate, highest at middle. Height equal to about two-thirds the length. Dorsal margin strongly arched, sloping somewhat more steeply toward posterior than toward anterior end. Ventral margin gently convex downward. Anterior end rounded. Posterior end slightly lower and less broadly rounded than anterior. Left valve larger than right, overlapping it around entire margin. Carapace seen from above, gently and evenly convex; ends bluntly angled. Surface with minute, irregularly spaced punctations.

Length, 0.62 mm.; height, 0.42 mm.; width, 0.31 mm.

This species occurs only in the upper part of the Goodland formation and in the Kiamichi. It is common except in the lower Kiamichi.

Plesiotypes selected from Station 5, Kiamichi formation.

CYTHERIDEA BAIRDIOIDES n. sp.

Pl. IV, fig. 18

Carapace in side view ovate, highest at middle. Height equal to about two-thirds the length. Dorsal margin evenly arched. Ventral margin convex downard. Anterior end broadly and evenly rounded. Posterior margin extended into a short, subacute beak at middle. Left valve overlapping right valve around entire periphery; overlap strongest along middle of dorsal and ventral margins. Carapace of moderate convexity, widest slightly posterior to middle. Surface punctate.

Length, 0.75 mm.; height, 0.48 mm.; width, 0.32 mm.

This species occurs in the lower two-thirds of the Kiamichi formation. It is very abundant in the lower part of its zone of occurrence, but in successively higher strata becomes less and less common, until near the top of its stratigraphic range it becomes quite rare.

Holotype from Station 5, Kiamichi formation.

CYTHERIDEA WASHITAENSIS n. sp.

Pl. IV, figs. 12, 14

Carapace in side view elongate-ovate, highest slightly anterior to middle. Height equal to somewhat less than two-thirds the length. Dorsal margin arched, obscurely angled at highest point. Ventral margin straight or very slightly convex downward. Anterior end obliquely rounded. Posterior end low, and somewhat acuminate. Left valve larger than right, and overlapping it around entire margin. Valves very moderately convex; widest at or slightly behind middle. Surface minutely punctate.

Length, 0.63 mm.; height, 0.38 mm.; width, 0.275 mm.

This species is very similar in general appearance to *C. oliverensis* but differs in the following respects: (1) the comparatively longer carapace; (2) less downward convexity of the ventral margin; (3) slightly more acuminate posterior end; (4) less convexity of carapace; and (5) greatest width or convexity of carapace, as seen in dorsal view, is at middle rather than distinctly posterior to middle.

Cytheridea washitaensis occurs throughout the Washita division of the Lower Cretaceous, from the base of the Duck Creek formation to the top of the Grayson. Through most of its range it is rare and becomes abundant only in the middle and upper portions of the Grayson.

Holotype from Station 34, Grayson formation.

CYTHERIDEA GRAYSONENSIS n. sp.

Pl. V, figs, 3, 4

Carapace in side view elongate-ovate, highest slightly anterior to middle. Dorsal margin arched. Ventral margin straight or very slightly sinuate along posterior one-half. Anterior end broadly rounded. Posterior end low, narrow, subacute, usually bearing a single short, blunt tooth at the postero-ventral angle. Left valve larger than right and overlapping it slightly. Surface smooth or minutely punctate.

Length, 0.7 mm.; height, 0.4 mm.; width, 0.34 mm.

This species, like *C. washitaensis*, reaches abundance only in the Grayson formation, although occurring through the Washita formations from the upper part of the Fort Worth upward into the basal shales of the Woodbine.

Holotype from Station 34, Grayson formation.

CYTHERIDEA PERFORATA (F. A. Roemer)

Pl. V, figs. 1, 2

Cytherina perforata Roemer, 1838, Neues Jahrb. f. Min., etc., p. 516, pl. 6, fig. 11.

Cythere hilseana Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 10, pl. 1, figs. 1a–g.

Bairdia perforata Bosquet, 1852, Mém. Cour. Acad. Roy. Sci. Belg., vol. 24, p. 24, pl. 1, figs. 8a–d.

Cytheridea jonesiana Bosquet, 1854, Mém. Comm. Carte. Géol. Neerl., vol. 2, p. 64, pl. 8, figs. 5a–d.

Cytheridea perforata Jones, 1857, Monogr. Tert. Entom. Eng., Paleontogr. Soc. London, p. 44, pl. 4, figs. 14a–e.

Cytheridea perforata Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 29, pl. 1, figs. 1–4.

Carapace in side view ovate, highest at or slightly in front of middle. Height equal to two-thirds the length. Dorsal margin strongly arched. Ventral margin very slightly convex downward. Anterior end broadly rounded. Posterior end narrower and obscurely angled slightly below middle. Valves rather strongly convex, widest at middle.

In dorsal view, ends similar, bluntly angled. Surface finely punctate.

Length, 0.52 mm.; height, 0.35 mm.; width, 0.3 mm.

This species has been found througout the Taylor formation. It occurs commonly in the lower part of the formation and becomes increasingly rarer upward.

Plesiotypes selected from Station 49, Taylor formation.

CYTHERIDEA PLUMMERI n. sp.

Pl. V, figs. 5–8

Carapace in side view triangular ovate, highest slightly anterior to middle. Height equal to about two-thirds the length. Dorsal margin strongly arched. Ventral margin gently convex downward in anterior half, slightly sinuate in posterior half. Anterior end rounded, finely spinose along lower part of margin. Posterior end with subacute postero-ventral angle. Left valve overlapping right around entire periphery, although very slightly posteriorly. Carapace in dorsal view, elongate-ovate, widest at about middle; anterior end blunt, posterior acute. Surface rather coarsely punctate, the punctations in center of valves being arranged in 3 to 4 shallow, parallel, vertical furrows, each furrow containing about 3 to 6 coarse punctae.

Length, 0.85 mm.; height, 0.55 mm.; width, 0.42 mm.

This fairly common species occurs in north Texas through the upper two-thirds of the Taylor formation. In central Texas it has been found near the base of the formation (Station 59).

This species occurs in two shell types, one of which is somewhat more globose, both in lateral and in dorsal view, than the other. The differences are doubtless sexual characters, the more globose form being probably the female.

Cotypes from Station 59, Taylor formation.

CYTHERIDEA EVERETTI Berry

Pl. V, figs. 9, 10

Cytheridea everetti Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 486, fig. 9.

Carapace in side view subtriangular, highest somewhat anterior to middle. Height equal to somewhat less than two-thirds of length. Dorsal margin strongly arched. Ventral margin gently convex downward in anterior half, slightly sinuate in posterior half. Anterior end rounded, bearing 8 to 10 fine spines along margin. Posterior end with acute postero-ventral angle. Ventral surface near posterior angle with 2 to 3 small spines. Left valve overlapping right. In dorsal view, carapace widest at middle; ends similar, acute. Surface finely punctate.

Length, 0.82 mm.; height, 0.5 mm.; width, 0.4 mm.

In north Texas, this species has been found throughout the entire Navarro formation, except in the glauconitic clays which lie just below the Navarro-Midway contact.

Plesiotypes selected from Station 60, Navarro formation.

CYTHERIDEA MONMOUTHENSIS Berry

Pl. V, figs. 11–14

Cytheridea monmouthensis Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 486, fig. 10.

Carapace in side view ovate, highest slightly anterior to middle. Height equal to about two-thirds the length. Dorsal margin arched. Ventral margin gently convex downward, with slight sinuosity in posterior third. Anterior end broadly rounded, denticulate. Posterior end bluntly angled, with small projecting "wing" on postero-ventral margin. Left valve overlapping right, with strongest overlap dorsally. In dorsal view, carapace widest at middle; ends subequal, subacute. Surface rather coarsely punctate, punctations in center of valves arranged in 3 to 4 roughly parallel, vertical furrows.

Length, 0.72 mm.; height, 0.47 mm.; width, 0.37 mm.

Two shell types are recognizable in this species, and the differences have been assumed to be sexual characters. The slightly more globose form is doubtless the female.

This species has been found to range in north Texas through the upper two-thirds of the Navarro formation.

Plesiotypes selected from Station 61, uppermost Navarro formation.

CYTHERIDEA TRUNCATA Berry

Pl. V, fig. 16

Cytheridea truncatus Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 485, fig. 6.

Carapace in side view triangular-ovate; highest somewhat in front of middle. Height equal to somewhat less than two-thirds the length. Dorsal margin strongly arched. Ventral margin straight or slightly sinuate. Anterior end rounded, bearing 3 to 4 small spines along lower margin. Posterior end low, truncated, with blunt postero-ventral angle, the ventral surface of which sometimes bears a few fine spines. Left valve larger than and overlapping the right slightly. Surface smooth.

Length, 0.56 mm.; height, 0.32 mm.; width, 0.27 mm.

This species is very rare in north Texas, but it has been found in a few samples from the Navarro formation.

Plesiotypes selected from Station 60, Navarro formation.

CYTHERIDEA GLOBOSA n. sp.

Pl. V, figs. 17, 19

Carapace in side view triangular ovate; height equal to slightly more than two-thirds the length. Greatest height slightly anterior to middle. Dorsal margin very strongly arched, obscurely angled at highest point. Ventral margin straight or very slightly sinuate. Anterior end broadly rounded, denticulate. Posterior end low, acute, bearing

2 or 3 fine spines along postero-ventral margin. Left valve overlapping right. Valves strongly convex. Carapace in dorsal view, widest at middle; ends subacute. Surface of valves punctate; punctations somewhat coarse near center of valves.

Length, 0.74 mm.; height, 0.51 mm.; width, 0.42 mm.

This species occurs commonly throughout the lower three-fourths of the Navarro formation but has not been found at all in samples from the upper part of the formation.

Holotype from Station 60, Navarro formation.

CYTHERIDEA FABAFORMIS (Berry)

Pl. V, fig. 18

Cytherella fabaformis Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 487, fig. 13.

Carapace in side view elongate, reniform; height equal to slightly more than half the length. Carapace highest anterior to middle. Dorsal margin gently arched. Ventral margin straight. Anterior end somewhat narrowed, obliquely rounded, bearing 4 or 5 blunt teeth along lower part of margin. Posterior end low, blunt, denticulate. Convexity of valves moderate, greatest width at about middle. Surface of valves rough, marked by coarse pits, furrows and ridges. Near the middle of the valves are two or three rather obscure, parallel, somewhat oblique, vertical furrows, each bearing a row of pits; a more prominent furrow extends longitudinally along the posterior one-third of the valves, slightly below the median line. Other pits are irregularly disposed.

Length, 0.67 mm.; height, 0.35 mm.

This species extends throughout the Navarro formation. It is fairly common throughout the greater part of its range but becomes rarer in the uppermost beds of the formation.

Plesiotypes selected from Station 60, Navarro formation.

CYTHERIDEA MICROPUNCTATA n. sp.

Pl. V, fig. 20; Pl. VI, fig. 6

Carapace in side view ovate; height equal to about two-thirds of length. Greatest height of carapace slightly anterior to middle. Dorsal margin gently arched. Ventral margin convex downward in anterior half, sinuate in posterior half. Anterior end broadly rounded, finely denticulate along lower portion of margin. Posterior end low, blunt, bearing 2 or 3 short, blunt spines. Left valve overlapping right slightly. Surface densely and finely punctate, giving it a granular appearance.

Length, 0.57 mm.; height, 0.36 mm.; width, 0.31 mm.

This species occurs in moderate abundance through all but the uppermost few feet of the Navarro formation.

Holotype from Station 60, Navarro formation.

CYTHERIDEA MACROPORA n. sp.

Pl. V, fig. 15

Carapace in side view triangular-ovate, highest slightly in front of middle. Height equal to slightly less than two-thirds length. Dorsal margin strongly arched, obscurely angled at highest point. Ventral margin straight or very slightly sinuate, although strong ventral tumidity of valves gives appearance of slight convexity at middle. Anterior end low, obliquely rounded. Posterior end low, slightly produced, with acute postero-ventral angle. Surface with deep, prominent pits.

Length, 0.55 mm.; height, 0.3 mm.

This very characteristic species occurs rather rarely in the uppermost part of the Navarro formation. It has also been found in samples from the Escondido formation in the region of Rio Grande.

Holotype from Station 61, uppermost Navarro formation.

Genus CYTHERE Müller, 1785

Cythere Müller, 1785, Entomostraca, etc.

Carapace in side view usually oblong-quadrate or oblong-ovate; usually highest in front of middle. Anterior end rounded, usually denticulate. Posterior end usually compressed, angled at about middle of margin, and frequently denticulate along lower edge. Left valve larger than right, and overlapping it more or less along dorsal margin, with strongest overlap at antero-dorsal angle. Surface smooth, punctate, or variously sculptured; ornamentation, when present usually moderate. An "eye tubercle" commonly present over anterior end of hinge line. Hinge consists of a strongly developed tooth at each end of the hinge line, connected by a narrow bar in the left valve; a single anterior tooth with postjacent socket, a furrow and a posterior socket, in the right valve.

CYTHERE CONCENTRICA (Reuss)

Pl. VI, figs. 4, 7

Cytherina concentrica Reuss, 1846, Verstein. böhm. Kreidef., vol. 2, p. 104, pl. 24, figs. 22a–c.
Cythere sculpta Cornuel, 1846, Mém. Soc. Géol. France, sér. 2, vol. 1, pt. 1, p. 201, pl. 8, figs. 20–23.
Cypridina roemeriana Bosquet, 1847, Mém. Soc. Roy. Sci., Liége, vol. 4, p. 362, pl. 2, figs. 2a–f.
Cythere punctatula Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 11, pl. 1, figs. 2a–n.
Cythere concentrica Bosquet, 1854, Mém. Comm. Carte géol. Neerlande, vol. 2, p. 81, pl. 8, figs. a–d.
Cytheropteron concentricum Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 31, pl. 1, figs. 5–10; pl. 4, fig. 19.

Carapace in side view subovate, highest at about middle. Dorsal margin arched, slightly flattened along hinge line. Ventral margin convex downward. Anterior end obliquely rounded, finely denticulate. Posterior end compressed, narrow, obliquely and roundly truncated. Valves strongly convex, with greatest width posterior to and below middle. Surface of valves marked by strong, concentric reticulations.

Length, 0.64 mm.; height, 0.37 mm.; width, 0.4 mm.

This small but very striking and easily recognizable species occurs from the base of the Goodland formation upward through the Fredericksburg division and into the Washita division as far as the base of the Pawpaw formation. It is common only in the Goodland.

