Stratigraphy and Ostracoda of the Brownstown and Tokio Formations-Southwest Arkansas.

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Stratigraphy and Ostracoda
of the
Brownstown and Tokio Formations
Southwest Arkansas

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in
The Department of Geology

by
Carl Peter Elmer Thorsen
B.S., Tulane University, 1951
M.S., Louisiana State University, 1954
May, 1959
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ABSTRACT

A study was made of the stratigraphy and Ostracoda of the Gulf Cretaceous Brownstown and Tokio formations of southwest Arkansas as part of a project by the Graduate School of Geology, Louisiana State University, to better understand the Upper Cretaceous stratigraphy of the Arkansas-Texas area.

Surface sections of the Brownstown and Tokio were measured, described and systematically sampled wherever the formations were sufficiently well exposed. A diagrammatic east-west stratigraphic section of the Tokio, based on surface sections, is presented to illustrate the facies changes experienced by the formation. In addition, three regional subsurface stratigraphic sections were constructed to demonstrate the relationship of the Brownstown and Tokio to adjacent formations and to illustrate the correlation of the Arkansas section with east Texas and northwest Louisiana.

The presence of an unconformity was demonstrated near the middle of the Tokio formation in southwest Arkansas which divides the formation into an upper and a lower member. The lower member is truncated and overlapped in a northeasterly direction.
A sequence of interbedded chalk and chalky marl within the Brownstown formation of Arkansas is considered to be the eastward extension of the Gober Chalk of Texas. This suggests that the portion of the Brownstown which overlies this chalk sequence in southwest Arkansas is younger than the Brownstown formation of Texas since the base of the Gober Chalk marks the top of the Brownstown in Texas.

The basal portion of the Brownstown formation is considered to have been deposited in a partially restricted basin environment. This resulted in the exclusion of an abundant fauna from the lower Brownstown and is probably responsible for the absence of *Exogyra ponderosa* from the basal portion of the formation. The lowest observed occurrence of *E. ponderosa* at the surface in this area is approximately thirty feet above the base of the Brownstown.

A total of 40 species of Ostracoda representing 17 genera were described and illustrated from surface samples of the Brownstown and Tokio formations collected in southwest Arkansas and southeast Oklahoma. Of these, 20 species have not been previously described. Four species of Ostracoda from the Brownstown and one species from the Tokio are considered to be reliable markers for these formations in this area.
On the basis of the Ostracoda, it is concluded that the Tokio formation is of the same age as the type Austin of Texas, that the type Brownstown formation is partially equivalent to both the upper portion of the type Austin and the basal portion of the type Lower Taylor groups of Texas, and that there is no hiatus in the Arkansas section which is equivalent to the type Austin-Taylor contact in Texas.
INTRODUCTION

In an attempt to furnish a more nearly complete understanding of the Upper Cretaceous deposits of southwest Arkansas and east Texas, a group of graduate students at Louisiana State University has undertaken a systematic faunal and stratigraphic study of the Upper Cretaceous sequence in this area. It was the writer's privilege to investigate the stratigraphy and ostracoda of the Brownstown and Tokio formations of southwest Arkansas as a part of this project.

The field work for this investigation was conducted during the summer and fall of 1956 and the summer of 1957. The Brownstown and Tokio formations were traced throughout the extent of their outcrop in southwest Arkansas and sections were measured and systematically sampled wherever the formations were sufficiently well exposed. In addition, numerous trips were made into east Texas and southeast Oklahoma to observe the Upper Cretaceous deposits in these areas.

Because of dense vegetation, moderate relief of the area, and the gentle dip of the formations (60 to 70 feet per mile), no continuous exposure of a complete section of either the Brownstown or the Tokio formation is found anywhere in southwest Arkansas. This, coupled with the lack of recognizable lithic or faunal marker beds within
these formations, made it necessary to resort to subsurface information to determine the relationship between individual exposures. Fortunately, there was sufficient United States Geological Survey topographic coverage of the area to determine the location and elevation of the majority of the partial sections measured, and subsurface control was sufficient to determine the structure in most areas. Plate I shows the distribution of the outcrop of the Brownstown and Tokio formations in southwest Arkansas and the location of all measured sections referred to in this report. Plate II shows the stratigraphic position of the samples collected for faunal study.
GENERAL STRATIGRAPHY

The Upper Cretaceous deposits of southwest Arkansas have a maximum thickness of approximately 1300 feet and cropout within a belt approximately 70 miles long in the extreme southwest portion of the state. The formations become thinner to the east and are progressively overlapped by younger beds which results in a marked eastward narrowing of the outcrop (figure 1).

To the west, the outcrop of the Upper Cretaceous formations in southwest Arkansas is terminated by the Red River and Little River alluvial valleys which separate the Cretaceous outcrop in Arkansas from that in east Texas (figure 1). This interruption of the continuity of the outcrop, coupled with the variation in facies experienced by these deposits, has made surface correlations between southwest Arkansas and east Texas extremely questionable. Consequently, this report has largely been restricted to southwest Arkansas. The writer's concept of the subsurface correlation of the Arkansas section with that of east Texas, based on lithology and electrical log character, is presented on plate IV.

On the basis of gross lithology, the entire Upper Cretaceous sequence of southwest Arkansas can be divided into two units, a lower clastic unit consisting of gravel,
UPPER CRETACEOUS OUTCROP
ARKANSAS—OKLAHOMA—TEXAS AREA
sand, and arenaceous clay, and an upper calcareous unit of marl and chalk (figure 2). Originally, the clastic deposits which constitute the lower part of the Upper Cretaceous in this area were considered a single formation and was referred to as the Bingen Sand (Hill, 1888; Veatch, 1906; Miser and Purdue, 1919). This clastic sequence has been subsequently divided into an upper unit of quartz sand and arenaceous clay with a basal bed of chert gravel termed the Tokio formation and a lower unit, composed largely of volcanic material, considered to be equivalent to the Woodbine of Texas (Dane 1929). However, Hazzard (1939) disagreed with this correlation and considered this volcanic sequence to be equivalent to the Eagle Ford of Texas. Hazzard applied the name Centerpoint volcanics to these deposits for the excellent exposures in the vicinity of Centerpoint, Howard County, Arkansas.

The upper calcareous portion of the Upper Cretaceous in this area was originally divided, in ascending order, into the Brownstown, Annona, and Marlbrook formations (Hill 1888, 1894). Subsequent work has demonstrated the presence of additional breaks within this sequence which has resulted in the division of the Brownstown into the Brownstown (Restricted) and Ozan formations and the Marlbrook into the Marlbrook (Restricted) and Saratoga formations (Dane, 1929). Also, the overlying Nacatoch and Arkadelphia formations are now known to be Cretaceous in age and are included in the Upper Cretaceous (Gulf
Series). Figure 2 shows the presently accepted divisions of the Upper Cretaceous deposits of southwest Arkansas.
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<td>ARKADELPHIA MARL</td>
<td>Dark gray marl with beds of limestone, chalk and calcareous sandstone.</td>
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<td>NAGATOCH SAND</td>
<td>Fine grained, yellow to gray, calcareous sand, very glauconitic in part, generally cross-bedded, with beds of arenaceous limestone and gray marl.</td>
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<td>SARATOGA CHALK</td>
<td>Chalk and chalky marl, very fossiliferous, basal one foot is very glauconitic and contains numerous phosphatic nodules.</td>
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<td>MARL MUD (Restricted)</td>
<td>Dark bluish gray chalky marl.</td>
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<td>ANNUNCA CHALK (Restricted)</td>
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<td>Gray, arenaceous marl with beds of chalk and calcareous sandstone, basal portion is fine to coarse grained glauconitic, calcareous sand termed Buckrange Sand member.</td>
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<td>BROWNSTOWN (Restricted)</td>
<td>Gray, arenaceous, micaceous marl.</td>
</tr>
<tr>
<td>TOKIO</td>
<td>Massive and cross-bedded, red, gray, or white, fine to coarse grained sand and gray and white arenaceous, micaceous clay with a basal bed of chert gravel.</td>
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<td>CENTERPOINT VOLCANICS</td>
<td>Tuffaceous sand and red and gray arenaceous clay with inbedded gravel.</td>
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**FIGURE 2**
TOKIO FORMATION

The deposits which constitute the Tokio formation were originally grouped with the underlying Eagle Ford sands and clays and termed the Bingen Sand by Hill (1888) and, because of their predominantly clastic nature, were considered to be Tertiary in age. Veatch in 1906, correctly established the Cretaceous age of these beds but still regarded them as a single formation. Miser and Purdue (1919) referred to the "Bingen Sand" as the "Bingen formation" and designated the upper 100 to 150 feet of quartz sand as the Tokio member. Dane (1929) elevated the Tokio to formational rank and redefined it by including at its base a gravel bed 30 to 40 feet thick; the remainder of the original Bingen formation has subsequently been named the Centerpoint volcanics (Hazzard, 1939). The type locality of the Tokio formation is in the vicinity of the settlement of Tokio in northern Hempstead County, Arkansas (plate 1).

STRATIGRAPHY

The Tokio formation is represented in the western part of its outcrop in southwest Arkansas by 350 to 375 feet of gray, micaceous, lignitic clay with several beds of red, brown, and white quartz sand and a basal bed of
gravel (plate II). The exact thickness of the gravel in this area is not known, however, Dane (1929) estimated its thickness to be between 10 and 20 feet. All of the clay samples examined are highly micaceous containing numerous euhedral grains of muscovite. The sands are both massive and bedded and consist of fine to medium, angular to subrounded, grains of quartz with a large percentage of heavy minerals. The gravels are composed mainly of novaculite but also contain numerous pebbles of igneous and metamorphic rock. Dane (1929) points out that the Tokio formation becomes thinner and increasingly arenaceous eastward and the basal gravel bed increases to more than 25 feet in thickness. The sands become coarser, predominantly cross bedded and more ferruginous.

Considering the east-west facies change experienced by the Tokio formation, Dane (1929) states that the western argillaceous facies extends eastward into the arenaceous facies in three poorly defined tongues. He states that the lowest tongue is near the base of the formation just above the basal gravels, another tongue is near the middle of the formation, and the third is at the top of the formation and includes some glauconitic sand and lenses of hard, calcareous, fine grained sandstone.

The writer constructed a composite measured section of the Tokio in the western portion of the outcrop (plate II) and it was seen that, above the basal gravel bed,
the lower half of the formation is predominantly an argillaceous unit; the upper half consists of a series of argillaceous intervals separated by more arenaceous beds. The uppermost arenaceous unit observed in this area is approximately 10 feet below the top of the formation and contains the calcareous sandstone lenses referred to by Dane. If this uppermost arenaceous interval is grouped with the adjacent arenaceous clays, this section can be roughly divided into three argillaceous units separated by more arenaceous beds in accordance with Dane's concept of three argillaceous tongues (plate II). Because of poor exposures and the difficulty of determining the stratigraphic position of isolated exposures, it was impossible to thoroughly check Dane's hypothesis of three eastward extending argillaceous tongues, however, as shown in figure 3, this generally seems to be correct.

The interval of calcareous sandstone lenses developed near the top of the Tokio formation is considered to be equivalent to the Blossom sand of Texas (Dane, 1929; Hazelzard, 1939) and is thought to be a correlative of the upper Tokio sand developed in the subsurface of the Arkansas-Louisiana-Texas area (plates III, IV).

A pronounced unconformity exists at the base of the Tokio as evidenced by the widely varying age of the deposits upon which the formation comes to rest. In Howard and Sevier Counties, the Tokio formation rests unconformably
upon the highly irregular surface of the Eagle Ford (Centerpoint) volcanics. The following partial sections demonstrate the nature of this contact:

Partial sections through Tokio-Centerpoint Volcanics contact

Section X

Location: 10.7 miles west of Nashville on Arkansas Highway No. 24 or 2.0 miles east of center of Saline River bridge on Arkansas Highway No. 24 in road cut on north side of road in NE/4, SW/4, Section 19, T-9-S, R-28-W, Howard County, Arkansas.

Top of Exposure ---- elevation = 515'
Eocene:
Gravel, massive, coarse, composed mainly of novaculite, in matrix of arenaceous clay.
Reddish brown weathering tan -------------- 6'

Tokio formation ---- elevation = 509'
Gravel, up to 6" in diameter, massive, composed mainly of novaculite but contains also some pebbles and cobbles of igneous rock and quartzite, moderately indurated with ferruginous cement, upper 3' has been cemented to a conglomerate. Dark red weathering to a reddish tan. Rests upon irregular surface of underlying Centerpoint Volcanics -------------- 12'

Centerpoint Volcanics ---- elevation = 497'
Clay, poorly bedded, slightly arenaceous with scattered thin beds of fine grained sand, contains abundant carbonaceous material. Mottled red, green, and gray weathering to purple ---- 6'

Section Z

Location: 9.9 miles west of Nashville on Arkansas Highway No. 24 or 2.8 miles east of center of Saline River bridge on Arkansas Highway No. 24 in road cut on north side of road in NW/4, SW/4, Section 20, T-9-S, R-28-W, Howard County, Arkansas.
Top of Exposure ---- elevation = 500'
Pleistocene:
Gravel, coarse, massive, composed mainly of novaculite pebbles, in matrix of arenaceous clay. Reddish brown weathering tan --------- 9'

Tokio formation ---- elevation = 491'
Clay, well bedded, arenaceous, with thin beds of hard, medium grained, ferruginous sandstone containing kaolinized feldspar grains. Gray weathering mottled gray and purple --------- 5'
Gravel, massive, composed mainly of novaculite pebbles in matrix of fine grained sand, moderately indurated with ferruginous cement. Reddish brown weathering tan --------- 7'

Centerpoint Volcanics ---- elevation = 479'
Clay, poorly bedded, slightly arenaceous, contains kaolinized feldspar fragments. Mottled red, green, and gray weathering purple --------- 5'

Section W

Location: 7.0 miles west of Nashville on Arkansas Highway No. 24 in bluff on west side of Blue Bayou where it crosses Highway No. 24 in NW/4, NW/4, Section 26, T-9-S, R-28-W, Howard County, Arkansas.

Top of Exposure ---- elevation = 400'
Pleistocene:
Gravel, coarse, massive, composed mainly of novaculite pebbles in matrix of arenaceous clay. Reddish brown weathering tan --------- 2'

Tokio formation ---- elevation = 398'
Gravel, massive, composed mainly of novaculite pebbles and cobbles in matrix of fine grained sand. Moderately indurated with ferruginous cement, upper 2' cemented to a conglomerate. Dark red weathering to reddish brown. Rests upon highly irregular surface of underlying Centerpoint Volcanics ------------------------ 5'6''

Centerpoint Volcanics ---- elevation = 392'6"
Clay, slightly arenaceous, mottled green, gray, and red weathering purple ------------------------ 4'6''
Sand, fine grained, chloritic, well bedded with thin beds of dark gray, arenaceous clay containing abundant carbonaceous fragments. Green and gray weathering light green

Sand, fine grained, chloritic, interbedded with black and brown carbonaceous, fine grained sand and dark gray carbonaceous clay

Section Y

Location: 1.3 miles south from Centerpoint on Arkansas Highway No. 4 in gravel pit on east side of road in north half of Section 1, T-9-S, R-28-W in Howard County, Arkansas.

Top of Exposure ---- elevation = 619'
Tokio formation:
Gravel, massive, composed mainly of novaculite with some pebbles and cobbles of igneous rock and quartzite in a matrix of fine to medium grained ferruginous sand. Moderately indurated with ferruginous cement, upper 4-5 feet cemented to a conglomerate. Reddish brown weathering tan. Rests upon highly irregular surface of the underlying Centerpoint Volcanics

Centerpoint Volcanics ---- elevation = 605'
Clay, very slightly silty, dark red weathering purple

Further to the east the Tokio overlaps the Centerpoint volcanics and comes to rest upon Lower Cretaceous deposits and finally upon the Atoka formation of Carboniferous age (Dane, 1929). The northeastward overlap of the underlying formations by the Tokio is clearly seen in the subsurface of southwest Arkansas as shown by plates III, IV. To the south, in the subsurface of extreme southwest Arkansas and north Louisiana, the Tokio also overlaps the Centerpoint Volcanics on the north flank of the Pine Island
uplift and comes to rest directly upon Lower Cretaceous (Comanche) deposits.

In the subsurface of southwest Arkansas, the Tokio formation is characterized by the development of three pronounced sands, termed the upper, middle, and basal Tokio sands, which are separated by variable thicknesses of glauconitic, calcareous, carbonaceous clay (plates III, IV). Further south, in north Louisiana, the middle and basal sands lose their identity while the upper Tokio sand remains a fairly persistent subsurface marker. The upper Tokio sand is believed to be equivalent to the Blossom sand of Texas (Jane, 1939; Hazzard, 1939) and the top of the Tokio formation in the subsurface is placed at the top of this sand.

The basal Tokio sand is graveliferous in many areas in the subsurface and rests upon deposits of varying age indicating that a considerable unconformity exists at the base of the formation (plates III, IV). Mr. Roy T. Hazzard pointed out to the writer that, in the subsurface, the middle Tokio sand is also graveliferous and an examination of numerous sample logs showed that this middle Tokio graveliferous zone can be traced in the subsurface of southwest Arkansas east of Miller and Lafayette Counties. It was also noted that the section underlying the middle Tokio gravels is apparently truncated in a northeastward direction indicating this graveliferous zone marks an
unconformity within the Tokio formation (plates III, IV). This truncation of the lower part of the formation accounts for the rapid northward decrease in thickness experienced by the Tokio as compared to adjacent formations. The Tokio formation has a thickness of only 370 feet at the surface in Howard and Sevier Counties while its thickness is in excess of 500 feet approximately twelve miles to the south in the subsurface. It may also be that the argillaceous lower portion of the Tokio, seen at the western end of the outcrop in Arkansas, does not simply experience an eastward change to an arenaceous facies but is also lost by truncation at the middle Tokio unconformity. This would result in the more arenaceous upper part of the Tokio constituting a progressively greater proportion of the formation to the east and would accentuate the tendency of the Tokio to become more arenaceous in this direction.

The problem of tracing the Tokio gravels at the surface is made extremely difficult by the almost universally present mantle of Quaternary gravels which represent terrace deposits primarily of the Pleistocene Epoch. These Quaternary gravels closely resemble the Tokio gravels from which, in most instances, they were derived and both are composed predominantly of novaculite cobbles and pebbles.
Some differences between the Quaternary and Tokio gravels can be observed. In general, the matrix of the Tokio gravels is composed of quartz sand relatively free of clay while the matrix of the Quaternary gravels consists mainly of arenaceous clay. The Tokio gravels are also slightly more consolidated and in places display indistinct horizontal bedding although both Tokio and Quaternary gravels are frequently cross-bedded. Both kinds of gravels are ferruginous and weather to some shade of brown, however, the Tokio gravels apparently weather to a darker shade than do the Quaternary gravels. These minor distinctions are apparent when both kinds of gravels are exposed in a single outcrop, however, it is at times difficult to determine the age of an isolated exposure. This is especially true in deeply weathered areas where the only indication of the presence of a graveliferous zone is float gravel at the surface.

In only one exposure noted by the writer does a sequence of well bedded Tokio sands and clays intervene between the Tokio and Quaternary gravels. In this exposure (section Z), the Tokio age of the lower gravel is without doubt.

The Tokio gravels are easily distinguished from the basal gravels of the underlying Centerpoint Volcanics due to the marked difference in composition and the resultant difference in color of the weathered outcrop.
The exposures of the Centerpoint gravels weather to various shades of green, red, and purple.

Dane (1929) considered the contact of the Tokio with the overlying Brownstown formation to be unconformable at the surface in Arkansas. In the western portion of the outcrop the contact is marked by the glauconitic, calcareous clay of the Brownstown resting upon the carbonaceous clay of the Tokio. This change in lithology is considered by Dane to represent a considerable break between the two formations. Although the actual contact is nowhere exposed in this area, this change in lithology is demonstrated by the following partial section through the Brownstown-Tokio contact from Sevier County:

Section I

Location: 0.5 miles east of center of Wilson Creek bridge on road from Ben Lomand to U. S. Highway 59-71 in the center of the NW/4, Section 5, T-11-S, R-29-W, Sevier County, Arkansas.