Plesiotypes selected from Station 2, Goodland formation.

CYTHERE SUBCONCENTRICA n. sp.

Pl. VI, figs. 5, 10

Carapace in side view elongate-ovate; greatest height slightly in front of middle. Dorsal margin arched, flattened along hinge line. Ventral margin gently convex downward. Anterior end broadly rounded. Posterior end narrow, rounded. Both anterior and posterior ends with broad, compressed areas exhibiting concentric striations. Valves strongly convex, widest slightly posterior to middle. Surface of valves with strong, quasi-concentric pits or reticulations, and with a low, rounded ridge near the ventral border.

Length, 0.9 mm.; height, 0.55 mm.; width, 0.5 mm.

This species is somewhat similar, and doubtless closely related to *C. westraliensis* Chapman,[11] described from the Gingin chalk of western Australia but differs from it conspicuously in many ways.

Cythere subconcentrica ranges from the upper part of the Denton formation through the Weno and into the basal portion of the Pawpaw.

Holotype from Station 26, basal Pawpaw formation.

CYTHERE TRIPLICATA (F. A. Roemer)

Pl. VI, figs. 2, 8

Cytherina triplicata, F. A. Roemer, 1840, Verstein. norddeutsch. Kreidegeb., p. 104, pl. 16, fig. 16.

[11]Chapman, F., 15, p. 54, Pl. 8, figs. 7, a-c, 8.

Cythere auriculata var. *semimarginata* Cornuel, 1846, Mém. Soc. Géol. France, ser. 2, vol. 1, pt. 1, p. 200, pl. 8, figs. 17, 18.

Cythereis triplicata Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 18, pl. 3, figs. 9a–h.

Carapace in side view oblong-ovate, with greatest height anteriorly and tapering to an acute angle posteriorly. Dorsal margin slightly convex, with marked downward curve at anterior end. Ventral margin gently and evenly convex downward. Anterior end compressed, obliquely rounded, denticulate. Posterior margin compressed, tapering to an acute angle at middle. Valves strongly convex, with greatest tumidity behind and below middle. Surface of valves with three convex, longitudinal ridges which are free anteriorly, and converge posteriorly. The ventral ridge is the longest of the three; the middle ridge the shortest. The ventral ridge curves downward away from the other two along the middle of the valves.

Length, 0.55 mm.; height, 0.3 mm.; width, 0.26 mm.

This is one of the commonest species, and one of the best markers of the upper part of the Grayson. It is present as a rare species in the basal Woodbine shales, and a single specimen has been found in the upper part of the Main Street formation at Station 33.

Plesiotypes selected from Station 34, Grayson formation.

CYTHERE SEMIPLICATA (Reuss)

Pl. VI, figs. 9, 15

Cytherina semiplicata Reuss, 1846, Verstein, böhm. Kreidef., vol. 2, p. 104, pl. 24, fig. 16.

Cythere semplicata Reuss, 1874, Paleontographica, vol. 20, pt. 2, p. 145, pl. 27, fig. 3.

Carapace in side view, oblong, subquadrate. Greatest height in front. Dorsal margin straight. Ventral margin straight except for slight sinuosity near anterior third. Anterior end rounded, finely denticulate and bearing narrow marginal rim. Posterior end compressed, keel-like, broadly angled at about middle. Valves gently convex, widest behind middle. Surface of valves with three short, convex ridges which extend from about the middle of the carapace posteriorly and terminate just anterior to compressed, posterior keel. Dorsal and ventral ridges curve inward posteriorly and are almost in contact with the middle ridge at their posterior terminations. A low, rounded elevation forms the anterior end of the median ridge.

Length, 0.75 mm.; height, 0.4 mm.; width, 0.33 mm.

This species ranges in north Texas from the upper Austin chalk to the top of the Wolfe City sand, member of the Taylor formation. It is very common in the upper Austin chalk, and decreases in abundance upward through the Taylor clays, until the Wolfe City sand it is quite rare.

Plesiotype selected from Station 42, Austin formation.

CYTHERE SPHENOIDES Reuss

Pl. VII, figs. 9, 14

Cythere sphenoides Reuss, 1854, Denkschr. K. Akad. Wiss. Wien, vol. 7, p. 141, pl. 26, fig. 2.

Cytheropteron sphenoides Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 33, pl. 1, figs. 18–20.

Carapace in side view ovate, highest anteriorly. Height equal to somewhat more than two-thirds the length. Dorsal margin strongly arched, ending posteriorly in an obscure angle. Ventral margin gently convex downward. Anterior end compressed, narrow, obliquely rounded, minutely denticulate. Posterior compressed, narrow, low, obliquely and roundly truncated, and bearing 3 or 4 short spines along the postero-ventral margin. Left valve slightly larger than and overlapping right valve along dorsal and anterior margins. Valves strongly convex, widest behind and below middle. The strongly tumid ventral portion of the valves bears a narrow ridge which runs longitudinally, paralleling the ventral margin. Surface of valves minutely and indistinctly punctate.

Length, 0.93 mm.; height, 0.66 mm.; width, 0.6 mm.

This very common species extends from the upper Austin chalk to the top of the Wolfe City sand member of the Taylor formation. It has not been found in beds above the Wolfe City sand.

Plesiotypes selected from Station 42, Austin formation, and Station 47, Taylor formation.

CYTHERE TAYLORENSIS n. sp.

Pl. VII, figs. 3, 4

Carapace in side view oblong-ovate, highest anteriorly. Dorsal margin arched, ending posteriorly in an obscure angle. Ventral margin gently convex downward. Anterior end compressed, obliquely rounded, minutely denticulate. Posterior end compressed, obliquely and roundly truncated, and with 3 or 4 blunt spines along postero-ventral margin. Tumid ventral portion of valves with narrow, projecting ridge that extends longitudinally and parallel to ventral margin. This ridge ends posteriorly in a short, backward-projecting angle and bears on some specimens a row of minute, obscure punctations. Surface of valves finely punctate.

Length, 0.82 mm.; height, 0.48 mm.; width, 0.48 mm.

This rather rare species occurs in about the middle third of the Taylor formation in the southern part of the north Texas area, and in the region of Red River it is present in the upper Austin chalk. This is one of the species that seems to indicate that the upper Austin chalk replaces the lower Taylor marls toward the north.

Cotypes from Station 58, middle Taylor formation.

CYTHERE FOERSTERIANA (Bosquet)

Pl. VI, figs. 1, 11

Cypridina foersteriana Bosquet, 1847, Mém. Soc. Roy. Sci. Liége, vol. 4, p. 364, pl. 2, figs. 4a–d.

Carapace in side view oblong-ovate, highest anteriorly. Dorsal and ventral margins convex, converging strongly posteriorly. Anterior end compressed, broadly rounded, denticulate, and with narrow, striated marginal area. Posterior end compressed, and tapering to an acute angle at about middle, denticulate along postero-ventral margin. Valves strongly convex, with greatest width slightly behind middle. Surface of valves with three longitudinal, convex ridges, which become obsolete as they converge posteriorly. A marked depression or pit occurs just below the anterior end of the dorsal ridge, and on some specimens 3 or 4 smaller pits behind this one. Rest of surface smooth.

Length, 0.8 mm.; height, 0.47 mm.; width, 0.37 mm.

The north Texas form differs from Bosquet's original figures in having a considerably higher anterior end, but otherwise it corresponds so closely that not even a varietal distinction is made. Jones and Hinde (**33,** p. 19) expressed the opinion that *C. foersteriana* (Bosquet) was probably the equivalent of *C. triplicata* (Roemer), but a number of conspicuous differences have been noted between these two forms.

Cythere foersteriana is fairly abundant in the lower Taylor clays up to the base of the Wolfe City sand member of the formation.

Plesiotype selected from Station 49, Taylor formation.

CYTHERE PONDEROSANA (Israelsky)

Pl. VI, fig. 3

Cythereis ponderosana Israelsky, 1929, Ark. Geol. Survey Bull. 2, p. 13, pl. 3 A, figs. 5–8.

This species is very similar to the preceding and was undoubtedly derived from it. The basis for the specific distinction is the degree of ornamentation of the surface. The surface is marked by three longitudinal ridges. A row of small, distinct pits or depressions lies just ventral to the dorsal ridge, the anterior one of these pits being much the most conspicuous. A similar row of pits extends longitudinally and just dorsal to the ventral ridge. Some carapaces show 2 or 3 small, inconspicuous pits just below the median ridge.

Length, 0.9 mm.; height, 0.51 mm.; width, 0.42 mm.

This species ranges from the base of the Wolfe City sand member of the Taylor upward to the top of the Taylor formation in the southern part of the north Texas area. It occurs in the uppermost Austin chalk in the region of Red River. This species is replaced in the Navarro fauna by *C. parallelopora*, which exhibits a still greater elaboration of the ornamental pitting of the surface, as described below.

Plesiotype from Station 51, Wolfe City sand member of Taylor formation.

CYTHERE PARALLELOPORA n. sp.

Pl. VI, fig 13

Carapace elongate-ovate, highest in front. Dorsal and ventral margins convex. Anterior end compressed, rounded; posterior end compressed, angled at middle. Surface with three longitudinal, convex ridges. A longitudinal row of pits lies beneath the dorsal ridge, the anterior one of these pits being very conspicuous and deep. A similar row of rather large pits runs just dorsal to the ventral ridge, and between this row of depressions and the median ridge are 3 or 4 longitudinal rows of smaller pore-like pits.

Length, 0.9 mm.; height, 0.47 mm.; width, 0.42 mm.

This species is present throughout the Navarro formation. It is similar to *C. rectangulopora* Berry **(7,** p. 483) in the Monmouth formation of Maryland, but in that species the longitudinal ridges are obscured by the strongly developed longitudinal rows of pits, which cover the entire surface of the carapace.

Holotype from Station 60, Navarro formation.

CYTHERE GAPENSIS n. sp.

Pl. VI, figs. 16, 17

Carapace in side view oblong-ovate, highest anteriorly. Dorsal margin straight except for marked downward curve just behind antero-dorsal angle. Ventral margin very gently convex downward. Anterior end somewhat obliquely rounded, rimmed and finely denticulate. Posterior end compressed, keel-like, obscurely angled slightly above the middle; convex and denticulate below, slightly excavated above. Continuations of the anterior marginal rim extend along the dorsal and ventral margins, uniting posteriorly to form a continuous peripheral rim. The ventral ridge divides into two just behind the antero-ventral angle, the upper branch extending backward and slightly obliquely upward, terminating at a point about one-third the length of the carapace from posterior end. A longer, median ridge parallels this one, arising just behind and free of the anterior marginal rim and ending just beyond the termination of the upper branch of the ventral ridge. The surface thus bears four narrow longitudinally disposed ridges, which are connected by numerous short, vertical cross-ridges.

Length, 0.7 mm.; height, 0.35 mm.; width, 0.34 mm.

This species marks the middle of the Taylor formation, having been found only in the Wolfe City sand and Pecan Gap chalk members of this formation and in the clays immediately overlying them.

Holotype from Station 55, Pecan Gap chalk.

CYTHERE CORNUTA (F. A. Roemer) var. GULFENSIS n. var.

Pl. VIII, figs. 1, 2, 6

Carapace in side view oblong, quadrate; highest in front. Height equal to about one-half length. Dorsal and ventral margins straight, converging slightly posteriorly. Anterior end broadly and obliquely rounded, coarsely denticulate. Posterior end somewhat narrower and lower than anterior, obliquely rounded, coarsely denticulate. Both anterior and posterior ends bear narrow, striated marginal areas. Valves with strongly developed, thin, laterally projecting, ventral alae, which bear a narrow striated border These "wings" terminate in a strong, postero-laterally projecting angle. Surface of valves smooth.

Length, 1.1 mm.; height, 0.56 mm.; width, 0.92 mm. (including wing tips).

This form is most closely related to *C. cornuta* var. *americana* Ulrich and Bassler (**61**, p. 122) from the Miocene of Maryland but seems to differ from both this form and from the original species as described by Roemer sufficiently to deserve at least a varietal distinction.

The present variety occurs throughout the Upper Cretaceous section of north Texas. It has been found by the writer from the Austin chalk to the top of the Navarro, and Moreman (**41**, p. 98) has reported it from the Eagle Ford. It is abundant in no part of its stratigraphic range but seems to occur most commonly in the Taylor formation.

Holotype from Station 59, lower Taylor formation.

CYTHERE RHOMBOIDALIS Berry

Pl. VII, figs. 1, 2

Cythere rhomboidalis Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 481, figs. 1, 2.

Carapace in side view oblong-ovate, highest in front of middle. Dorsal margin arched. Ventral margin gently convex downward. Anterior end obliquely rounded. Posterior end compressed, narrow, roundly truncated. Valves strongly convex, with greatest width ventrally; valves with flat ventral surface. Tumid ventral portion of valves with prominent, strongly pitted ridge. Surface of valves punctate, punctations strongest near center of valves.

Length, 0.87 mm.; height, 0.55 mm.; width, 0.55 mm.

This is the most typical of all the Navarro species of ostracods and occurs as a common species in most parts of the formation.

Plesiotype selected from Station 60, Navarro formation.

CYTHERE OVATA (Berry)

Pl. VII, figs. 10, 13

Cythereis ovata Berry, 1925, Am. Jour. Sci., ser. 5, vol. 9, p. 484, fig. 15.

Carapace in side view elongate-ovate, highest slightly anterior to middle. Dorsal margin gently and evenly arched. Ventral margin slightly convex downward. Anterior end somewhat compressed, broadly and obliquely rounded, minutely denticulate. Posterior end narrower, compressed, bluntly rounded. Valves strongly tumid ventrally. Surface of valves minutely punctate.

Length, 1.25 mm.; height, 0.73 mm.; width, 0.74 mm.

This species, like the preceding, occurs as a rather common species throughout the Navarro formation, although it is rare in the glauconitic clays just beneath the Navarro-Midway contact.

Plesiotype selected from Station 60, Navarro formation.

CYTHERE ACUTOCAUDATA n. sp.

Pl. VII, figs. 5, 6

Carapace in side view oblong-ovate, highest anteriorly. Dorsal margin arched, straight along hinge line. Ventral margin slightly convex downward. Dorsal and ventral margins converging somewhat posteriorly. Anterior end broadly and obliquely rounded, and bearing 3 or 4 short spines along lower part of margin. Posterior end compressed, keel-like, obliquely truncated, with acute postero-ventral angle. Valves strongly tumid ventrally. Surface smooth except for tumid ventral portion which is marked by 3 or 4 narrow, inconspicuous ridges.