Brownstown formation:
- Clay, slightly arenaceous, glauconitic, micaceous, calcareous with scattered shell fragments.
- Dark gray weathering light gray

Not exposed

Tokio formation:
- Clay, arenaceous, micaceous, very carbonaceous.
- Gray weathering light gray

To the east, in Howard and Hempstead Counties, south and east of the town of Nashville, a much more pronounced lithologic change marks the Brownstown-Tokio contact.
In this area, the gray marl of the Brownstown rests upon the white, arenaceous, noncalcareous clay of the Tokio formation. A zone of lignite and lignitic clay six inches to one foot thick is present at the top of the Tokio and the contact between the formations is apparently irregular. The following partial sections demonstrate these relationships:

Section E

Location: 1.1 miles south of Nashville on Arkansas Highway No. 4 in road cut on east side of road and in gully on west side of road in the center of the NE/4 of Section 1, T-10-S, R-27-W, Howard County, Arkansas.

Top of Exposure ---- elevation = 441'

Brownstown formation:
Marl, slightly arenaceous, micaceous, scattered shell fragments. Contains marly chalk lenses up to 2' in length. Gray weathering olive drab with irregular ferruginous stain and abundant calcite nodules on surface ------ 3'

Marl, same as above but without chalk lenses ----------------------------------------------- 7'

Clay, arenaceous, slightly lignitic, ferruginous, with thin beds of ferruginous sand. Reddish brown weathering tan. Rests upon slightly irregular weathering surface of Tokio formation ------------------------------------------ 0'8''

Tokic formation ---- elevation = 430'

Clay, arenaceous, very lignitic, contains numerous plant fragments and thin beds of lignite. Dark gray to black weathering purple ------------------------------------------ 1'4''

Clay, slightly silty becoming arenaceous downward, micaceous, scattered carbonaceous fragments. Light gray weathering white ----------------------------- 3'
Section C

Location: 5.3 miles east of Nashville on Arkansas Highway No. 24 in road cut on north side of road in the SE/4, SE/4 of Section 22, T-9-S, R-26-W in Hempstead County, Arkansas.

Top of Exposure ---- elevation = 427'

Brownstown formation:
Marl, slightly arenaceous, micaceous, scattered shell fragments. Gray weathering olive drab with scattered ferruginous stain. Small calcite nodules weather out of marl and are abundant on surface ---------------- 3'

Marl, same as above but contains lenses of marly chalk up to 2' in length ------------ 3'

Marl, same as above but without chalk lenses - 7'

Marl, arenaceous, micaceous, contains thin beds of dark gray calcereous, carbonaceous clay. Rests upon slightly irregular surface of Tokio formation -------------------------------- 2'

Tokio formation ---- elevation = 412'
Lignite, bedded, with lamination of lignitic clay ------------------------------- 0'6''

Clay, slightly arenaceous, increasingly carbonaceous toward top and transitional into lignite bed above. Gray weathering purple --- 1'6''

Clay, slightly arenaceous. Light gray weathering white ---------------------- 0'6''

Clay, silty, slightly carbonaceous. Gray weathering slate blue gray ------------ 2'

Clay, lignitic, slightly arenaceous. Black weathering purple ----------------- 2'

Clay, arenaceous, with thin partings of fine grained sand. Light gray weathering white with irregular ferruginous stain -------------- 3'

Sand, fine grained, argillaceous, with clay laminations, clay contains scattered fragments of carbonaceous material. Gray and brown weathering pink and red, clay weathers white - 8'
As pointed out by Dane (1929), the nature of the Brownstown-Tokio contact indicates a sedimentary break between the two formations. However, there is no evidence of truncation of the Tokio and the relationship between the formations is considered to be disconformable.

In the subsurface of the Arkansas-Louisiana-Texas area, the Brownstown-Tokio contact is placed at the top of the upper Tokio (Blossom) sand. In those areas where this sand is not developed, no reliable separation can be made between the two formations on the basis of electrical log character and they are treated as the Brownstown-Tokio undifferentiated.

Paleontology

The Tokio formation is only sparsely fossiliferous at the outcrop. The fossils are generally preserved only as molds and casts since the highly permeable nature of the formation has facilitated the destruction of the original shell material. Dane (1929) reports that Dr. L. W. Stephenson identified the following fossils collected from the Tokio formation in southwest Arkansas:

Pelecypoda:

- *Inoceramus* aff. *I. barabini* Morton
- *Leptosolen* aff. *L. biplicatus* Conrad
- *Nucula* sp.
- *Leda* sp.
- *Yoldia* sp.
- *Striarca* sp.
- *Anomia* cf. *A. argentaria* Morton
- *Lucina* sp.
- *Cardium* (Trachycardium) sp.
- *Corbula* cf. *C. oxyrema* Conrad
Corbula cf. C. subgibbosa Conrad
Tellina sp.
Trigonarca sp.
Ostrea plumosa Morton ?

Gastropoda:
Gyrodus sp.
Anchura sp.
Natica ?
Pugnellus sp.

Vertebrata:
Lamna texana Roemer

On the basis of this fauna, Stephenson considered the Tokio formation to be of the same age as the Austin chalk and equivalent to the Bonham clay and Blossom sand of northeast Texas.

No occurrence of Exogyra ponderosa within the Tokio was reported by Dane or observed by the writer at the surface in Arkansas, however, Mr. Roy T. Hazzard has informed the writer that he has observed E. ponderosa in subsurface cores from the upper part of the Tokio formation in northwest Louisiana. At the outcrop, the lowest occurrence of E. ponderosa observed by the writer was approximately 30 feet above the top of the Tokio formation (plate II).

Numerous samples were collected from the Tokio formation at the outcrop in Arkansas and examined for microfauna. Practically all of the samples were completely devoid of microfauna and only two samples, 0-4 and 0-5, contained Ostracoda.
Israelsky (1929) stated that the Tokio formation contained an abundant microfauna and reported the following Ostracoda from Tokio samples collected at the surface in Arkansas:

Cythereis bicornis Israelsky  
Cythereis hannai Israelsky  
Cytheropteron tokiana Israelsky  
Cytheropteron sp.

Subsequently, in 1935, Israelsky's 1929 paper was republished by the Arkansas Geological Survey and Israelsky states in the revised introduction that none of the Tokio samples examined by him were fossiliferous. However, the type locality of these species is given by Israelsky (1929) as the NE/c, SE/4, Sec. 23, T-10-S, R-28-W, Howard County, which is well within the outcrop of the upper portion of the Tokio formation. This locality was collected, as were all exposures of the Tokio in the vicinity, but no Ostracoda were obtained. Several of the samples contained arenaceous Foraminifera indicating that this portion of the formation is marine and the lack of calcareous microfossils is probably due to the intense leaching which the Tokio formation has undergone.

It is the writer's opinion that the species Cythereis bicornis Israelsky was definitely described from the Tokio formation. The paratype of this species, paratype slide No. 5344 of Dr. H. V. Howe's collection, Louisiana State University, is considerably more ornate than those forms
of this species which occur in the Brownstown formation and is considered to be ancestral to the Brownstown forms. Unfortunately, none of Israelsky's Tokio species were observed by the writer in the two samples of the Tokio formation which contained Ostracoda. These samples, 0-4 and 0-5, are from the extreme western end of the outcrop in Sevier County and were found to contain the following forms:

- *Brachycythere sphenoides* (Reuss)
- *Haplocytheridea* ? n. sp. 1
- *Haplocytheridea* ? n. sp. 2

None of these species can be used to definitely establish the age of the Tokio formation; however, they indicate that the Tokio is probably not older than the Austin group of Texas. Subsurface correlations substantiate Stephenson's conclusion that the Tokio formation of southwest Arkansas is equivalent to the Blossom sand and Bonham clay of northeast Texas (plate III).

**ORIGIN**

That portion of the Tokio formation exposed at the outcrop in southwest Arkansas was deposited in a shallow water, near shore, marine environment. The proximity of the shore line is suggested by the coarseness of the basal Tokio clastics, the abundance of cross-bedded sands, and the presence of carbonized plant material. The marine origin of the outcropping Tokio is shown by the fauna which it contains.
The transgressive nature of the lower portion of the Tokio is indicated by the pronounced unconformity at the base of the formation which results in the basal gravel bed coming to rest upon progressively older deposits in a northeasterly direction. That the shore line lay to the northeast is further indicated by the formation becoming thinner, more coarsely clastic, and the sands increasingly cross-bedded in this direction.

The graveliferous zone near the middle of the formation probably represents shoaling of the sea and reworking of the up-dip basal Tokio gravel during middle Tokio time. The apparent truncation of the lower portion of the formation beneath this middle Tokio graveliferous zone suggests that the lower portion of the formation experienced some erosion in the up-dip areas.

Upper Tokio time is represented by a sequence of sands and arenaceous clays. The clastic supply diminished near the close of Tokio time as is shown by the relative lack of coarsely clastic material in the uppermost Tokio and swamp conditions existed along the shore of the Tokio sea which resulted in the well developed lignitic zone at the top of the formation.

The Tokio formation represents the last of the predominantly clastic Upper Cretaceous deposits in southwest Arkansas and, as such, marks the close of a definite period in the stratigraphic history of the area. The remainder
of Upper Cretaceous time is represented primarily by calcareous clay and chalk deposition.
BROWNSTOWN FORMATION (RESTRICTED)

The name Brownstown was first applied by Hill in 1888 to the marl beds exposed in the vicinity of Brownstown in Sevier County, Arkansas, which he at that time considered to overlie the Annona chalk. Subsequently, Hill, in 1901, used the term in referring to the marls both above and below the Annona chalk in southwest Arkansas. Later, Veatch (1906) restricted the name Brownstown to the deposits between the base of the Annona chalk and the top of the Bingen sand (see discussion of the Tokio formation). Dane (1926, 1929) believed that a significant break within this sequence could be recognized throughout southwest Arkansas and divided the Brownstown of Veatch into two formations, retained the name Brownstown for the lower and applied the name Ozan to the upper formation.

STRATIGRAPHY

In the vicinity of the type locality, the Brownstown formation, as restricted by Dane, consists of approximately 165 feet of gray to dark gray, slightly arenaceous, micaceous marl. The formation becomes slightly more arenaceous toward the base and the basal few feet consist of dark gray, arenaceous, micaceous, glauconitic clay. The
Brownstown increases slightly in thickness eastward to just south of the town of Nashville where it attains a thickness of approximately 195 feet and then thins steadily eastward until it is overlapped by the Ozan formation. In the area where the Brownstown has the greatest thickness, the formation is apparently less arenaceous than to the east or west and a zone of chalk lenses is developed near its base which may indicate that this area was slightly embayed during Brownstown time. To the south, in the subsurface, there is an irregular development of limestone or chalk stringers near the base of the formation which probably is equivalent to the zone of chalk lenses exposed at the outcrop.

In the subsurface of extreme southwest Arkansas, a conspicuous chalk or chalky marl bed approximately 50 feet thick occurs in the upper part of the Brownstown formation. Mr. Roy T. Hazzard suggested to the writer the possibility of this chalk bed being the eastward extension of the Gober chalk of Texas. This concept is substantiated by subsurface correlations based on lithology and electrical log characteristics and the writer's correlation of the Arkansas subsurface section with that of east Texas is shown on plate III.

It is believed that this upper Brownstown chalk (the Gober chalk of Texas) is exposed at the surface in extreme southwest Arkansas and southeast Oklahoma. The following
section was observed in eastern McCurtain County, Oklahoma:

Section T

Location: 1.1 miles west of Oklahoma-Arkansas line on Oklahoma Highway No. 21 in road cut on south side of road and in excavation on north side of road in the SW/cor of Section 28, T-9-S, R-27-E in McCurtain County, Oklahoma.


Clay, arenaceous, calcareous, micaceous, glauconitic with scattered dark mineral grains. Dark gray weathering gray --------------- 3'

Sand, very fine grained, argillaceous, calcareous, glauconitic, black chert pebbles to ½" in diameter scattered throughout, contains lenses of hard, dark gray to black, calcareous sandstone. Dark gray to black weathering gray ------------------------------- 1'

Sand, fine grained, very glauconitic, contains phosphatic fossil fragments and nodules. Dark gray to black weathering gray. Rests upon slightly irregular surface of underlying unit ------------------------------------- 0'4"

Gober chalk equivalent (?) Interbedded chalk and calcareous clay. Chalk beds are up to 2'10" thick, light gray to buff, arenaceous, micaceous, fossiliferous, with scattered grains of glauconite and dark minerals, some of the chalk beds are extensively bored. The clay beds are up to 1'6" thick, dark gray to black, arenaceous, glauconitic, pyritic, calcareous, fossiliferous with scattered pebbles of black chert ------------------- 11'

Base not exposed
Approximately two miles east of this exposure, in western Little River County, Arkansas, Dane (1929) reports the following section which he considers to represent the basal portion of the Ozan formation:

Location: 5.65 miles from Foreman along road to Arkinda in bank of creek on east side of road in NW/4, Section 12, T-12-S, R-32-W.

- Bed of hard, white-weathering earthy chalk containing numerous large prints of *Inoceramus* ------------------------------- 1'6"

- Massive, sandy, micaceous marl containing lenses of hard, marly chalk. This bed and the one below it contain large *Ilacenticeras, Mortoniceras* aff. *M. delawarense* (Morton), and straight ammonites (*Baculites*) more than a foot long ---------------------------------- 5'

- Gray, sandy marl containing abundant scattered coarse glauconitic grains and black, well rounded chert pebbles and grains, most of them flat, as much as \( \frac{1}{2} \)" in diameter ----------- 2'

- Glaucnitic marly sand in small lenses scattered through non-glaucnitic marl ------------------ 0'6"
  (Dane considers this bed to mark the base of the Ozan formation)

- Soft, bedded, micaceous, slightly sandy marl - 1'

Although no exact correlation between these two exposures can be made, field relationships indicate that they are approximately equivalent, and the sequence of inter-bedded chalk and calcareous clay is believed to represent the depositional feather edge of the Gober chalk of Texas. The Little River County section displays a lesser development of chalk than does the McCurtain County section, however, this is to be expected for subsurface data show
that the chalk sequence experiences a rapid eastward change to a marl facies in this area.

The belief that this chalk sequence is equivalent to the Gober chalk of Texas is substantiated by the fact that Dr. Keith Young of the University of Texas and Mr. Roy T. Hazzard have identified the following ammonites collected by the writer from the exposure in McCurtain County, Oklahoma:

**Mortoniceras delawarense** (Morton)
**Parapuzosia sp.**

Both Dr. Young and Mr. Hazzard consider these to be Austin ammonites and typical of the Gober chalk of Texas. The Austin age of this section is further indicated by the presence of the ammonite genera **Placenticeras** and **Mortoniceras** (**Mortoniceras delawarense**) reported by Dane (1929) from the equivalent exposure in Little River County, Arkansas.

Subsurface data show that the top of the upper Brownstown "Gober" chalk is approximately 50 feet below the base of the Ozan formation just south of the outcrop in western Little River County (plate III); however, the writer was unable to establish the Brownstown-Ozan contact at the surface in this area due to the lack of sufficient exposures. It should be noted that, since the Brownstown formation of Texas lies below the Gober chalk, the portion of the Brownstown in southwest Arkansas which
lies between the top of the "Gober" chalk and the base of the Ozan formation is younger than the Brownstown formation of Texas (plate III). Also, if this view is correct, the Brownstown-Ozan contact at the surface in this area has been placed too low in the section by Dane (1929).

Dane (1929) considered the relationship between the Brownstown and Ozan formations to be unconformable at the surface in Arkansas. This unconformity is marked by an irregular contact between the formations and by "borings" into the Brownstown marl which are filled with the glauconitic sand of the overlying Buckrange sand, the basal member of the Ozan formation. A depositional break between the two formations is further indicated by a distinct difference in the Ostracoda assemblages even in those areas where both formations have developed similar lithologies. The following partial sections demonstrate the nature of the Brownstown-Ozan contact at the surface in southwest Arkansas:

Section AA

Location: 0.14 miles south of center of Middle Fork Ozan Creek on Arkansas Highway No. 4, or, 0.76 miles north of Sardis Church on Arkansas Highway No. 4 in road cut on west side of road in SE/4, NW/4, Section 20, T-10-S, R-26-W, Hempstead County.

Top of Exposure ---- elevation = 422'

Ozan formation:
Clay, very arenaceous, glauconitic, micaceous, calcareous with crumbly nodules of white calcite on surface, fossiliferous, transitional
into unit below. Gray weathering light gray to white -------------------------- 7'

Sand, fine grained argillaceous, micaceous, glauconitic, calcareous, with crumbly nodules of calcite on surface, gray weathering light gray -------------------------- 3'

Sand, fine grained, ferruginous, slightly micaceous, calcareous, rests upon irregular and "bored" surface of underlying unit. Brown weathering buff -------------------------- 0'3"

Brownstown formation ---- elevation = 412'
Clay (Marl) slightly silty, calcareous, slightly micaceous, nodules of crumbly calcite on surface, fossiliferous, upper surface is irregular and "bored". Borings are filled with the ferruginous sand of overlying unit. Gray weathering olive drab -------------------------- 3'

Section BB

Location: 1.4 miles north of intersection of Arkansas Highway No. 55 and east-west road in Tollette on Arkansas Highway No. 55 in road cut on west side of road in SE/4, SW/4, Section 33, T-10-S, R-27-W, Howard County.

Top of Exposure ---- elevation = 355'
Ozan formation:
Clay, arenaceous, glauconitic, micaceous, calcareous, fossiliferous. Gray weathering light gray to white -------------------------- 5'

Sand, fine grained, very glauconitic, slightly micaceous, argillaceous. Gray weathering light gray. Rests upon irregular and "bored" surface of underlying unit -------------------------- 3'

Brownstown formation ---- elevation = 347'
Clay, slightly silty, calcareous, ferruginous stained. Upper surface is irregular and "bored". Borings filled with glauconitic sand of overlying unit. Brownish gray weathering gray -------------------------- 1'
Clay, very slightly silty, calcareous, scattered mica flakes, abundant imprints of pelecypods. Gray weathering light gray --------- 3'6"

Clay (Marl), very slightly silty, very calcareous (chalky) slightly micaceous with lenses of dark gray, hard chalky marl or marly chalk containing abundant pelecypod fragments. Gray weathering light gray-brown - 5'

To the west, at the type locality of the Brownstown formation in Sevier County, 0.1 mile west of Gravelly Hill Church on the road from Ben Lomand to Brownstown, in the NE/4, NW/4, NW/4 of Section 10, T-11-S, R-29-W, the Brownstown-Ozan contact is apparently irregular but no "borings" are present. Here, the glauconitic calcareous, argillaceous sand of the basal Ozan rests upon the slightly arenaceous, slightly carbonaceous marl of the Brownstown; this carbonaceous marl grades downward within a few feet into the normal gray, weathering greenish-brown, marl of the Brownstown formation.

In the subsurface of the Arkansas-Louisiana-Texas area, the Ozan-Brownstown contact is placed at the base of the basal Buckrange sand member of the Ozan formation. In those areas where this sand is not developed, no definite division can be made between the two formations on the basis of electrical log character and lithology.