Length, 0.9 mm.; height, 0.5 mm.; width, 0.52 mm.

This common and easily recognizable species ranges through the lower two-thirds of the Navarro formation in north Texas.

Holotype from Station 60, Navarro formation.

CYTHERE HUNTENSIS n. sp.

Pl. VI, fig. 12

Carapace in side view ovate, highest anteriorly. Dorsal and ventral margins straight, converging slightly posteriorly. Anterior end broadly rounded. Posterior end tapering to an acute angle at middle. A narrow marginal rim extends around the entire periphery. A narrow, sharp ridge rises near the antero-dorsal angle of the valves, within and free of the marginal rim, and after running obliquely downward and backward for a short distance, curves directly backward so as to form a longitudinal ridge that lies just above the median lateral line. A second lateral ridge arises near the antero-ventral margin, in contact with the marginal rim, and runs slightly obliquely backward and upward. A third shorter ridge rises at the postero-ventral angle, in contact with the marginal rim, and extends anteriorly between the ventral-lateral and the ventral marginal ridges and terminates at about one-third the length of carapace from the anterior end. Short cross-ridges connect these longitudinal ridges with each other, giving a coarsely reticulate or fenestrate appearance to the surface of the valves.

Length, 0.55 mm.; height, 0.32 mm.

This rather rare species has been found only in the uppermost beds of the Navarro formation. It is somewhat similar in appearance to *C. gapensis* of the Taylor formation but several conspicuous differences make the two species distinct.

Type locality, Station 61, topmost Navarro beds.

Genus CYTHEREIS Jones, 1849

Carapace in side view elongate, subquadrate, or ovate. Dorsal and ventral margins usually straight, subparallel, converging more or less posteriorly, with greatest height of carapace at anterior end. Anterior end rounded, rimmed and usually denticulate. Posterior end usually compressed and keel-like, angled at about middle. Surface usually strongly sculptured, with tubercles, spines, pits, and reticulations, sometimes smooth or only moderately sculptured. Left valve larger than right, and overlapping along dorsal and anterior margins; strongest overlap at antero-dorsal angle. Hinge consisting of a pair of strong terminal teeth in the left valve, with an anterior tooth and postjacent socket and a posterior socket in the right valve. The connecting bar between the terminal teeth, which characterizes the hinge structure of the genus *Cythere*, is absent in this genus.

CYTHEREIS CARPENTERAE n. sp.

Pl. VI, fig. 14

Carapace oblong, highest in front, narrowing posteriorly. Dorsal margin straight or slightly sinuate. Ventral margin straight. Anterior end rounded, rimmed, denticulate. Continuations of the anterior marginal rim extend as narrow ridges along the dorsal and ventral margins of the valves, terminating about one-fourth of the length of carapace from the posterior end in low, rounded tubercles. Posterior end compressed, narrow, keel-like, sharply angled below middle. Valves flat, carapace narrow, internal cavity shallow. Surface of valves with fine, granular pits.

Length, 0.55 mm.; height, 0.28 mm.; width, 0.17 mm.

This species ranges from the upper Walnut clays upward through about the lower two-fifths of the Goodland formation. It is in no place common but is present in most samples from its zone of occurrence.

Holotype from Station 1, basal Goodland shales below the Lake Worth Dam.

CYTHEREIS FREDERICKSBURGENSIS n. sp.

Pl. VIII, figs. 12, 13

Carapace in side view oblong, highest anteriorly. Dorsal and ventral margins converging slightly posteriorly. Dorsal margin straight except for slight downward curve behind antero-dorsal angle. Ventral margin straight. Anterior end obliquely rounded, strongly rimmed, denticulate. Continuations of the anterior marginal rim extend ridgelike along dorsal and ventral borders of the valves. Posterior end compressed, keel-like, bluntly angled slightly below middle, and bearing 3 or 4 small teeth along postero-ventral margin. Surface of valves with strong subcentral tubercle and a lesser elevation posterior and slightly dorsal in position to the first one, and marked by prominent, meshlike reticulations, each reticular space enclosing several fine punctations.

Length, 0.95 mm.; height, 0.48 mm.; width, 0.42 mm.

This species is characteristic of the Fredericksburg division of the lower Cretaceous from the upper Walnut clays to the top of the Kiamichi shales. It varies in abundance at different levels but is common throughout most of its entire stratigraphic range.

Holotype from Station 2, Goodland formation.

CYTHEREIS MAHONAE n. sp.

Pl. VII, fig. 7

Carapace oblong, highest in front. Dorsal and ventral margins straight, converging slightly posteriorly. Anterior end rounded, rimmed and minutely denticulate. Continuations of the anterior marginal rim extend ridgelike along the dorsal and ventral borders of valves. Posterior end compressed, rather bluntly angled at middle. Valves with narrow, median-longitudinal ridge that runs slightly obliquely backward and upward from a point about one-fourth the length of carapace from the anterior end to a point just in front of the compressed posterior end. Surface between the ridges with prominent reticulations, arranged roughly in longitudinal rows.

Length, 0.7 mm.; height, 0.34 mm.; width, 0.3 m.

This species ranges from the upper Walnut clays into the lower part of the Kiamichi shales. It is common in most samples from its zone of occurrence.

Holotype from Station 4, Goodland formation.

CYTHEREIS NUDA (Jones and Hinde)

Pl. X, figs, 8, 9

Cythereis cornuta (non Roemer) Jones, 1849 Mongr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 21, pl. 5, figs. 13a–e.
Cythereis ornatissima var., Jones, 1870, Geol. Mag., p. 75.
Cythereis ornatissima (Reuss) var. *nuda* Jones and Hinde, 1889, Suppl, Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 23, pl. 1, fig. 76; pl. 2, figs. 9, 12–14; pl. 4, fig. 14.

Carapace in side view suboblong, highest in front. Anterior end obliquely rounded, rimmed and denticulate. Posterior end compressed, angular, coarsely denticulate along postero-ventral margin. Dorsal margin straight except for downward slope at anterior end. Ventral margin straight. Dorsal and ventral margins with rough, pitted ridges, which terminate in low, posterior angles. A rounded, subcentral node has a smaller, ovate tubercle behind it. Rest of surface smooth, or sometimes shows obscure reticulation, especially on the posterior one-half.

Length, 0.98 mm.; height, 0.52 mm.; width, 0.45 mm.

This species extends with varying, but generally upwardly diminishing, abundance throughout the Washita division. It is most common in the Duck Creek formation. The members of the species exhibit a number of minor variations throughout the stratigraphic range, but the variations are not deserving of even varietal distinction.

Plesiotype selected from Stations 8, 10, and 11, Duck Creek formation.

CYTHEREIS KRUMENSIS n. sp.

Pl. IX, figs. 1, 2

Cythereis ornatissima var. *reticulata,* of authors, in part.

Carapace oblong, highest in front. Dorsal margin straight, with very slight downward curve at anterior end. Ventral margin straight. Dorsal and ventral margins converge somewhat posteriorly. Anterior margin obliquely rounded, rimmed, denticulate. Posterior end compressed, angled slightly below the middle and denticulate along lower margin. A prominent subcentral node has a smaller, longitudinally elongated elevation behind it. Surface, incuding two elevations, covered by fine reticulations.

Length, 0.72 mm.; height, 0.37 mm.; width, 0.35 mm.

This species ranges through the Duck Creek and Fort Worth formations. It reaches its greatest abundance in the upper Fort Worth limestone.

Holotype from Station 16, Fort Worth formation.

CYTHEREIS PAUPERA (Jones and Hinde)

Pl. X, figs. 11, 12

Cythereis ornatissima var. *paupera,* Jones and Hinde, 1889, Suppl. Monogr. Cret. Entom. Eng. Irel., Paleontogr. Soc. London, p. 23, pl. 2, figs. 10, 11.

Carapace oblong, highest in front. Dorsal margin straight except for slight downward curve at anterior end. Ventral margin straight. Anterior end rounded, rimmed, denticulate. Posterior end compressed, angled at middle, denticulate along lower margin. A subcentral node has a smaller tubercle behind it, the smaller tubercle bearing 2 or 3 short spines. Dorsal and ventral margins bear low ridges, which are more or less spinose, and traces of spines occur here and there over the entire surface of the valves.

Length, 0.87 mm.; height, 0.49 mm.; width, 0.48 mm.

This species is one of the most characteristic of all markers of the Washita division. It occurs fairly commonly, from the base of the Fort Worth formation upward to the top of the Grayson, and two or three specimens have been found in the Duck Creek formation. It occurs most abundantly in the Fort Worth and Denton formations.

Plesiotype selected from Station 23, Denton formation.

CYTHEREIS WORTHENSIS n. sp.

Pl. VII, figs. 8, 12

Carapace oblong, highest in front. Dorsal and ventral margins straight, slightly convergent posteriorly. Anterior end rounded, rimmed and denticulate. Continuations of the anterior marginal rim extend ridgelike along the dorsal and ventral borders of the valves. Posterior end compressed, angled at middle. Surface of valves with median-longitudinal ridge, beginning just behind the anterior marginal rim and extending slightly obliquely, posteriorly and upward, and terminating at a point just in front of the compressed, posterior end. Short, low ridges connecting this median ridge with the dorsal and ventral marginal ridges form an obscure reticulation.

Length, 0.55 mm.; height, 0.27 mm.; width, 0.2 mm.

This species very closely resembles *C. mahonae*, but differs in its constantly smaller size and in the much less distinct reticulation of the valves.

Cythereis worthensis ranges through the Washita division from the base of the Fort Worth formation upward into the basal Woodbine shales. Its zone of abundance is in the Fort Worth formation, and it is rare or only moderately common through the remainder of its stratigraphic range.

Holotype from Station 16, Fort Worth formation.

CYTHEREIS WINTONI n. sp.

Pl. VIII, figs. 3, 7

Carapace elongate, highest at anterior end. Dorsal margin straight. Ventral margin slightly sinuate. Dorsal and ventral margins converging somewhat posteriorly. Anterior end obliquely rounded, and bearing a narrow, sharp, marginal rim. Continuations of this rim extend ridgelike along the dorsal and ventral borders of the valves, and terminate posteriorly in short, blunt knobs. Posterior end compressed, keel-like, obliquely truncated, with acute postero-ventral angle. Carapace in dorsal view, narrow anteriorly, widening posteriorly, with greatest width about one-fourth length of carapace from posterior end. Surface of valves with single prominent subcentral tubercle, and sometimes with 2 or 3 very small, inconspicuous knobs irregularly placed. Surface otherwise smooth.

Length, 0.85 mm.; height, 0.46 mm.; width, 0.42 mm.

This striking species, though rare, is an excellent stratigraphic marker, for it has been found only in the Fort Worth formation.

Cotypes from Station 17, Fort Worth formation.

CYTHEREIS DENTONENSIS n. sp.

Pl. VIII, figs. 10, 11

Cythereis ornatissima var. *reticulata,* of authors, in part.

Carapace oblong, highest in front. Dorsal margin straight except for slight downward curve at anterior end. Ventral margin straight. Dorsal and ventral margins converging slightly posteriorly. Anterior end broadly rounded, rimmed, denticulate. Dorsal and ventral continuations of the anterior marginal rim are obscure anteriorly but terminate posteriorly in high, prominent, rough knobs. Posterior end compressed, keel-like, slightly produced, acutely angled slightly below middle. Valves with prominent, rounded, subcentral knob and with smaller, very inconspicuous tubercle behind the first. Surface of valves marked with fine, strong reticulations.

Length, 0.77 mm.; height, 0.37 mm.; width, 0.42 mm.

The forms included in this new species are nearest to the original figures of *C. ornatissima* var. *reticulata* Jones and Hinde,[12] of any of the variety of forms that have been included by various authors under this name. In redescribing this variety as a separate species, their name could not be applied, since it had been preoccupied by Kafka's **(36,** p. 15) *Cytheréis reticulata* from the Bohemian Cretaceous.

This species ranges from the base of the Fort Worth formation upward to the top of the Grayson. It is rare in the Fort Worth, abundant in the Denton, and becomes rarer upward to the Grayson where it is common.

Holotype from Station 23, Denton formation.

[12]Jones, T. R. and Hinde, G. J., **33**, p. 24, Pl. 1, figs. 67, 68, 77; Pl. 4, figs. 9–12.

CYTHEREIS ORNATISSIMA (Reuss)

Pl. X, figs. 10, 13

Cytherina ornatissima Reuss, 1846, Verstein. böhm. Kreidef., pt. 2, p. 104, pl. 24, figs. 12, 18.
Cytherina ciliata Reuss, *ibid.*, fig. 17.
Cytherina echinulata Williamson, 1847, Trans. Manchester Lit. Phil. Soc. vol. 8, pl. 4, figs. 75, 76.
Cythereis ciliata Jones, 1849, Monogr. Entom. Cret. Eng., Paleontogr. Soc. London, p. 19, pl. 4, figs. 11a–h.
Cypridina muricata Reuss, 1851, Haidinger's Nat. Abhandl., vol. 4, pt. 1, p. 50, pl. 5, figs. 12a–c.
Cythere ornatissima Bosquet, 1854, Mém. Comm. Carte géol. Neerlande, vol. 2, pp. 107–110, pl. 9, figs. 6a–d.
Cythere (Cythereis) ornatissima Williamson, 1872, Trans. Lit. Phil. Soc. Manchester, ser. 3, vol. 5, p. 136.

Carapace oblong, highest in front. Dorsal margin straight except for slight downward curve at anterior end. Ventral margin straight. Dorsal and ventral margins converging slightly posteriorly. Anterior margin rounded, rimmed, denticulate. Posterior end compressed, angled at middle, denticulate along postero-ventral margin. A rounded subcentral node has a smaller node posterior to it. Entire surface of valves densely beset with small rounded tubercles or short spines.

Length, 0.87 mm.; height, 0.47 m.; width, 0.45 mm.

This species ranges from the middle of the Fort Worth formation upward to the top of the Grayson. Its greatest numerical development is found in the Weno and in the lower part of the Pawpaw formations.

Plesiotype selected from Stations 25 and 26, Weno formation, and Station 34, Grayson formation.

CYTHEREIS HAWLEYI n. sp.

Pl. IX, figs. 3, 4

Cythereis ornatissima var. *reticulata*, of authors, in part.