PALEONTOLOGY

The Brownstown formation is abundantly fossiliferous carrying both a rich macrofauna and microfauna. As Dane
(1929) pointed out, the most characteristic fossil of
the Brownstown is *Exogyra ponderosa* which the writer found
abundantly represented from approximately thirty feet
above the base to the top of the formation and through­
out the overlying Ozan (plate II). Dane (1929) reports
that Dr. L. W. Stephenson identified the following forms
from the Brownstown formation of Arkansas:

**Echinodermata:**
- *Hemiaster* (?)

**Vermes:**
- *Hamulus major* Gabb
- *Hamulus onyx* Morton
- *Hamulus squamosus* Gabb

**Molluscoidea:**
- *Lingula* sp.

**Mollusca:**
- *Nucula* sp.
- *Leda* sp.
- *Cucullaea* sp.
- *Nemodon* sp.
- *Inoceramus* sp.
- *Ostrea plumosa* Morton
- *Ostrea mesenterica* Morton
- *Crypehaea vesicularis* Lamarck (variety)
- *Exogyra ponderosa* Roemer
- *Exogyra ponderosa* var. *erraticostata* Stephenson
- *Pecten* sp. (small)
- *Pecten* sp. (large, smooth)
- *Anomia argentea* Morton
- *Paranomia scabra* (Morton)
- *Pholadomya* sp.
- *Liopista* (Cyrella) *bella* (Conrad)?
- *Venerilla conradi* (Morton)
- *Craseaeleides* ? *conradi* (Whitfield)?
- *Lucina globula* Conrad?
- *Cardium dumosum* (Conrad)?
- *Cyprinella depressa* Conrad
- *Collina* sp.
- *Cypophora* sp.
- *Corcula* sp. (large)
- *Dentalium* sp.
Cerithium sp.
Turritella quadrilirata Johnson
Natica sp.
Baculites sp.
Placenticeras sp.
Scaphites hippocrepis (DeKay)

Fish scales and bones
Shark teeth

A complete section of the Brownstown formation was
composited and collected by the writer in the vicinity
of the type locality and was found to contain the follow­
ing Ostracoda:

Ostracoda from the type section of the
Brownstown formation

Cytherella austinsensis Alexander
Cytherella n. sp. 1
Cytherella sp.
Cytherelloidea ozanana Sexton
Cytherelloidea tolettenensis Sexton
Cytherelloidea sp.
Bairdoppiata rotunda (Alexander)
Haplocytheridea ? plummeri (Alexander)
Haplocytheridea ? n. sp. 2
Asciocythere n. sp. 1
Cytheridea ? n. sp. 1
Krithe cf. K. postprojectia Schmidt
Eocytheropteron sp.
Orthonotacythere hannai (Israelsky)
Orthonotacythere cf. O. scrobiculata Alexander
Brachycythere ledaforma (Israelsky)
Brachycythere sphenoides (Reuss)
Brachycythere cf. B. taylorensis (Alexander)
Brachycythere n. sp. 1
Brachycythere n. sp. 2
Brachycythere n. sp. 3
Alatacythere cf. A. ponderosana (Israelsky)
Alatacythere tokiana (Israelsky)
Alatacythere ? n. sp. 1
Cythereis bicornis Israelsky
Cythereis ? hannai (Israelsky)
Cythereis ? spoorl (Israelsky)
Cythereis ? n. sp. 1
Cythereis sp.
**Veenia** *szanana* (Israelsky)  
**Veenia** cf. *V. gapensis* (Alexander)

Numerous samples of the Brownstown formation from areas other than the type locality were examined for Ostracoda and the following forms were found which were not represented at the type locality:

- *Paracypris* sp.
- *Haplocytheridea* ? *insolita* (Alexander and Alexander)
- *Haplocytheridea* ? sp.
- *Orthonotacythere* sp.
- *Monoceratina* sp.
- *Pterygocythere* sp.
- *Cythereis* ? n. sp. 2
- *Veenia arachoides* (Berry)

**ORIGIN**

The Brownstown formation was deposited upon the clays of the uppermost Tokio in a slowly transgressive sea. The slowness of the transgression is suggested by the absence of appreciable quantities of reworked Tokio material in the basal portion of the Brownstown. However, in those areas where a lignitic zone is developed at the top of the Tokio, the basal Brownstown contains abundant fragments of carbonized material which is considered to have been derived from the underlying Tokio lignite. In those areas where the uppermost Tokio is represented by a less distinctive lithology, a slowly transgressing sea would have afforded sufficient time for the reworked Tokio material to be so thoroughly disseminated that its identity would be lost.
The Brownstown formation becomes slightly more arenaceous toward its base but, in general, reflects a uniformity of sedimentary conditions. The lack of appreciable clastic material suggests that the northeastward lying source area was one of low relief and the supply of clastics was at a minimum.

The basal Buckrange sand member of the overlying Ozan formation is considered by Dane (1929) to represent a long period of reworking and to be the coarser residue of a much thicker deposit. This suggests that Brownstown deposition was brought to a close by stabilization of the depositional basin and the Buckrange sand was probably in part derived from reworking of the uppermost Brownstown formation.

An exception to normal Brownstown deposition is indicated by the basal portion of the formation in the western part of its exposure in southwest Arkansas. In this area, the basal thirty to forty feet of the Brownstown is practically devoid of microfauna and probably indicates the existence of adverse environmental conditions during early Brownstown time. This basal portion of the formation contains lenses and beds of very dark gray, hard calcareous clay which may represent deposition in a restricted basin environment. Such an environment would have largely excluded an abundant fauna from the area and is probably responsible for the absence of Exogyra
ponderosa from the basal portion of the Brownstown. It is interesting to note that the lowest observed occurrence of *E. ponderosa* in the Brownstown (approximately thirty feet above the base of the formation) approximately coincides with the lowest occurrence of an abundant microfauna.
CONCLUSIONS AND CORRELATIONS

A total of 40 species of Ostracoda from 17 genera were represented in the surface samples collected from the Brownstown and Tokio formations in southwest Arkansas and southeast Oklahoma. Twenty of the species observed have not been previously described. Of these, 11 will be named as new species in a manuscript presently being prepared for publication, lack of sufficient specimens prevents naming the remaining 9 species. Those species which will be named as new species are designated by number in this report and are as follows:

Brownstown formation

Cytherella n. sp. 1
Haplocytheridea ? n. sp. 2
Asciocythere n. sp. 1
Cytheridea ? n. sp. 1
Brachycythere n. sp. 1
Brachycythere n. sp. 2
Brachycythere n. sp. 3
Alatacythere ? n. sp. 1
Cytheresia ? n. sp. 1
Cytheresia ? n. sp. 2

Tokio formation

Haplocytheridea ? n. sp. 1

Four of the species restricted to the Brownstown formation in southwest Arkansas are considered to be sufficiently abundant and diagnostic to differentiate the
Brownstown from adjacent formations at the surface in this area. These species are:

- Brachycythere n. sp. 3
- Cytheridea ? n. sp. 1
- Alatacythere ? n. sp. 1
- Asciocythere n. sp. 1

The distinctive species Haplocytheridea ? n. sp. 1 has been observed only in the Tokio of southwest Arkansas and should be a reliable marker for this formation.

The upper portion of the Brownstown contains a much more abundant microfauna than does the lower part of the formation. Of the thirty-one species occurring in the type Brownstown, only nine are represented in the lower part of the formation. These nine species are also represented throughout the remainder of the Brownstown which suggests that they could exist under a wider range of environmental conditions than those species restricted to the upper part of the formation. Because of this uneven distribution of fauna, it would be extremely hazardous to conclude that the exclusion of a species from the lower Brownstown formation reflects its regional stratigraphic range.

The Ostracoda of the Brownstown and Tokio formations in Arkansas were compared with those of the type sections of the Austin and Lower Taylor groups of Texas. This was made possible through the courtesy of Dr. H. V. Howe who allowed the writer to examine the Ostracoda assemblages
from measured sections of the type localities. A comparison was also made with Mr. R. J. Collins' collection from the Ozan formation of Arkansas. It was found that, of the 31 species occurring in the type Brownstown, 12 are represented in the Ozan formation, 15 in the type Austin, and 15 in the type Lower Taylor.

On the basis of the Ostracoda, the Brownstown is easily distinguished from the Ozan formation for 19 of the species occurring in the type Brownstown are not represented in the overlying Ozan and an even greater number of Ozan species are not found in the Brownstown formation. In a like manner, the Austin group is readily differentiated from the Lower Taylor in Texas by their Ostracoda assemblages. However, it is difficult to definitely determine if the Brownstown of Arkansas is equivalent to either the Austin or Lower Taylor of Texas. The Distribution of Species Chart (figure 4) shows that 14 of the type Brownstown species are represented in the type sections of both the Austin and Lower Taylor groups, one species is restricted to the type Austin, one species to the type Lower Taylor and 15 species are not represented in either. Using the greatest number of species in common method of correlation, there is no indication that a correlation of the Brownstown formation of Arkansas with the type Lower Taylor is preferable to a correlation
DISTRIBUTION OF OSTRACOD SPECIES
BASED ON SAMPLES EXAMINED BY WRITER

[Graph of distribution patterns across various localities, with labels for localities such as Tokio Fm, Arkansas and Gore Chalk, SE Oklahoma.]

Lower Taylor Group
Type Locality
with the type Austin and the Brownstown may be partially equivalent to both groups.

The characteristic species *Haplocytheridea plummeri* (Alexander) is abundantly represented in the Brownstown and overlying formations in Arkansas but is not found below the base of the type Lower Taylor in Texas. This would suggest that the Brownstown formation of Arkansas is younger than the type Austin and probably equivalent to the lower portion of the type Lower Taylor. However, it should be noted that both the type Brownstown and type Lower Taylor have similar lithologies, both being primarily calcareous clay or marl, while the type Austin is predominantly a chalk sequence. This difference in lithology may account for the absence of *Haplocytheridea plummeri* in the type Austin.

An analysis of the Ostracoda assemblages of the type sections of the Austin and Lower Taylor groups showed that *Cythereis plummeri* Israelsky, a distinctive and abundant species, can be used with certainty to differentiate these two sequences in this area; *C. plummeri* does not occur in the Austin sediments but is abundantly represented in the Lower Taylor. Assemblages were examined from numerous sections of the Austin and Taylor groups in Texas over a distance of approximately 200 miles and this relationship of the occurrence of *Cythereis plummeri* to the Austin-Taylor contact was confirmed.
<table>
<thead>
<tr>
<th>Brownstown - Other Than Type Section</th>
<th>Brownstown Type Section</th>
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<tbody>
<tr>
<td>Lower</td>
<td>Mid</td>
</tr>
<tr>
<td>Lower</td>
<td>Mid</td>
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</tbody>
</table>

- **Check List of Ostracod Species**

- Cytidria Austinensis
- Cytidria sp
- Cytidria N SP 1
- Cytidria Dea Ozanana
- Cytidria Dea Tollettensis
- Cytidria Dea SP
- Paracypris SP
- Barocythere Rotunda
- Haplocythere N PLUMMER
- Haplocythere N SOLITA
- Haplocythere N SP 1
- Haplocythere N SP 2
- Haplocythere N SP 3
- Ascocytidria N SP 1
- Cytheridea N SP 1
- Krithe of K Postprojecta
- Eucythereopteron SP
- Orthocythere Mahnai
- Orthocythere of S Schobikulata
- Orthocythere n SP 1
- Orthocythere n SP 2
- Orthocythere n SP 3
- Brachycythere Sphenoides
- Brachycythere cf B. TAYLOPENISI
- Brachycythere Ledaforma
- Alatacythere of A. Ponderosana
- Alatacythere Tokiana
- Alatacythere N SP 1
- Pterygocythere SP
- Cytidria Bicornis
- Cytidria N Mahnai
- Cytidria N Spoorni
- Cytidria N SP 1
- Cytidria N SP 2
- Cytidria N SP 3
- Veenia Arachoides
- Veenia Ozanana
- Veenia of V Gapensis
In Arkansas, *Cythereis plummeri* does not occur in the Brownstown formation but is abundantly represented in the overlying Ozan, even in those areas where the two formations have developed similar lithology. This suggests that the Brownstown-Ozan contact is equivalent to the Austin-Taylor contact in Texas and that the top of the Brownstown formation marks the top of the Austin equivalents in Arkansas. However, it is important to note that no species which could be considered ancestral to *Cythereis plummeri* is found in either the Brownstown of Arkansas or the Austin of Texas. This implies that *C. plummeri* immigrated into the Arkansas and Texas areas as a fully developed species and did not evolve in these areas. Such a species is not ideally suited for correlation over wide areas for it probably arrived in different areas at different times, therefore, the lowest occurrence of *C. plummeri* in Arkansas and Texas need not be equivalent in time.

The most reliable paleontologic correlations are based not upon a single form but upon a sequence of forms which represent all or part of an evolutionary trend. Such a trend is displayed by the *Cythereis bicornis* Israelsky group of Ostracoda which tends to evolve to progressively less ornate forms. In the Austin and Lower Taylor groups of Texas, this group of Ostracoda is well represented and the development of progressively less
ornate forms is clearly seen. The most ornate and deeply sculptured forms are found in the lower portion of the Austin group while the simpler specimens occur in the Lower Taylor.

In the Brownstown formation of southwest Arkansas, *Cythereis bicornis* is represented in the lower part of the formation by more ornate and deeply sculptured forms than in the upper portion of the formation. However, due to the smaller stratigraphic interval represented, the range of variation seen in the Brownstown specimens represents only a portion of the total variation displayed by the Texas forms. When the series from the Brownstown of Arkansas is compared with that from the type sections of the Austin and Lower Taylor groups of Texas, a correlation can be made on the degree of ornamentation which indicates that the Brownstown of Arkansas is equivalent to the upper part of the type Austin and the basal portion of the type Lower Taylor groups.

*Cythereis bicornis* Israelsky was described from the Tokio formation of Arkansas. The paratype of the species, paratype slide No. 5344 of Dr. H. V. Howe's collection, Louisiana State University, is considerably more ornate than any of the Brownstown forms and correlates with forms restricted to the type Austin of Texas. This substantiates the correlation of the Tokio formation of Arkansas with the Austin group of Texas. The variation within
VARIATION WITHIN THE SPECIES
CYTHEREIS BICORNIS ISRAELSKY

Cythereis bicornis
Upper Brownstown Formation
Southwest Arkansas

Cythereis bicornis
Lower Brownstown Formation
Southwest Arkansas

Cythereis bicornis
Tokio Formation
Southwest Arkansas
Illustrated from photograph of holotype.

Plate V
the species *C. bicornis* in southwest Arkansas is illustrated in plate V.

Another evolutionary trend is seen in the *Cytherella semiplicata* (Reuss) group of Ostracoda in the Austin group of Texas. In the lower portion of the Austin, this group is represented by forms in which the posterior termination of the median ridge is connected to the dorsal and ventral ridges by short vertical ridges. This connection is progressively lost in younger forms and the median ridge becomes more definitely separated from the muscle swelling. The forms occurring in the uppermost portion of the type Austin have completely lost the connection of the median ridge with the dorsal and ventral ridges and the median ridge is separated from the muscle swelling by a well defined sulcus. This form correlates with those collected from the exposures of the upper Brownstown "Gober" chalk in McCurtain County, Oklahoma. This tends to support a correlation of this chalk sequence with the upper portion of the Austin group of Texas.

In conclusion, it would seem that, based on the Ostracoda, the type Brownstown of Arkansas is partially equivalent to both the upper portion of the type Austin and the lower part of the type Lower Taylor groups of Texas and that there is no depositional break in the Arkansas section which is equivalent to the type Austin-Taylor contact of Texas.
DESCRIPTION OF GENERA AND SPECIES

Phylum ARTHROPODA

Class CRUSTACEA

Order OSTRACODA

Suborder PLATYCYDA Sars, 1865

Family CYTHERELLIDAE Sars, 1866

Genus CYTHERELLA Jones, 1849

CYTHERELLA AUSTINENSIS Alexander 1929

Plate VI, figures 1a, b

Cytherella obesa Alexander (not Jones and Kirby, 1884), Texas University Bulletin 2907, p. 51, pl. 1, figs. 3, 6 (female).

Cytherella austinensis Alexander, 1929, Texas University Bulletin 2907, p. 51, pl. 2, figs. 4, 6 (male).


Cytherella bullata Loetterle, 1937, Nebraska Geological Survey, Second Series, Bulletin 12, p. 50, pl. 8, figs. 4a, b.

Cytherella cf. C. obesa (Alexander) Swain, 1952, United States Geological Survey, Professional Paper 234-B, p. 69, pl. 8, fig. 2


Cytherella austinensis Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, Louisiana State University Press, pp. 244-245, 2 figs.
DESCRIPTION: Sexually dimorphous, females larger and more elongate than males. Carapace in lateral view ovate, females highest at center, males slightly anterior of center; anterior margin rounded; posterior margin narrower and rounded; dorsal outline arched and gently angulate; ventral outline convex; surface smooth; right valve larger than left, overlaps along all margins, greatest overlap along dorsal and ventral margins; surface of left valve bears a shallow depression paralleling anterior margin.

Dimensions: 0.76 x 0.48 mm. (male)
0.90 x 0.59 mm. (female)

Localities: H-3, H-4, DD-1, DD-2,
DD-3, DD-4, T-1, T-2,
T-4, T-6, H-5, A-1, B-1.

CYTHERELLA SI.
Plate VI, figures 2a, b

DIAGNOSIS: A species of the genus Cytherella characterized by an elongate, oval lateral outline and a compressed antero-ventral margin in left valve.

DESCRIPTION: In lateral view oblong, ovate, males highest at center, females just behind center; anterior margin rounded; dorsal outline gently arched, slightly angulate at center in males, just behind center in females; ventral outline slightly convex; posterior margin rounded; antero-ventral portion of left valve compressed to form
a narrow shelf-like feature parallel to anterior margin; surface smooth; right valve largest, overlaps left valve along all margins except anterior margin, greatest overlap in anterior one-half of dorsal margin, overlap in females greater than in males; viewed dorsally, posterior is blunt, anterior pointed with anterior portion of left valve compressed, line of valve juncture slightly sinuous, males widest just behind middle, females widest near posterior.

**REMARKS:** Differs from *Cytherella parallela* Reuss of Alexander (1929) in that anterior and posterior margins are more acutely rounded and overlap of right valve is not as pronounced.

**Dimensions:**
- 0.66 x 0.42 mm. (female)
- 0.62 x 0.34 mm. (male)

**Localities:**
- H-2, H-4, H-5, DD-1,
- DD-2, T-1, T-2, I-4,
- F-1, F-2, F-4, F-5,
- A-1, A-2, B-1, B-2,
- G-2.

**CYTHERELLA N. SP. 1**

Plate VI, figures 3a, b

**DIAGNOSIS:** A species of the genus *Cytherella* characterized by a blunt projection at center of the posterior margin of the right valve and a strongly arched dorsal outline.
DESCRIPTION: In lateral view ovate, highest slightly behind middle; anterior margin roundly angulate; posterior margin wider, angulate, with a blunt projection at center in right valve; dorsal outline strongly arched and angulate in right valve, straight in left; ventral outline convex; surface smooth; right valve largest, overlaps left valve along all margins, greatest overlap dorsally at point of angulation; viewed dorsally, anterior rounded, posterior broad and blunt, widest just behind middle, line of valve juncture sinuous; line of concrescence coincides with inner margin; muscle scar pattern indistinct but apparently consists of numerous small scars arranged in an oval group; hingement adont.

REMARKS: Differs from Cytherella tuberculifera Alexander in that dorsal and anterior margins are angulate, greatest height is posterior of middle, overlap by right valve is more pronounced, and dimensions are smaller. The writer could not definitely establish the male of this species. All specimens had approximately the same length, however, several specimens had significantly less height. These more elongate forms are tentatively considered males. In spite of the inability to definitely establish the male of this species, the abundance and characteristic appearance of the female warrants its description as a new species. Species established on over fifty female specimens.
Dimensions: 0.78 x 0.52 mm. (female)
0.78 x 0.48 mm. (male ?)

Localities: H-2, H-4, H-5, I-4, F-2, F-4
F-5, A-1.

Genus CYTHERELLOIDEA Alexander, 1929

CYTHERELLOIDEA OZANANA Sexton, 1951

Plate VI, figure 4

Cytherelloidea ozanana Sexton, 1951, Journal of Paleontology, vol. 25, no. 6, p. 812, pl. 117, figs. 3, 6 (given in error by author as figs. 4, 5).