Carapace in side view oblong, highest in front. Dorsal margin straight or very slightly sinuate. Ventral margin straight. Dorsal and ventral margins converge slightly posteriorly. Anterior end obliquely rounded, rimmed, minutely denticulate; prominent ridgelike continuations of the anterior marginal rim extend backward along dorsal and ventral borders of the valves. Posterior end compressed, bluntly angled at about middle, denticulate along lower margin. A rounded subcentral node has behind it a smooth, ovate tubercle. Surface of valves, except the two elevations, very finely reticulate.

Length, 0.61 mm.; height, 0.33 mm.; width, 0.3 mm.

This species occurs fairly commonly through the Denton and Weno formations. A single specimen has been found in the lower Pawpaw at Station 26.

Holotype from Station 25, Weno formation.

CYTHEREIS SANDIDGEI n. sp.

Pl. IX, figs. 6, 7

Carapace oblong, subovate, highest in front. Dorsal and ventral margins straight or slightly convex, and strongly converging posteriorly. Dorsal margin with strong downward slope just behind antero-dorsal angle. Anterior end rounded, rimmed and denticulate; low, ridgelike continuations of the anterior marginal rim extend along the dorsal and ventral borders of the valves, the dorsal ridge denticulate along upper border. Posterior end compressed, keellike, angled slightly below middle. Surface coarsely but obscurely reticulate, with short, smooth, median longitudinal ridge along center of valves. Carapace in dorsal view strongly convex; widest at middle.

Length, 0.68 mm.; height, 0.4 mm.; width, 0.37 mm.

This species is an excellent horizon marker. It has been found in only two stratigraphic zones: first, in a zone just a few feet in thickness, on each side of the plane of contact of the Weno formation with the overlying Pawpaw, and second, in the upper Grayson, where it is rare.

Holotype from Station 26, upper Weno formation.

CYTHEREIS SUBOVATA n. sp.

Pl. IX, fig. 5

This species is very similar in general shape to *C. sandidgei,* from which it was doubtless derived. It differs, however, in that the median longitudinal ridge, as well as the remainder of the valve surface, is covered by the reticular pits.

Length, 0.65 mm.; height, 0.37 mm.; width, 0.37 mm.

This fairly common species is restricted to the upper part of the Grayson formation, where it occurs with *C. sandidgei.*

Cotypes from Station 34, Grayson formation.

CYTHEREIS ROANOKENSIS n. sp.

Pl. IX, fig. 10

Cythereis ornatissima var. *reticulata,* of authors, in part.

Carapace oblong, highest in front. Dorsal and ventral margins straight, somewhat convergent posteriorly. Dorsal margin slightly notched near anterior end. Anterior end obliquely rounded, rimmed, denticulate. Prominent, ridgelike continuations of the anterior marginal rim extend along dorsal and ventral borders of valves. Posterior end compressed, angled slightly below middle, denticulate along lower margin. Surface of valves strongly reticulate, and bearing a prominent, median-longitudinal ridge, which is markedly thicker and higher anteriorly. Ridge also covered by reticular pits.

Length, 0.82 mm.; height, 0.44 mm.; width, 0.4 mm.

This species occurs in the upper portion of the Grayson and in the basal shales of the Woodbine.

Holotype from Station 34, Grayson formation.

CYTHEREIS BURLESONENSIS n. sp.

Pl. IX, figs. 8, 11

Cythereis ornatissima var. *reticulata,* of authors, in part.

Carapace oblong, highest in front. Dorsal margin straight, except for downward curve at anterior end. Ventral margin straight. Dorsal and ventral margins subparallel, converging very slightly posteriorly. Anterior end obliquely rounded, rimmed and denticulate. Ridgelike continuations of the anterior marginal rim extend backward along dorsal and ventral margins, the dorsal ridge denticulate along upper border. Posterior end compressed, angled at about middle, finely denticulate along posteroventral margin. Valves strongly convex. Prominent subcentral node has somewhat smaller elevation behind it. Entire surface of valves strongly and coarsely reticulate. Length, 1.25 mm.; height, 0.55 mm.; width, 0.54 mm.

This species has been recorded from the upper Grayson and from the basal shales of the Woodbine formation.

Holotype from Station 35, Grayson formation.

CYTHEREIS EAGLEFORDENSIS n. sp.

Pl. IX, figs. 9, 12

Cythereis ornatissima var. *reticulata*, of authors, in part.

Carapace oblong, highest in front. Dorsal margin straight except for slight downward curve at anterior end. Ventral margin straight. Anterior end rounded, rimmed, denticulate. Posterior continuations of the anterior marginal rim extend as low ridges along the dorsal and ventral borders of the valves. Posterior end compressed, very short, broadly angled slightly below middle. Valves moderately convex, widest well behind middle. Surface with prominent reticulations and with two low, obscure nodes on the median lateral line of the carapace.

Length, 0.76 mm.; height, 0.45 mm.; width, 0.37 mm.

This species has been found only in the Eagle Ford formation, in the zones of the two ammonite species *Metoicoceras irwini* Moreman and *M. whitei* Hyatt, which occur respectively at about the bottom and top of the middle third of the formation in north Texas.

Holotype from Station 39, Eagle Ford formation.

CYTHEREIS AUSTINENSIS n. sp.

Pl. VII, fig. 11

Carapace oblong, highest in front. Dorsal and ventral margins straight, subparallel, converging slightly posteriorly. Anterior end broadly and evenly rounded, with convex marginal rim which becomes obsolete as it approaches dorsal and ventral borders. Dorsal and ventral ridges arise just within and free of the ends of the anterior marginal rim. Posterior end compressed, bluntly angled at middle, bearing 2 or 3 blunt teeth along lower margin. Prominent, rounded, subcentral node forms the anterior end of a short, median-longitudinal ridge, which is connected with the dorsal marginal ridge at their posterior terminations by a short, prominent, cross-ridge. Surface strongly and finely reticulate.

Length, 0.54 mm.; height, 0.3 mm.

This species is somewhat similar to *C. mahonae* and *C. worthensis*, but is easily distinguished by the strong cross-ridge connecting the dorsal and the median longitudinal ridges at their posterior ends.

Cythereis austinensis is a common and characteristic member of the microfauna of the upper part of the Austin chalk in north Texas.

Holotype from Station 42, Austin formation.

CYTHEREIS DALLASENSIS n. sp.

Pl. VIII, figs. 8, 9

Carapace oblong, highest in front. Dorsal and ventral margins straight, converging slightly posteriorly. Anterior end rounded, rimmed, denticulate. Posterior end compressed and keel-like, produced and angled at middle, rimmed, denticulate along lower border. A rounded subcentral tubercle bears 3 or 4 small spines. Entire surface of valves covered by short, blunt spines that are connected by short, thin, radiating ridges, giving a strongly mesh-like, reticular appearance. Prominent spinose or tuberculate elevations mark the posterior terminations of the low dorsal and ventral marginal ridges.

Length, 0.82 mm.; height, 0.42 mm.; width, 0.38 mm.

This species occurs fairly commonly in the upper part of the Austin chalk and rarely in the lower Taylor formation.

Holotype from Station 42, Austin formation.

CYTHEREIS BICORNIS Israelsky

Pl. VIII, figs. 4, 5

Cythereis bicornis Israelsky, 1929, Ark. Geol. Survey Bull. 2, p. 19, pl. 4 A, fig. 10.

Carapace oblong, highest in front. Dorsal margin straight. Ventral margin straight or very slightly convex downward. Dorsal and ventral margins parallel. Anterior end obliquely rounded, rimmed, denticulate along lower portion. Posterior continuations of anterior marginal rim extend as irregular ridges along dorsal and ventral borders of valves. The ventral marginal ridge terminates at about one-third the length of carapace from posterior end, in a high, straight, hornlike, laterally projecting spine. Posterior end compressed, narrow, strongly produced and acutely angled at middle. A small, rounded, subcentral tubercle forms the anterior end of a short, median-longitudinal ridge. This ridge curves slightly dorsal in the region of the spinose termination of the ventral ridge, then bends back to its median position and becomes obsolete. Surface with a number of irregular, reticular pits.

Length, 0.7 mm.; height, 0.33 mm.; width, 0.4 mm. (measured from tip to tip of the hornlike spines).

This species is characteristic of the lower third of the Taylor formation in north Texas and is fairly common in all samples from Taylor marls and clays up to the base of the Wolfe City sand member of the formation. It has been found rarely in the upper part of the Austin chalk.

Plesiotype from Station 49, Taylor formation.

CYTHEREIS RUGOSISSIMA n. sp.

Pl. IX, figs. 13, 14

Carapace oblong, highest anteriorly. Dorsal margin straight, notched near anterior end. Ventral margin gently convex downward, swinging upward in an even curve posteriorly. Anterior end broadly and obliquely rounded, with sharp, narrow marginal rim, and coarsely denticulate along lower half of margin. Anterior marginal rim continues unbroken along ventral margin; dorsal continuation broken by antero-dorsal notch. Posterior end compressed, keel-like, rimmed, truncated, denticulate along lower margin. A small, rounded, subcentral node is separated by a notch from a short, irregular, median-longitudinal ridge which lies behind it. Surface finely and strongly reticulate. In dorsal view carapace widest behind middle.

Length, 0.8 mm.; height, 0.42 mm.; width, 0.35 mm.

This species has been found only in the lower third of the Taylor formation. In most places in this zone it is not common, although it occurs abundantly at some localities and at certain levels.

Holotype from Station 59, Taylor formation.

CYTHEREIS COMMUNIS Israelsky

Pl. IX, fig. 18

Cythereis communis Israelsky, 1929, Ark. Geol. Survey Bull. 2, p. 14, pl. 3 A, figs. 9–13.

Carapace in side view elongate, slightly higher at anterior end and tapering very gradually toward posterior end. Dorsal margin irregular, with two shallow notches near anterior end. Ventral margin straight. Anterior end rounded, very coarsely denticulate along lower third of margin, and bearing a thickened, rounded, peripheral rim. Posterior end compressed, irregular, bluntly angled, denticulate along postero-ventral margin. Rough, ridgelike continuations of the anterior marginal rim extend along dorsal and ventral borders of the valves. A third, shorter ridge extends along the median-longitudinal line of the valves. Surface of carapace finely punctate.

Length, 0.76 mm.; height, 0.39 mm.; width, 0.38 mm.

This species is typical of the Navarro and occurs fairly commonly throughout the entire formation.

Plesiotype from Station 60, Navarro formation.

CYTHEREIS HAZARDI Israelsky

Pl. IX, figs. 15, 17

Cythereis hazardi Israelsky, 1929, Ark. Geol. Survey Bull. 2, p. 19, pl. 4 A, fig. 9.

Carapace oblong, highest at anterior end. Dorsal and ventral margins straight, subparallel, converging slightly posteriorly. Dorsal margin with shallow notch just behind antero-dorsal angle. Anterior margin rounded, bearing a narrow peripheral rim, coarsely denticulate along lower margin. Posterior end compressed, truncated, coarsely denticulate along postero-ventral margin. High, narrow, ridgelike continuations of the anterior marginal rim extend along the dorsal and ventral borders of the valves, terminating posteriorly in high, blunt knobs. A high, sharp, median-longitudinal ridge is divided at the middle by a deep notch, and is considerably thickened anterior to this notch. Irregular cross-ridges connect the median ridge with the dorsal and ventral ridges, giving a coarsely reticulate, or fenestrate appearance to the test.

Length, 0.75 mm.; height, 0.37 mm.; width, 0.37 mm.

This species, like *C. communis*, ranges throughout the Navarro formation, in which it is nowhere very common.

Plesiotype from Station 60, Navarro formation.

Genus CYTHEROPTERON G. O. Sars, 1865

Carapace in side view ovate, or subrhomboidal. Anterior end usually rounded. Posterior end produced into an acute beak, which usually curves more or less strongly dorsally. Ventral surface usually produced laterally, forming a broad, flat winglike extension or ala. On some species the ventral portion of the carapace is merely tumid or bears a slightly thickened ridge instead of broad "wings." Surface smooth or sculptured. Hinge consisting of a pair of small, terminal teeth in the right valve and a finely crenulate bar in the left valve.

CYTHEROPTERON HOWELLI n. sp.

Pl. X, figs. 1, 2

Carapace in side view ovate, highest at about middle. Dorsal margin evenly arched. Ventral margin gently convex downward. Anterior end obliquely rounded. Posterior end compressed, slightly produced, acute. Left valve slightly larger than right valve, and overlapping it dorsally. Valves strongly convex; greatest width ventrally. Ventral edge of valves with strong, pitted ridge. Surface smooth, or on some specimens exhibiting very obscure reticulation.

Length, 0.66 mm.; height, 0.37 mm.; width, 0.4 mm.

This species occurs fairly commonly in the upper Goodland formation and rarely in the Kiamichi.

Holotype from Station 2, Goodland formation.

CYTHEROPTERON TUMIDUM n. sp.

Pl. X, figs. 16, 17

Carapace in side view ovate, highest anterior to middle. Dorsal margin arched. Ventral margin gently convex downward. Anterior end obliquely rounded. Posterior end with short, compressed, acute beak at middle. Carapace in dorsal view ovate, widest slightly posterior to middle. Valves roundly tumid ventrally. Surface of valves punctate.

Length, 0.62 mm.; height, 0.37 mm.; width, 0.32 mm.

This species ranges from the upper Goodland upward to the top of the Kiamichi formation. It is very rare in the Goodland and becomes increasingly common upward; in the upper Kiamichi it is fairly abundant.

Holotype from Station 5, Kiamichi formation.

CYTHEROPTERON RUGOSALATUM n. sp.

Pl. X, figs. 3, 4

Carapace in side view elongate-ovate, highest somewhat anterior to middle. Dorsal margin moderately arched.

Ventral margin convex downward. Anterior end obliquely rounded. Posterior end with short, compressed beak, curving slightly dorsally. Strongly developed, broad, flat, rounded ventral alae are present, and their outer margins bear several irregular depressions. Carapace irregularly convex; a narrow, shallow, slightly oblique furrow divides the carapace into two unequal lobes, the anterior lobe being considerably smaller than the posterior. Surface smooth.

Length, 0.6 mm.; height, 0.3 mm.; width, 0.43 mm.

This rare, but very striking species ranges through the Weno and Pawpaw formations in north Texas. A single specimen has been found in the lower Duck Creek, at Station 10.

Holotype from Station 25, Weno formation.

CYTHEROPTERON BILOBATUM n. sp.