DESCRIPTION: In lateral view ovate, dorsal and ventral margins nearly parallel; anterior and posterior margins broadly rounded; pronounced rim along dorsal, anterior, and ventral margins, dorsal rim is interrupted by a slight sulcus just anterior of center; shallow muscle depression located near middle of carapace just above median line; a short bar is located just above muscle depression in right valve and is slightly inclined in an antero-ventral direction, two longitudinal ridges located below muscle depression, upper ridge curves upward just posterior of muscle depression and terminates in a prominent knob near posterior margin, lower ridge nearly horizontal and terminates in a pronounced knob near posterior margin, a sharp, straight, vertical ridge connects
the posterior edges of these two knobs.

Dimensions: 0.55 x 0.33 mm. (female)

Localities: F-3, DD-2.

CYTHERELLOIDEA TOLLETTENSIS Sexton, 1951

Plate VI, figure 9

Cytherelloidea tollettensis Sexton, 1951, Journal of Paleontology, vol. 25, p. 812, pl. 117, figs. 4, 5 (given in error by author as figs. 3, 6).


DESCRIPTION: Sexually dimorphous. In lateral view ovate, anterior margin broadly rounded, posterior margin slightly angulate at center, posterior angulation more pronounced in males; dorsal and ventral margins parallel; females slightly angulate at postero-dorsal angle; females with a pronounced rim along dorsal, anterior, and ventral margins; a deep muscle depression located at center just above median line; a straight longitudinal bar located just dorsal of muscle depression, extends to posterior margin where it terminates in a large boss; a large boss is located at postero-ventral angle and an arcuate ridge, coincident with posterior margin, connects the posterior edge of this boss with the one above; an arcuate, convex downward bar is located below muscle depression and just above ventral marginal rim; surface between ridges very
finely pitted; males essentially the same but boss at postero-ventral angle is lacking and one at posterior termination of dorsal bar is not as well developed.

Dimensions: 0.55 x 0.34 mm. (female)
0.55 x 0.30 mm. (male)

Locality: H-5.

CYTHERELLOIDEA SP.
Plate VI, figures 5a, b

DIAGNOSIS: A species of the genus Cytherelloidea characterized by parallel dorsal and ventral margins and a low, rounded boss at postero-dorsal angle.

DESCRIPTION: Sexually dimorphous. In lateral view oblong, ovate; anterior margin broadly rounded, posterior margin acutely rounded, more acutely in females; dorsal and ventral outlines straight and parallel; pronounced ridge developed along all margins, dorsal ridge depressed just above shallow, centrally located muscle depression where it ends just below start of anterior marginal ridge; slight swelling of dorsal ridge at postero-dorsal angle results in a low boss, boss more conspicuous in females; a well defined, arcuate, convex downward ridge located just below muscle depression, a low swelling located just above each end of ridge in males, anterior swelling more pronounced than posterior; surface between ridges ornamented by irregular, fine pits and striations.
REMARKS: Differs from *Cytherelloidea tolettensis* Sexton in that dorsal ridge is at dorsal margin, lacks boss at postero-ventral angle, and surface is more coarsely pitted. Due to the lack of sufficient specimens of both sexes, the specific placement of this species can not be definitely established.

Dimensions: C.48 x 0.27 mm. (female)  
0.46 x 0.27 mm. (male)

Localities: H-4, H-5, F-5.

Suborder *PODOCOPA* Sars, 1865

Family *CYPRIIDAE* Baird, 1849

Subfamily *CYPRIDINAE* Baird, 1846

Genus *PARACYPRIS* Sars, 1899

**PARACYPRIS SP.**

Plate XI, figure 1

DIAGNOSIS: A species of the genus *Paracypris* characterized by a bluntly rounded anterior margin and a highly arched dorsal outline of which the anterior portion is straight.

DESCRIPTION: Carapace in lateral view elongate, ovate, highest just anterior of middle; anterior margin bluntly and obliquely rounded; dorsal outline highly arched, anterior portion straight, sloping antero-ventrally from highest point, posterior portion smoothly arched; ventral
outline slightly concave; posterior margin acutely rounded; surface smooth; left valve larger than right, overlap greatest along ventral margin; internal features not observable.

REMARKS: Resembles Paracypris angusta Alexander but differs in that posterior is not as produced and dimensions are smaller. This is probably a new species, however, due to the lack of sufficient specimens, the specific placement of this species cannot be definitely established.

Dimensions: 0.61 x 0.32 mm.
Locality: T-2.

Family Bairdiidae Sars, 1923
Subfamily Bairdinae Sars, 1923
Genus Bairdofilata Coryell, Sample and Jennings, 1935

Bairdofilata Rotunda (Alexander), 1927
Plate VI, figure 6


Bairdia cf. B. rotunda Swain, 1946, Maryland Board of Natural Resources, Cretaceous and Tertiary Subsurface Geology, p. 200, pl. 13, figs. 15, 16.


DESCRIPTION: Carapace sub-triangular in lateral view, slightly elongate posteriorly, greatest height just anterior of center; anterior margin broadly and obliquely rounded with a gentle angulation just below median line; posterior margin roundly angulate, angulation slightly lower than anterior angulation, posterior margin of right valve slightly upturned; dorsal outline strongly arched; ventral outline convex, central portion of ventral margin of right valve slightly concave; left valve larger than right, greatest overlap along dorsal and ventral margins, particularly in middle of ventral margin; surface of carapace smooth or minutely punctate; marginal areas widest anteriorly, line of concrescence departs from inner margin anteriorly and posteriorly; radial pore canals and muscle scars not observable; hingement consists of crenulate terminal cusps in right valve with crenulate terminal sockets in left.

REMARKS: The presence of crenulate terminal elements of the hingement places this species in the genus Bairdopilata.

Dimensions: 1.15 x 0.75 mm.

Family CYTHERIDAE Baird, 1850
Subfamily CYTHERIDEINAE Sars, 1925
Genus HAPLOCYTHERIDEA Stephenson, 1936

HAPLOCYTHERIDEA ? LUMMERI (Alexander), 1929
late VII, figures 2a-c

Cytheridea plummeri Alexander, 1929, Texas University Bulletin 2907, p. 73, pl. 5, figs. 5-8.

Cytheridea plummeri Alexander and Alexander, 1933, American Midland Naturalist, vol. 14, p. 280, figs. 1a, b, 4a, b.


Haplocytheridea plummeri Schmidt, 1948, Journal of Paleontology, vol. 22, no. 4, p. 424, pl. 52, figs. 27-29, text fig. 2f.

Not Cytheridea plummeri Skinner, 1956, Transactions, Gulf Coast Association of Geological Societies, 6th Annual Meeting, p. 197, pl. 4, figs. 2a-d.


DIAGNOSIS: A species questionably of the genus Haplocytheridea characterized by a pyriform lateral view
and three to four vertical furrows located in central
portion of carapace.

DESCRIPTION: Sexually dimorphic, females shorter
and more compact than males. In lateral view carapace
is pyriform, females highest at middle, males slightly
anterior of middle; anterior margin obliquely rounded,
denticulate; posterior margin narrow, angulate postero-
ventrally; dorsal outline strongly arched, dorsal margin
straight, sloping postero-ventrally, meets anterior and
posterior margins with distinct angulation; ventral out-
line slightly concave behind middle; left valve larger
than right overlapping along entire margin, greatest over-
lap along dorsal margin; surface punctate with three to
four pronounced vertical furrows formed by larger punctae
located in central portion of carapace; marginal area
moderately wide anteriorly with numerous straight radial
pore canals; line of concrescence departs from inner mar-
gin anteriorly; muscle scar pattern consists of a vertical
row of four irregularly ovate scars with two in front;
hingement merodont, strongly developed, consists of crenu-
late terminal teeth in right valve connected by a low
crenulate bar, left valve with complementary dentition
and a well developed accommodation groove above hinge
bar.

REMARKS: Taxonomic position uncertain. Presence
of accommodation groove in left valve makes the
placement of this species in the genus Haplocytheridea
doubtful.

Dimensions: 0.86 x 0.53 mm. (male)
0.80 x 0.53 mm. (female)


HAPLOCYTHEIDEA ? INSOLITA (Alexander and Alexander), 1933
Plate XI, figure 8

Cytheridea insolita Alexander and Alexander, 1933, American Midland Naturalist, vol. 14, p. 283, figs. 2a, b, 3a, b.


DIAGNOSIS: A species questionably of the genus Haplocytheridea characterized by the Haplocytheridea ? plummeri (Alexander) shape, the right valve larger than the left, and the positive hinge elements in the left valve.

DESCRIPTION: Sexually dimorphous, females shorter and more compact than males. In lateral view carapace is pyriform, highest just anterior of middle; anterior margin broadly and obliquely rounded; posterior margin narrow, angulate postero-ventrally; dorsal outline strongly
arched, dorsal margin straight, sloping postero-ventrally; ventral outline slightly concave behind middle; right valve larger than left overlapping along entire margin; surface of carapace punctate with three centrally located vertical furrows formed by larger punctae; marginal area widest anteriorly with numerous straight radial pore canals; hingement merodont, left valve with terminal crenulate teeth connected by a low crenulate bar, right valve complimentary with a shallow accommodation groove above hinge bar.

REMARKS: This species is differentiated from *Haplocytheridea *plummeri (Alexander) by the reversal of the hinge elements and the right valve being the largest.

Dimensions: 0.81 x 0.50 mm. (male)
0.70 x 0.50 mm. (female)

Locality: T-1.

**HAPLOCYTHERIDEA N. SP. 1**

**Plate VI, figures 7a-c**

**DIAGNOSIS:** A species questionably of the genus *Haplocytheridea* characterized by a sub-triangular shape in lateral view and a short longitudinal groove near the center of the left valve.

**DESCRIPTION:** In lateral view compact, sub-triangular, greatest height just anterior of middle; anterior margin
broadly and obliquely rounded, denticulate in well preserved specimens; posterior margin narrower, acutely rounded, meeting dorsal margin with a slight angulation; dorsal outline arched, angulate, dorsal margin straight, inclined postero-ventrally; ventral outline convex; left valve largest overlapping along entire margin; surface coarsely punctate, left valve with an arcuate row of coarser punctae forming a vertical groove near center of carapace in front of which is a shorter, less distinct groove formed by three to four large punctae, a short longitudinal groove is located just behind these two vertical grooves; right valve with one distinct, centrally placed, vertical groove which tends to bifurcate dorsally, a shorter, indistinct vertical groove located just behind; marginal area narrow with numerous, irregularly spaced radial pore canals; line of concrescence coincides with inner margin; hingement consists of terminal crenulate teeth in right valve with a low crenulate bar between, left valve complimentary with a shallow accommodation groove; muscle scars not observable.