Pl. X, figs. 14, 15

Carapace ovate, highest at middle. Dorsal margin strongly arched. Ventral margin moderately convex downward. Anterior end obliquely rounded. Posterior end with short, compressed, dorsally curving beak. Valves strongly tumid ventrally. A broad, shallow furrow divides the carapace roughly into two unequal lobes, the anterior being slightly smaller than the posterior lobe. Surface of valves minutely punctate.

Length, 0.5 mm.; height, 0.3 mm.; width, 0.25 mm.

This species has been found only in middle of the Weno formation and at only one locality, where it is very abundant.

Holotype from Station 29, Weno formation.

CYTHEROPTERON ACUTOLATUM n. sp.

Pl. X, fig. 7

Carapace in side view oblong-ovate, highest at about middle. Dorsal margin arched, sloping steeply toward anterior and flatly toward posterior end. Ventral margin gently convex downward. Anterior end with acute antero-ventral angle. Posterior end with narrow, compressed, tapering beak. Ventro-lateral "wings" strongly developed, broad and flat, and swinging backward in an even curve to a sharp, angular posterior termination. Valves strongly convex, widest behind middle. Surface smooth.

Length, 0.57 mm.; height, 0.3 mm.

This rare species has been found only in the upper Weno and the basal part of the Pawpaw formation.

Holotype from Station 26, basal Pawpaw formation.

CYTHEROPTERON NAVARROENSE n. sp.

Pl. X, figs. 5, 6

Carapace in side view ovate, highest slightly anterior to middle. Dorsal margin evenly arched. Ventral margin gently convex downward. Anterior end low, narrow, blunt. Posterior end with compressed, somewhat produced, dorsally curving beak. Valves strongly tumid ventrally and with strongly developed, rounded, ventro-lateral alae. Surface of valves smooth.

Length, 0.7 mm.; height, 0.37 mm.; width, 0.45 mm.

This species has been found to range throughout the Navarro formation, although it is nowhere very common.

Holotype from Station 60, Navarro formation.

CYTHEROPTERON HANNAI (Israelsky)

Pl. IX, fig. 16

Cytheridea (?) hannai Israelsky, 1929, Ark. Geol. Survey Bull. 2, p. 12, pl. 2 A, fig. 10.

Carapace in side view ovate, highest anteriorly. Dorsal margin straight. Ventral margin strongly and evenly convex downward. Anterior end broadly rounded. Posterior end with thin, flat edge and short, compressed, keel-like projection near posteró-dorsal angle. A shallow, vertical furrow divides the carapace into a larger more tumid posterior lobe, and a smaller anterior lobe. Surface of carapace rough, marked by numerous coarse, reticular pits and by several short, blunt, rounded, rough tuberculate projections; two of these tubercles, near the ventral margin, are larger than the others.

Length, 0.7 mm.; height, 0.38 mm.

This rare, but very striking species has been found in the lower two-thirds of the Navarro formation.

Plesiotype from Station 60, Navarro formation.

SUMMARY AND CONCLUSIONS

From the time the writer first became interested in ostracods, he has been impressed with the value of this group in identifying formations and zones within formations. The great and often striking variations exhibited by the common genera of ostracods, and the ease with which the writer has been able to identify the formations on the basis of the ostracods alone, even before he had made a careful study of the species, served as stimuli to make an intensive study of the group.

A survey of the literature on Cretaceous ostracods revealed three important facts. First, most of the species of the ostracods were recorded as having an extensive vertical range. This was exactly contradictory to the writer's observations as to the stratigraphic value of the ostracods in the Texas Cretaceous formations. Second, the descriptions and figures of the Cretaceous ostracod species demonstrated that the specific definitions were very broad, and that a number of related, though obviously different, forms were placed together under one specific name. This, of course, accounted for the broad stratigraphic range ascribed to these species. Third, many of the species were found to have a very wide geographic distribution, being reported from such widely separated areas as Europe, South Africa, and Australia. And, to add to their distributional area, they were found to occur also in the Cretaceous rocks of Texas.

It has become necessary, therefore, in order to make the ostracods useful as stratigraphic markers, to redefine and to limit many of the "species" of the earlier writers.

Many of the variations of these old species have now been made new species and varieties. A large number of the new species described in this paper are not forms that are restricted to this area, but are rather the result of this breaking up of the older, all-inclusive species.

With their species thus more closely defined, the ostracods have proved valuable as guide fossils in the Cretaceous rocks of north Texas. But even with the more limited specific distinctions, only a few of the species are restricted to a single formation or portion of a formation. Therefore, recognition of formations and of horizons within these formations must be based partly upon associations of species. As an illustration, *Cythereis fredericksburgensis* n. sp. ranges throughout the Fredericksburg division of the Lower Cretaceous. Associated with *C. carpenterae* n. sp., this species indicates upper Walnut or lower Goodland, and the presence of *Cytherella ovata* in the association further limits the horizon to lower Goodland, since *Cytherella ovata* has not been found to occur in the Walnut formation. Associated with an abundance of *Paracypris siliqua, Cythereis fredericksburgensis* indicates upper Goodland. With *Cytheridea bairdioides* and *C. amygdaloides,* it marks upper and lower Kiamichi, respectively.

The distributional chart included with this paper is prepared to assist the micropaleontologist in recognizing formations and horizons by such associations of species.

Some species that have a stratigraphic range extending through several formations frequently occur in appreciable numbers only in a restricted "zone of abundance." Therefore relative abundance of the various species in different parts of their stratigraphic range is indicated on the chart by the letters "r," rare; "c," common; and "a," abundant.

For relatively small geographic districts, even closer zoning than has been attempted in this paper is possible by means of the recognition of variations of certain species in a given direction—variations that are too minute to deserve specific or even varietal distinction, but which are nevertheless sufficiently obvious to be used in what may be called an "evolutionary column," in which these straight-line modifications serve to distinguish the successive horizons from which any group of individuals of the species in question were taken.

A single example will serve to illustrate this method. *Cythere rhomboidalis* Berry is a common ostracod of the Navarro formation (Pl. VII, figs. 1, 2). It is characterized by a strong, pitted ridge that extends longitudinally along the tumid ventral portion of the valves. Upward in the Navarro, some individuals of the species show greater and greater depression of the slight furrow that lies above this pitted ridge and divides it from the rest of the valve-surface, and an increasing tumidity of the valve area just above this furrow. At the top of the Navarro formation, a few show this swollen area to assume almost the proportions of a second, rounded longitudinal ridge. By careful study a series exhibiting these changes may be made, and close correlations are possible on the basis of this series.

Too much emphasis can not be placed on the necessity of applying this method only locally. A series of such minute changes may have been begun earlier in one locality in the Cretaceous seas than in another or may, in fact, never have occurred at all except in some isolated bay or lagoon. Hence, if a worker attempts to make close correlations between strata in widely separated areas on the basis of such minute variations as have been described above, he at once encounters factors which are certain to lead to errors.

The author's first attempts at correlating Cretaceous formations in widely separated areas met with the same difficulties which complicated his early attempts at establishing definite zones in the Texas Cretaceous. On account of the loose, broad specific definitions of the earlier writers, and the resulting great statigraphic range ascribed to these "species" in the Cretaceous formations of Europe and other regions, only the broadest kind of correlation could be established between the Cretaceous strata of north Texas and those elsewhere.

Even when the writer's narrower species definitions had made close zoning in the Texas Cretaceous possible, the difficulties of wide-range correlation had not been removed. The author's closely-defined species had not been recognized in the Cretaceous of other parts of the world. Until detailed studies established the presence of these more restricted species in their respective zones in the Cretaceous formations of other regions, close correlation was still impossible.

The first opportunity for studies of this type was afforded when Mr. E. Willard Berry **(7)** described the ostracods of the Monmouth formation of Maryland. Through the courtesy of Dr. John R. Sandidge the writer had the opportunity of studying some material from this formation; these studies have revealed a close community of species between the Monmouth formation of Maryland and the Navarro of Texas. This correlation checks with one which had preciously been made on the basis of the macrofossils.[13]

Later, the opportunity was offered, again by Dr. Sandidge, of making studies of the ostracods from the Ripley and Selma formations of Alabama. These two formations have long been regarded as correlative with the Taylor and Navarro formations in Texas. An examination of a number of samples from the Selma and Ripley formations disclosed an agreement of species and of fossil zones with those of the Taylor and Navarro that amounted almost to identity. This might be expected because of the proximity of the two areas.

During the fall of 1927, through the courtesy of Dr. Joseph A. Cushman, the writer had the opportunity of studying some ostracods from the European Cretaceous, and of establishing thereby more firmly his conviction, that carefully determined ostracod species are valuable in intercontinental correlation.

---

[13]Clark, Wm. B., **19**, p. 329.

In a recent paper[14] dealing with the ostracod species *Bairdia subdeltoidea* (Münster) the writer divided this species into two new species and one variety, each with a definite, restricted, stratigraphic range. The original species name was retained for the form occurring in the Eagle Ford formation of Texas, which has been correlated with the Turonian of Europe.

The author's studies of *Bairdia subdeltoidea* and its allies indicate an evolutionary change toward diminishing angularity, or increasing rotundity, in the margins of the shell through successively higher strata.

In some samples from the Turonian Plänermergeln from the vicinity of Dresden, supplied by Dr. Cushman, the writer found examples of *Bairdia subdeltoidea* which corresponded exactly in the angularity of their margins with the Texas Eagle Ford form. The European form was slightly larger, but otherwise was exactly similar.

Other samples from the Cenomanian in the vicinity of Dohna, Saxony, contained members of this species which exhibited slightly greater angularity than the Turonian form. This is exactly what would be expected, in view of the writer's studies on the Texas Cretaceous forms. Unfortunately the Texas Cenomanian, represented by the Woodbine formation, has not furnished any examples of *Bairdia subdeltoidea,* so that direct comparison of individuals of this species was impossible.

It thus seems conclusive that when careful, detailed, studies are made of the ostracods of the Cretaceous formations of Europe, and when restricted specific definitions are applied, the ostracods can be used with as much accuracy in making close correlation of formations in widely separated areas as can any other group of fossils.

---

[14]Alexander, C. I., 5, pp. 29–33, Pl. 6.

BIBLIOGRAPHY

1. Adkins, W. S., The Weno and Pawpaw formations of the Texas Comanchean: Univ. Texas Bull. 1856, 1918 (1920).
2. Adkins, W. S., Geology and mineral resources of McLennan County: Univ. Texas Bull. 2340, 1923.
3. Adkins, W. S., and Winton, W. M., Paleontological correlation of the Fredericksburg and Washita formations in north Texas: Univ. Texas Bull. 1945, 1919.
4. Alexander, C. I., The micrology of the lower Washita formations: Univ. Texas Bull. 2544, pp. 65–67, pl. 14, 1925.
5. Alexander, C. I., The stratigraphic range of the Cretaceous ostracod *Bairdia subdeltoidea* and its allies: Jour. Pal., vol. 1, pp. 29–33, pl. 6, 1927.
6. Berry, E. Wilbur, The flora of the Woodbine sand at Arthur's Bluff, Texas: U. S. Geol. Survey Prof. Paper 129–G, 1921.
7. Berry, E. Willard, The Upper Cretaceous ostracoda from Maryland: Amer. Jour. Sci., ser. 5, vol. 9, pp. 481–487, figs. 1–15, 1925.
8. Bosquet, J., Description des Entomostracés fossiles de la Craie de Maestricht: Mém. Soc. Roy. Sci., Liége, vol. 4, 1847.
9. Bosquet, J., Description des Entomostracés fossiles des terrains tertiaires de la France et de la Belgique; Mém. Cour. Acad. Roy. Belgique, vol. 24, Bruxelles, 1852.
10. Bosquet, J., Monographie des Crustaceés fossiles du terrain crétacé de Duché Limbourg: Mém. de la commission pour la description de la carte géologique de la Neerlande, vol. 2, 1854.
11. Carpenter, Margaret, Micrology of the Upper Washita: Univ. Texas Bull. 2544, pp. 71–74, pls. 16, 17, 1925.
12. Carsey, Dorothy Ogden, The foraminifera of the Cretaceous of central Texas: Univ. Texas Bull. 2612, 1926.
13. Chapman, Frederick, Ostracoda from the Cambridge greensand: Ann. Mag. Nat. Hist., ser. 7, vol 3, pp. 331–346, 1898.
14. Chapman, Frederick, Foraminifera and ostracoda from the Cretaceous of East Pondoland: Ann. S. Afr. Mus., ser. 4, vol. 5, 1903.
15. Chapman, Frederick, Foraminifera and ostracoda from the Gingin Chalk: Geol. Surv. West. Australia, Bull. No. 72, 1917.
16. Chapman, Frederick, On some foraminifera and ostracoda from the Cretaceous of Umzamba River, Pondoland: Trans. Geol. Soc. S. Afr., vol. 26, 1923.
17. Chapman, Frederick, Cretaceous and Tertiary foraminifera of New Zealand, with an Appendix on the ostracoda: Geol. Surv.

New Zealand, Paleont. Bull. No. 11, pp. 98–106, pls. 21–22, 1926.

18. Chapman, Frederick, and Sherborn, C. D., On the ostracoda of Gault at Folkestone: Geol. Mag., vol. 10, pp. 345–349, pl. 16, 1893.

19. Clark, Wm. B., Upper Cretaceous of Maryland; Md. Geol. Surv. Rept. 1916.

20. Cornuel, J., Description des Entomostracés fossiles du terrain crétacé inférieur du Département du Haute-Marne: Mém. Soc. Géol. France, ser. 2, vol. 1, pt. 2, pp. 193–205, pl. 7, 1846.

21. Cornuel, J., Description des nouveaux fossiles microscopiques du terrain crétacé inférieur du Département de la Haute-Marne: Mém. Soc. Géol. France, ser. 2, vol. 3, pp. 241–246, pl. 3, 1848.

22. Dane, C. H., and Stephenson, L. W., Notes on the Taylor and Navarro formations in east-central Texas: Bull. Amer. Assoc. Pet. Geol., vol. 12, pp. 41–58, 1928.

23. Dumble, E. T., The Geology of east Texas: Univ. Texas Bull. 1869, 1918.

24. Egger, J. G., Die Ostrakoden der Miocän-Schichten bei Ortenburg in Nieder-Bayern, Neues Jahrb. für Min., etc., pp. 403–443, 1858.

25. Egger, J. G., Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen, Abhandl. d.k. bayer. Akad. Wiss., Wien, ser. 2, vol. 21, pt. 1, pp. 177–188, 200, pls. 25, 27, 1899.

26. Egger, J. G., Ostrakoden und Foraminiferen der Eybrunner Kreidemergeln: Bericht. Nat. Ver., Regensburg, 1910.

27. Gardner, Julia, On Scott's new correlation of the Texas Midway: Amer. Jour. Sci., ser. 5, vol. 12, no. 71, pp. 453–455, 1926.

28. Hill, R. T., Geography and Geology of the Black and Grand Prairies of Texas: U.S. Geol. Surv., 21st Ann. Rept. pt. 7, 1900.

28A. Israelsky, Merle C., Upper Cretaceous ostracoda of Arkansas: Ark. Geol. Survey Bull. 2, pp. 1–28, pls. 1A–4A, 1929.

29. Jones, T. R., Monograph of the Entomostraca of the Cretaceous formation of England: Paleontogr. Soc. London, 1849.

30. Jones, T. R., Monograph of the Tertiary Entomostraca of England: Paleontogr. Soc. London, 1856.

31. Jones, T. R., Notes on the foraminifera and ostracoda from the deep boring at Richmond: Quart. Jour. Geol. Soc., London, vol. 40, pp. 765–777, pl. 34, 1884.

32. Jones, T. R., Notes on the Cretaceous Entomostraca, Geol. Mag., pp. 74–76, 1870.

33. Jones, T. R., and Hinde, G. J., Supplementary monograph of the Cretaceous Entomostraca of England and Ireland: Paleontogr. Soc. London, 1889.
34. Jones, T. R., and Sherborn, C. D., Notes on the Tertiary Entomostraca of England, with special reference to those of the London Clay: Geol. Mag., pp. 340–391, 1887.
35. Jones, T. R., and Sherborn, C. D., Supplementary monograph of the Tertiary Entomostraca of England and Ireland: Paleontogr. Soc. London, Mon. for 1888, 1889.
36. Kafka, Joseph, "Ostracoda," in Fritsch's Crustaceen der böhmischen Kreideformation: Prague, 1887.
37. Knowlton, F. H., Fossil Plants from Arthur's Bluff: U. S. Geol. Surv., pt. 7, 1900, pp. 314–316.
38. Mahon, Sadie, Micrology of the middle Washita formations: Univ. Texas Bull. 2544, pp. 67–71, pls. 15, 24, 25, 1925.
39. Marsson, T., Cirripedien und Ostrakoden der weissen Schreibkreide der Insel Rügen: Mittheilungen aus dem naturwiss. Vereine von Neu-Vorpommern und Rügen in Greifswald, pp. 1–50, pls. 1, 2, 1880.
40. Moreman, W. L., Micrology of the Woodbine, Eagle Ford and Austin Chalk Formations: Univ. Texas Bull. 2544, pp. 74–78, pls. 18, 19, 26, 27, 1925.
41. Moreman, W. L., Fossil zones of the Eagle Ford of north Texas: Jour. Pal., vol. 1, pp. 89–101, pls. 13–16, 1927.
42. Münster, G., Ueber einige fossile Arten *Cypris* und *Cythere*: Neues Jahrb. für Min., etc., pp. 60–67, 1830.
43. Plummer, Helen Jeanne, Foraminifera of the Midway formation of Texas: Univ. Texas Bull. 2644, 1926.
44. Reuss, A. E., Die Versteinerungen der böhmischen Kreideformation: Stuttgart, 1845.
45. Reuss, A. E., Die Foraminiferen und Entomostraceen des Kreidemergels von Lemburg: Haidingers Natur. Abhandl., vol. 4, pt. 1, pp. 17–52, pl. 6, 1851.
46. Reuss, A. E., Beiträge zur Charakteristik der Kreideschichten in den Ostalpen: Denkschr. k. Akad. Wiss., vol. 7, pp. 1–156, pls. 1–31, 1854.
47. Reuss, A. E., Ein Beitrag zur genaueren Kenntniss der Kreidegebilde Meklenbergs: Zeit. deutsch. geol., Ges., vol. 7, pp. 261–293, pls. 8–11, 1855.
48. Reuss, A. E., Die Foraminiferen, Bryozoen und Ostrakoden des Pläners: Paleontographica, vol. 20, pt. 2, pp. 73–157, pls. 20–28, 1874.
49. Roemer, F. A., Die Cytherinen des Molasse-Gebirges: Neues Jahrb. für Min., etc., vol. 43, pp. 514–519, pl. 6, 1838.
50. Roemer, F. A., Die Versteinerungen des norddeutschen Kreidegebirges: Hanover, 1840–1841.

51. Scott, Gayle, Some Gerontic Ammonites from the Duck Creek formation: Texas Chr. Univ. Quart. vol. 1, no. 1, 1924.
52. Scott, Gayle, Etudes stratigraphiques et paléontologiques sur les terrains crétacés du Texas: Thèse Doctorat, Univ. de Grenoble, France, 1926.
53. Scott, Gayle, A new correlation of the Texas Cretaceous: Amer. Jour. Sci., ser. 5, vol. 12, no. 71, pp. 157–161, 1926.
54. Scott Gayle, The Woodbine sand of Texas interpreted as a regressive phenomenon: Bull. Amer. Assoc. Pet. Geol., vol. 10, pp. 613–624, 1926.
55. Shuler, E. W., Geology of Dallas County: Univ. Texas Bull. 1818, 1918.
56. Stephenson, L. W., Contributions to the geology of northeastern Texas and southeastern Oklahoma: U. S. Geol. Surv., Prof. Paper 120, 1918.
57. Stephenson, L. W., Notes on the stratigraphy of the Upper Cretaceous formations of Texas and Arkansas: Bull. Amer. Assoc. Pet. Geol., vol. 11, pp. 1–17, 1927.
58. Thomas, N. L., and Rice, E. M., Changing characters in some Texas species of *Guembelina:* Jour. Pal., vol. 1, pp. 141–144, 1927.
59. Udden, J. A., Characteristics of some Texas sedimentary rocks as seen in well samples: Bull. Amer. Assoc. Pet. Geol., vol. 5, pp. 373–385, 1920.
60. Udden, J. A., Baker, C. L., and Böse, E., Review of the geology of Texas: Univ. Texas Bull. 44, 1916.
61. Ulrich, E. O., and Bassler, R., Ostracoda of the Miocene of Maryland: Geol. Surv. Maryland, Miocene Rept.
62. Williamson, W. C., Memoir on some of the microscopical objects found in the mud of the Levant and other deposits: Trans. Manchester Lit. Phil. Soc., vol 8, 1847.
63. Williamson, W. C., Corrections of the nomenclature of the objects figured in a memoir "On Some of the Minute Objects Found in the Mud of the Levant": Trans. Manchester Lit. and Phil. Soc., ser. 3, vol. 5, pp. 131–139, 1872.
64. Winton, W. M., The Geology of Denton County: Univ Texas Bull. 2544, 1925.
65. Winton, W. M., and Adkins, W. S., The Geology of Tarrant County: Univ. Texas Bull. 1931, 1919.
66. Winton, W. M., and Scott, Gayle, The Geology of Johnson County: Univ. Texas Bull. 2229, 1922.
67. Wright, J., List of the Cretaceous microzoa of the north of Ireland: Rep. Proc. Belfast Nat. Field Club, 1873–1874, pp. 73–99, pls. 2, 3, 1875.

PLATES I–X

PLATE I

The magnification of all figures on Plates I–X is 42x the natural size.

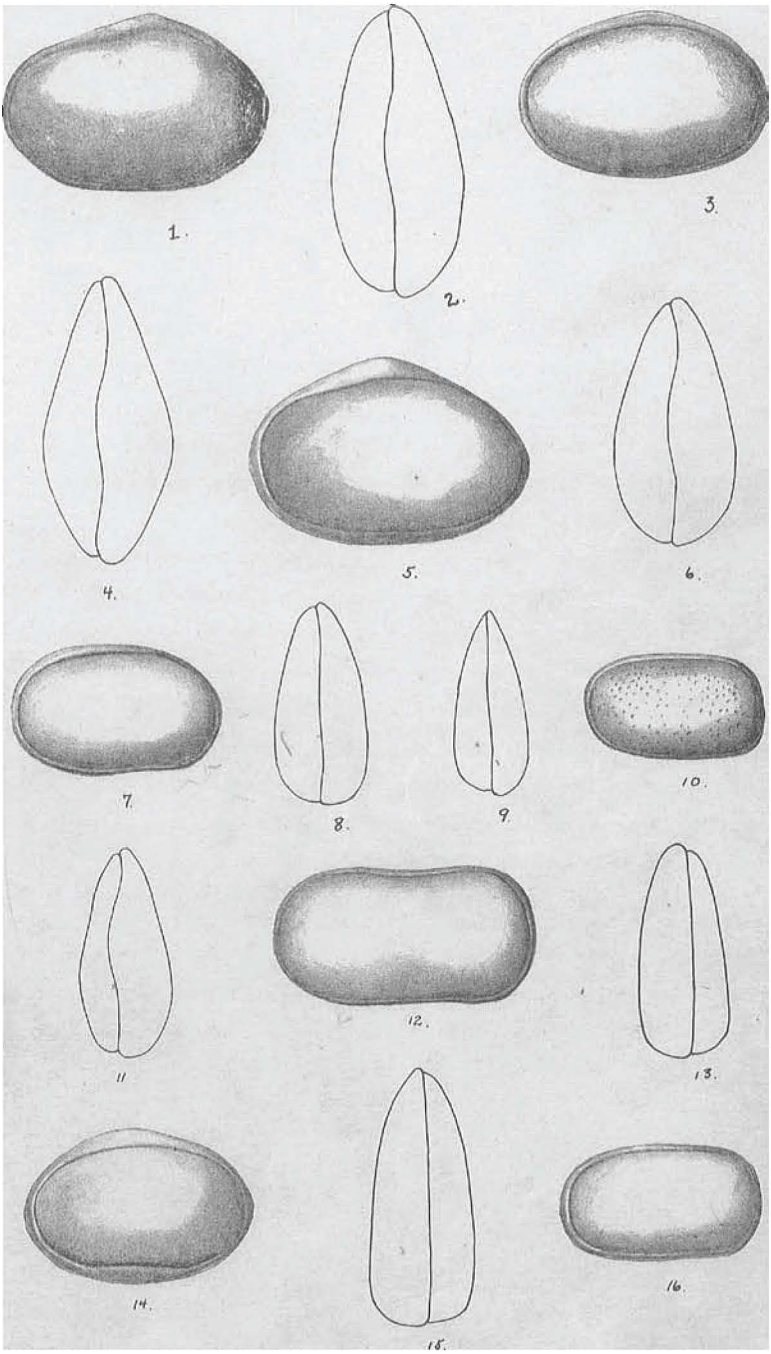

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11
12.
13.
14.
15.
16.

PLATE II

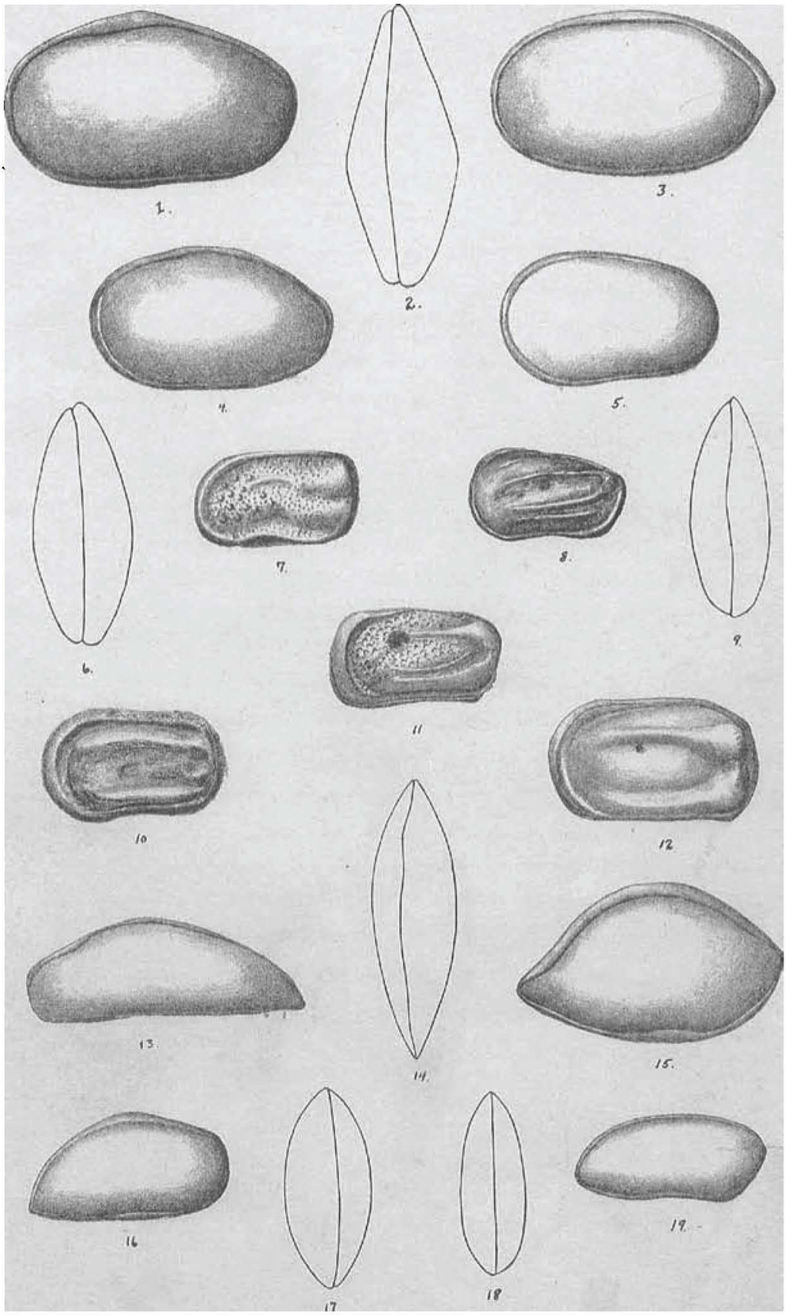

1.
2.
3.
4.
5.
6.
7.
8.
9.
10
11
12
13.
14.
15.
16
17
18
19.

PLATE III

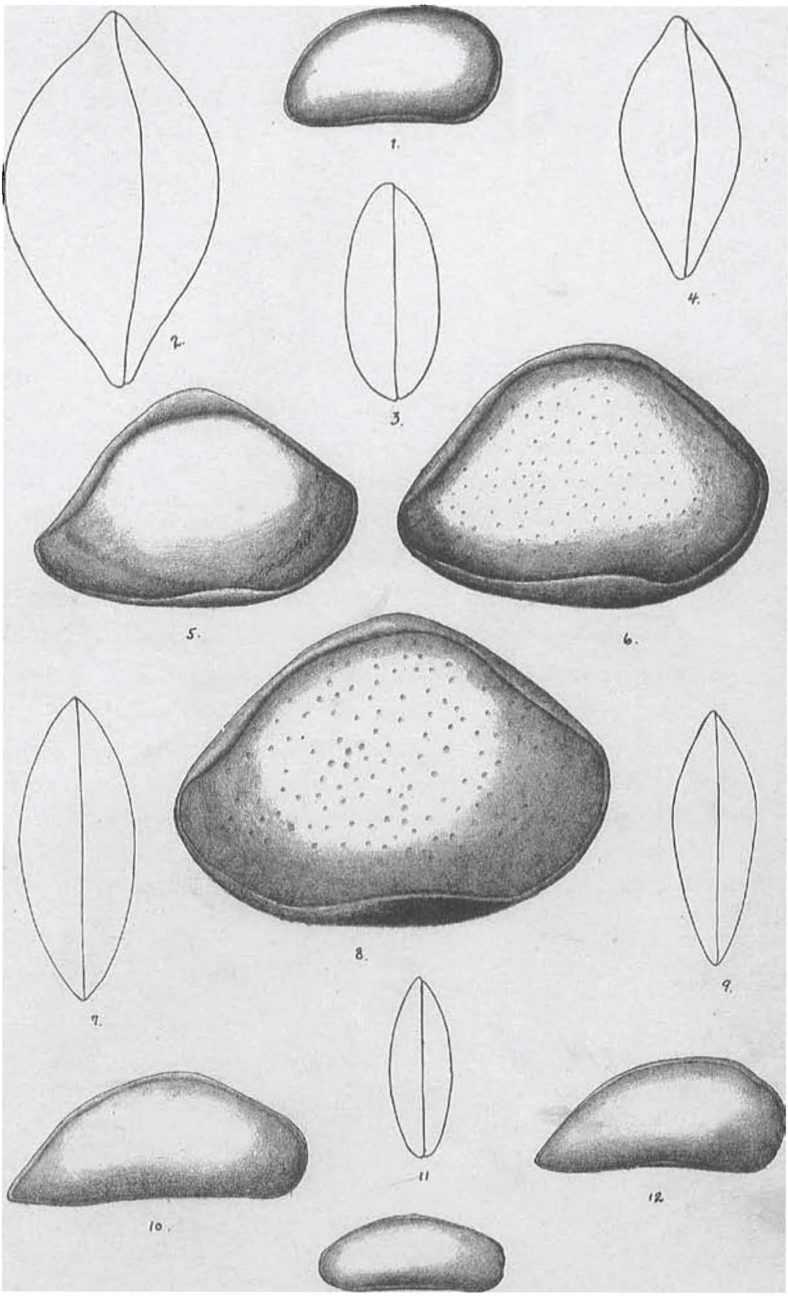

1.
2.
3.
4.
5.
6.
8.
7.
9.
10.
11
12

PLATE IV

Figure—		Page
1.	*Paracypris dentonensis* n. sp., right valve view	65
2.	*Paracypris pulchella* n. sp., right valve view	66
3.	*Paracypris angusta* n. sp., right valve view	67
4.	*Paracypris dentonensis* n. sp., dorsal view	65
5.	*Paracypris siliqua* Jones and Hinde, young individual, right valve view (see pl. 3, figs. 7, 10)	65
6.	*Cytheridea oliverensis* n. sp., dorsal view	68
7.	*Paracypris angusta* n. sp., dorsal view	67
8.	*Paracypris pulchella* n. sp., dorsal view	66
9.	*Krithe cushmani,* n. sp., dorsal view	67
10.	*Cytheridea oliverensis* n. sp., right valve view	68
11.	*Krithe cushmani* n. sp., right valve view	67
12.	*Cytheridea washitaensis* n. sp., right valve view	71
13.	*Cytheridea amygdaloides* (Cornuel) var. *brevis* (Cornuel), right valve view	70
14.	*Cytheridea washitaensis* n. sp., dorsal view	71
15.	*Cytheridea goodlandensis* n. sp., right valve view	69
16.	*Cytheridea amygdaloides* (Cornuel), right valve view	69
17.	*Cytheridea amygdaloides* (Cornuel), dorsal view	69
18.	*Cytheridea bairdioides* n. sp., right valve view	70

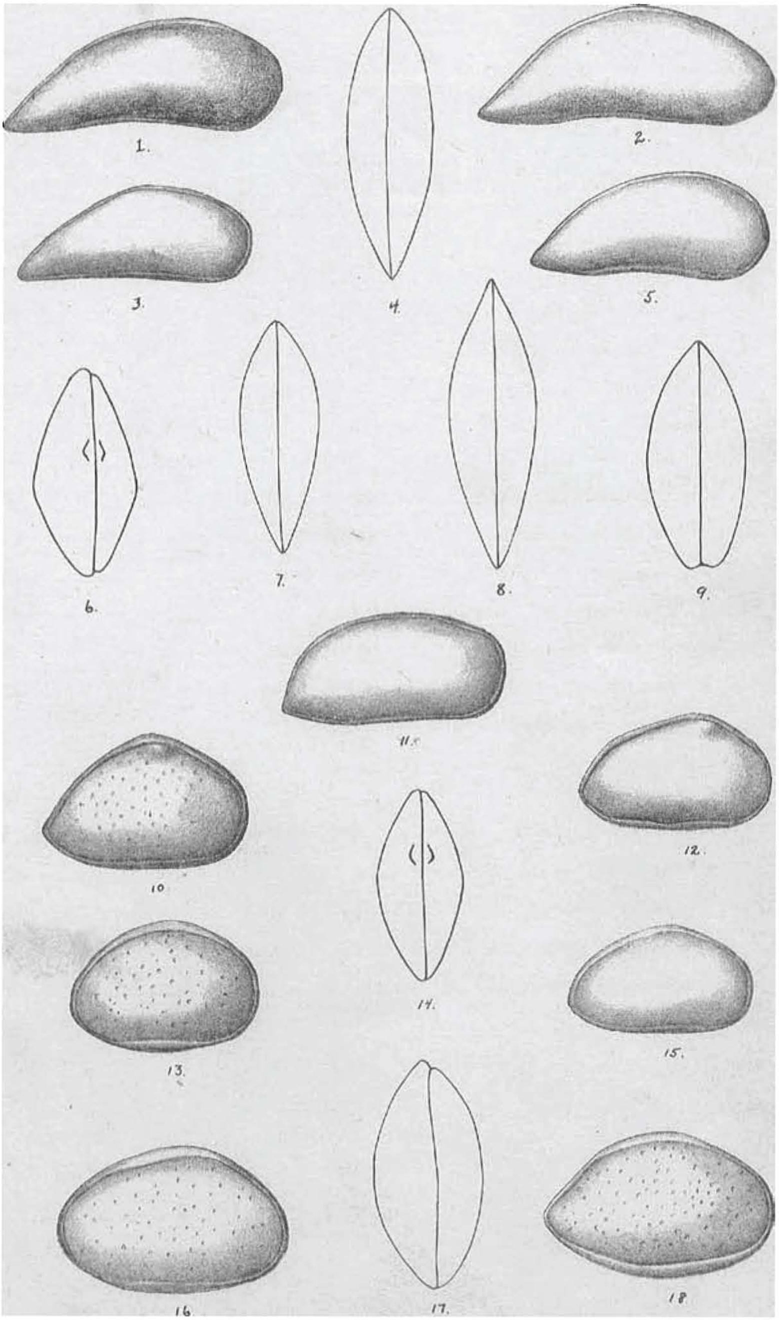

1.
2.
3.
4.
5.
6.
7.
8.
9.
11.
10
12.
14.
13.
15.
16
17.
18.

PLATE V

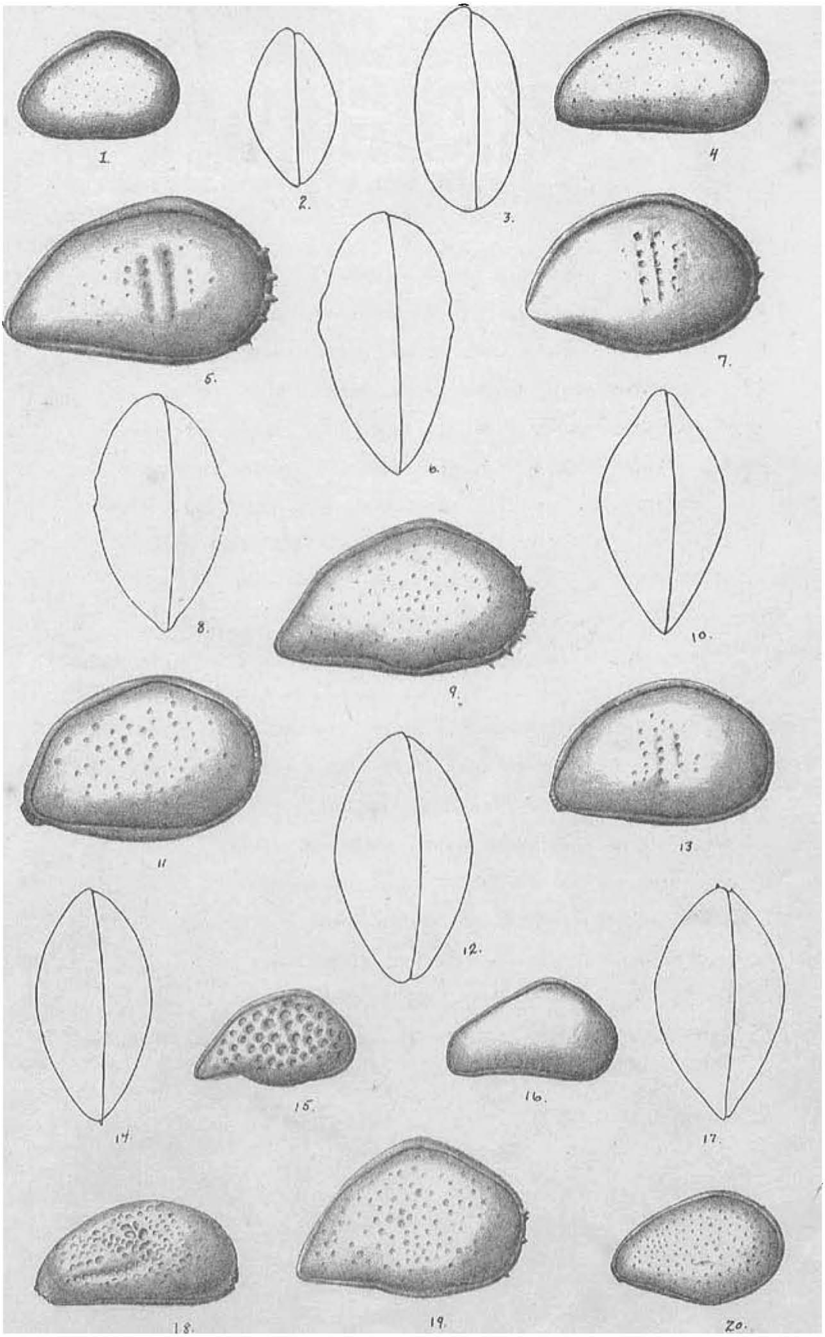

1.
2.
3.
4
5.
6.
7.
8.
9.
10.
11
12.
13
14
15.
16.
17.
18.
19.
20.

PLATE VI

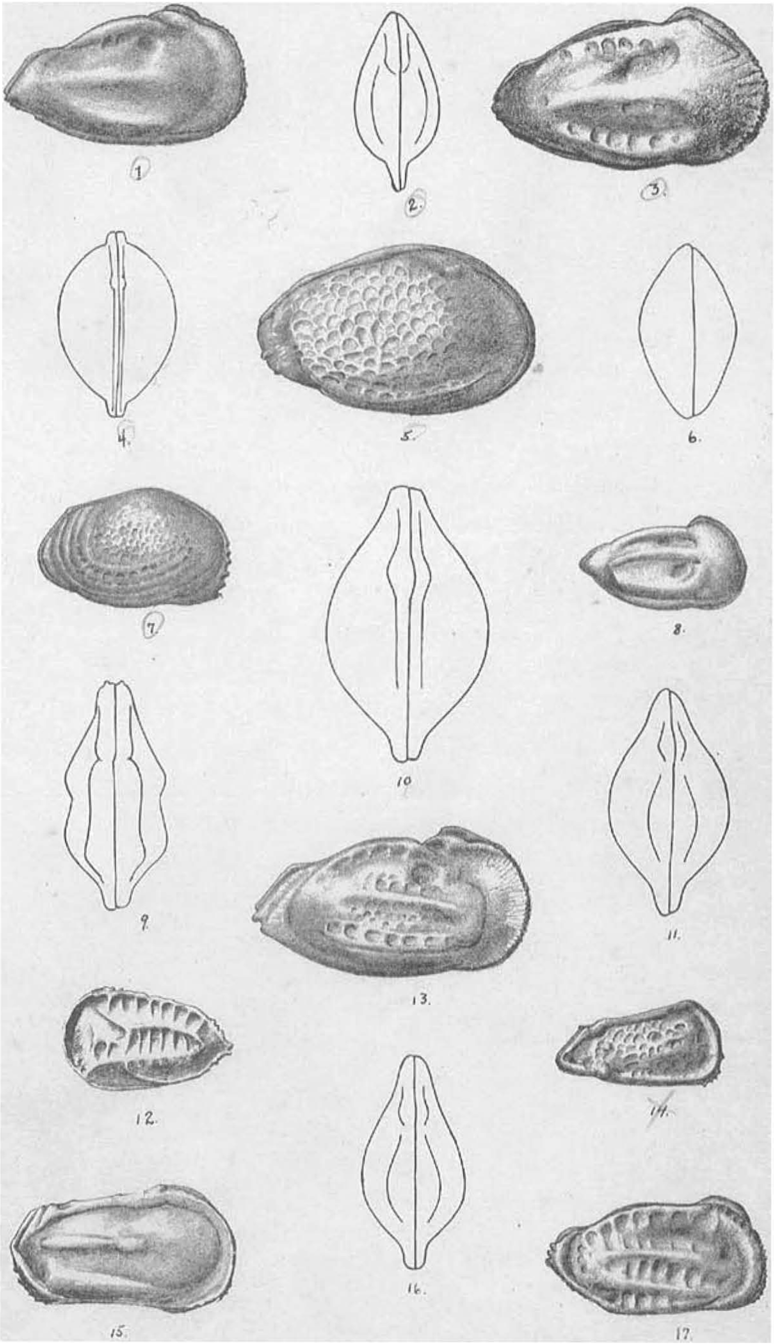

1
2.
3.
4.
5.
6.
7
8.
9.
10
11.
13.
12.
14.
15.
16.
17.

PLATE VII

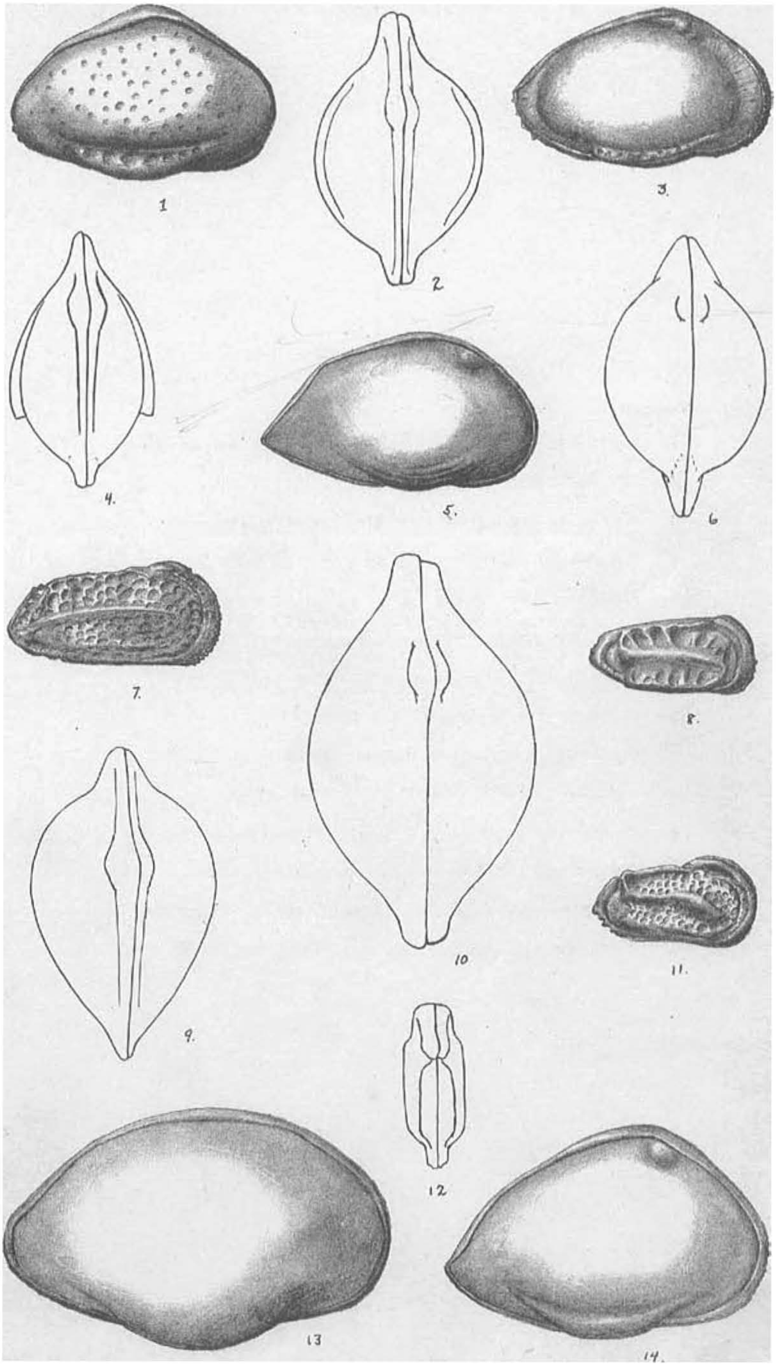

1
2
3.
4.
5.
6
7.
8.
9.
10
11.
12
13
14.

PLATE VIII

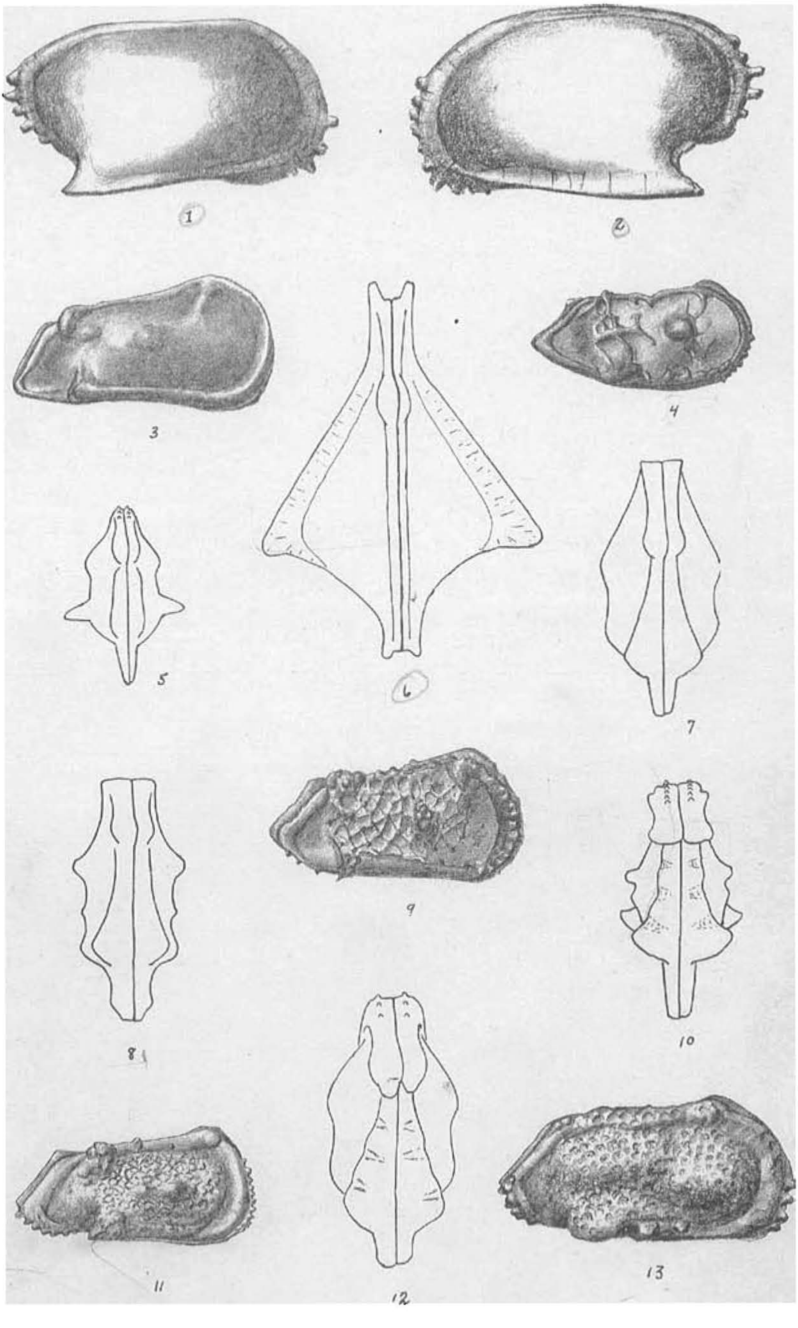

1
2
3
4
5
6
7
8
9
10
11
12
13

PLATE IX

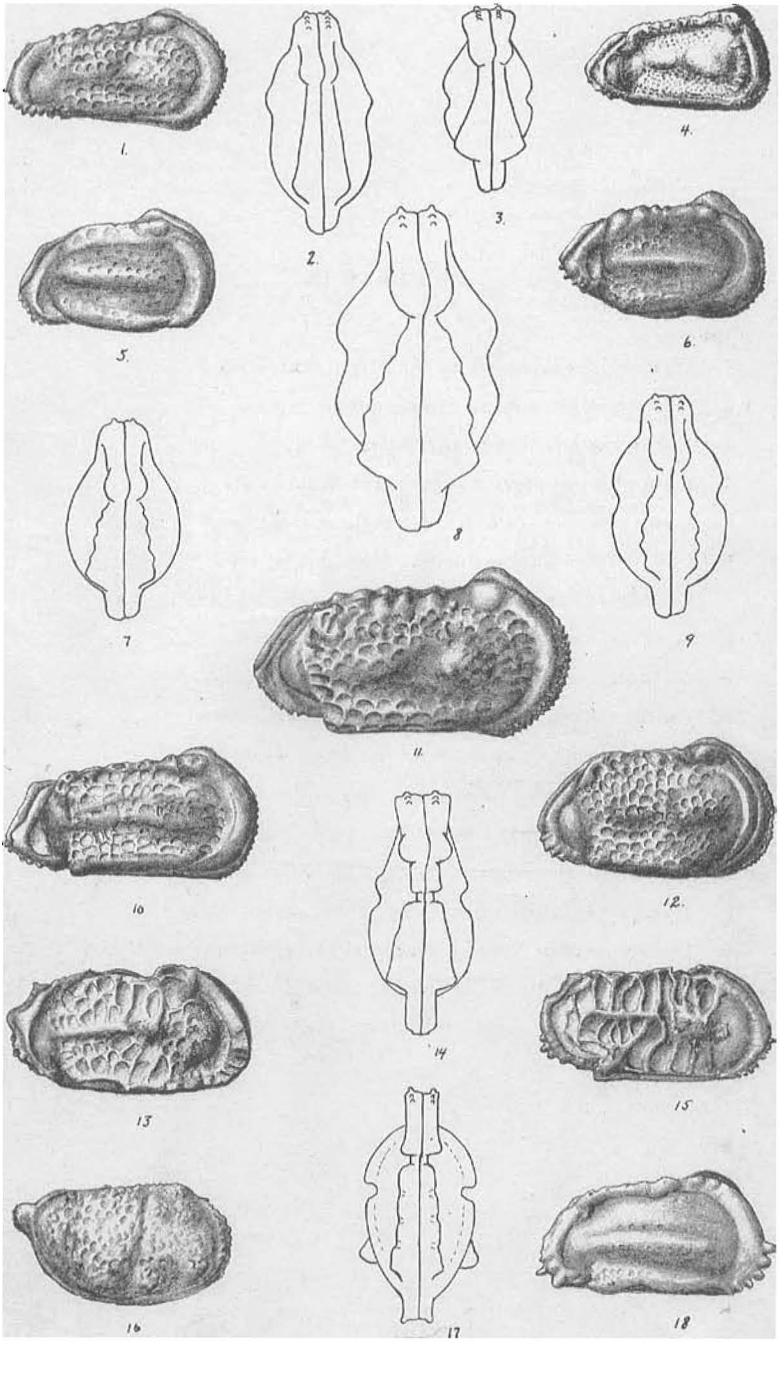
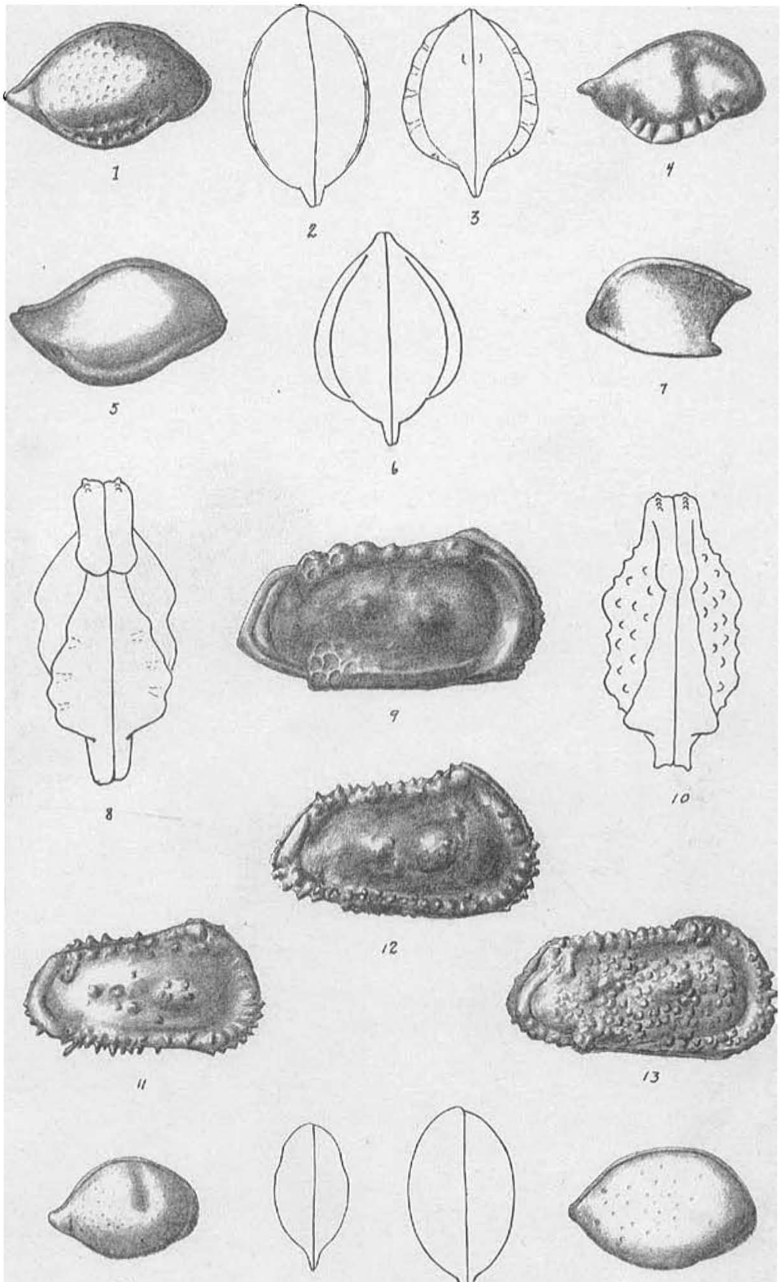

1.
2.
3.
4.
5.
6.
7
8
9
11.
10
12.
14
13
15
16
17
18

PLATE X


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

INDEX