REMARKS: This species resembles Haplocytheridea ? grangerensis Howe and Laurencich but is more coarsely punctate and has a longitudinal depression in center of left valve. Differs from Haplocytheridea ? plummeri (Alexander) in being less pointed posteriorly, in the possession of the longitudinal groove in center of left valve,
and in its smaller dimensions. Taxonomic position uncertain. Presence of accommodation groove in left valve makes placement of this species in the genus **Haplocytheridea** doubtful. This species is based on more than fifty specimens.

**Dimensions:** 0.57 x 0.40 mm.

**Localities:** 0-4, 0-5. This species has also been observed by the writer in subsurface cores from the upper part of the Tokio formation in southwest Arkansas.

**HAPLOCYTHÉRIDEA ? N. SP. 2**
Plate VII, figures 4a-d

**DIAGNOSIS:** A species questionably of the genus **Haplocytheridea** characterized by a tear-drop shape in lateral view and two to three vertical rows of larger punctae in central portion of carapace.

**DESCRIPTION:** Sexually dimorphous, females shorter and more compact than males. In lateral view tear-drop shaped, highest at middle with dorsal and ventral margins converging posteriorly; anterior margin broadly and slightly obliquely rounded, finely denticulate; posterior margin narrow, roundly angulate just below middle, meets dorsal margin with a slight angulation; dorsal outline arched, dorsal margin slopes postero-ventrally, meets
anterior margin with a slight angulation; ventral outline convex, rising posteriorly; left valve largest, overlapping right valve along entire margin; surface irregularly and coarsely punctate, two prominent vertical rows of coarser punctae in central portion of carapace, in front and behind of which are less distinct, shorter vertical rows of coarser punctae; marginal area widest anteriorly with numerous radial pore canals; radial pore canals nearly straight but show tendency to become irregular near outer margin; line of concrescence departs slightly from inner margin anteriorly; hingement merodont consisting of terminal crenulate teeth in right valve with a crenulate bar between, left valve complimentary with a well developed accommodation groove; muscle scar pattern consists of a vertical row of four oval scars with two oval scars in front.

REMARKS: This species has the same general shape as *Haplocytheridea* ? *monmouthensis* (Berry) but lacks the small projecting "wing" at postero-ventral margin of right valve. Differs from *Haplocytheridea* ? *plummeri* (Alexander) in that posterior margin is less pointed, overlap of left valve not as pronounced, hingement not as strongly developed, and in its smaller dimensions. Taxonomic position uncertain. Presence of accommodation groove in left valve makes the placement of this species in the genus *Haplocytheridea* doubtful. This species based on more than
one hundred specimens.

Dimensions: 0.80 x 0.48 mm. (male)
0.71 x 0.46 mm. (female)


HAPLOCYTHERIDEA ? SP.

Plate VI, figures 2a, b

DIAGNOSIS: A small species questionably of the genus Haplocytheridea characterized by a sub-triangular shape and a coarsely perforate surface.

DESCRIPTION: In lateral view small, ovate, sub-triangular, highest slightly in front of middle; anterior margin broadly and obliquely rounded; posterior margin narrower, acutely rounded; dorsal outline highly arched, angulate, dorsal margin straight, strongly inclined postero-ventrally, meets posterior margin with a slight angulation; ventral outline gently convex; left valve largest overlapping along entire margin; carapace inflated latero-ventrally; surface bears numerous coarse punctae arranged in a sub-rectangular pattern, several indistinct vertical ridges, formed by the lack of punctae, located in central portion of carapace; marginal area moderately
wide bearing numerous, slightly sinuous radial pore canals which become more numerous and tend to bifurcate along antero-ventral margin; line of concrescence departs from inner margin anteriorly and posteriorly; hingement merodont, left valve with terminal crenulate sockets and an accommodation groove above hinge bar; muscle scar pattern not discernible.

REMARKS: Closely resembles *Haplocytheridea rayburnensis* Butler and Jones but is more ovate in lateral outline and apparently possesses a median hinge bar as middle element of hingement in right valve. However, a complete right valve was not available for study. Taxonomic position uncertain, presence of accommodation groove makes the placement of this species in the genus *Haplocytheridea* doubtful.

Dimensions: 0.46 x 0.32 mm.


Genus *ASCIOCYHERE* Swain, 1952

*ASCIOCYHERE* N. SP. 1

Plate VII, figures 3a-c

DIAGNOSIS: A small species of the genus *Asciocythere* characterized by its amygdaloid shape.

DESCRIPTION: In lateral view ovate, amygdaloid, highest just anterior of middle; anterior margin broadly
and obliquely rounded, a shallow depression parallels anterior margin in both valves and delineates a narrow, compressed, shelf-like area along anterior margin; dorsal outline highly arched; posterior margin acutely rounded in left valve, more gently rounded in right; ventral outline strongly convex; surface of carapace finely punctate; left valve considerably larger than right, greatest overlap along dorsal and ventral margins, virtually no overlap along anterior margin; ligament merodont, left valve with terminal crenulate sockets separated by a smooth bar with a shallow accommodation groove above; marginal area widest anteriorly with numerous straight radial pore canals; line of concrescence departs slightly from inner margin anteriorly; muscle scar pattern not visible.

Remarks: Similar to the lower Cretaceous species "Asciocythere amygdaloides brevis" (Alexander), which questionably equals "Asciocythere rotunda" (Vanderveen), but differs in being smaller, more compact, and possessing a compressed anterior marginal shelf. This species based on twenty specimens.

Dimensions: 0.50 x 0.35 mm.

Genus CYTHERIDEA Bosquet, 1852

CYTHERIDEA ? N. S. I 1

Plate VII, figures 5a-c

DIAGNOSIS: A questionable species of the genus Cytheridea characterized by an ovate lateral outline, a blunt projection at center of posterior margin of left valve, and strongly infolded margins.

DESCRIPTION: In lateral view ovate, oblong, narrowing posteriorly, highest slightly anterior of middle, roundly angulate at center of anterior and posterior margins; anterior margin rounded with slight swelling at center in left valve; posterior margin roundly angulate with a blunt projection developed at center in left valve; dorsal outline gently arched, dorsal margin straight, sloping posteriorly, meets anterior and posterior margins with a slight angulation; ventral outline convex meeting posterior margin with a slight angulation; left valve much larger than right overlapping along all margins, greatest overlap at center of posterior and anterior margins; margins strongly infolded along entire periphery, particularly in left valve; viewed dorsally anterior and posterior blunt, carapace widest slightly in front of middle, line of valve juncture slightly sinuous; surface of carapace coarsely punctate, larger punctae form two vertical furrows in central portion of carapace; marginal areas narrow with numerous straight radial pore canals;
line of concrescence departs from inner margin anteriorly and posteriorly; muscle scar pattern consists of a vertical row of four oval scars with two rounded scars in front; hingement merodont with terminal elongate, crenulate teeth in right valve with a crenulate ridge between, left valve complimentary.

**REMARKS:** This species fits no known genus, however, lack of sufficient specimens prevented erecting a new genus. On the basis of hingement, muscle scar pattern, and surface ornamentation, this species has been tentatively placed in the genus *Cytheridea*. However, the strongly infolded margins and shape of the carapace do not fit the description of this genus. This species based on four right valves, five left valves, and one complete carapace.

**Dimensions:** 0.32 x 0.48 mm.

**Locality:** F-1.

Genus *KRITHE* Brady, Crosskey and Robertson, 1874

*Krithe cf. K. POSTPROJECTA* Schmidt, 1943

Plate VI, figure 8

*Krithe postprojecta* Schmidt, 1943, *Journal of Paleontology*, vol. 22, p. 409, pl. 61, fig. 8, text fig. 2d.


**DIAGNOSIS:** A species of the genus *Krithe* characterized by the posterior margin developed into a rounded projection at postero-ventral angle.

**DESCRIPTION:** In lateral view, oblong, greatest height approximately at middle; anterior margin bluntly rounded; posterior margin obliquely rounded, slopes postero-ventrally making an acute angle with ventral margin, a conspicuous invagination in lower portion of posterior margin below which the posterior margin is developed into a low, rounded projection; dorsal outline gently arched; ventral margin slightly convex; surface of carapace smooth; left valve larger than right overlapping along all margins, overlap least along postero-dorsal margin; internal characteristics not observable.

**REMARKS:** Apparently fits description and illustration of *Krithe postprojecta* Schmidt. No type specimens were available for comparison.

- Dimensions: 0.57 x 0.29 mm.

Subfamily CYTHERURINAE Muller, 1894

Genus EOCYTHEROPTERON Alexander, 1929

**EOCYTHEROPTERON Sp.**

Plate VII, figures 1a, b
DIAGNOSIS: A species of the genus *Eocyttheropteron* characterized by a series of concentric incised lines which parallel the periphery of the carapace.

DESCRIPTION: Carapace tumid; in lateral view ovate, highest anteriorly, inflated latero-ventrally; anterior margin broadly and obliquely rounded; dorsal outline smoothly arched; ventral outline strongly convex; posterior margin narrow, acutely rounded, bears a distinct, blunt, upturned caudal process near dorsal margin in left valve; surface of carapace finely pitted, six to eight concentric, shallow incised lines parallel periphery of carapace; left valve much larger than right; hingement merodont, right valve with crenulate terminal teeth and a crenulate median bar, left valve complimentary; marginal area narrow with widely spaced radial pore canals; line of concrescence departs slightly from inner margin anteriorly; muscle scars not visible.

REMARKS: Resembles *Eocyttheropteron tumidum* (Alexander) but differs in lateral outline, in the possession of concentric incised lines on surface, and a more pronounced caudal process. This is probably a new species but the lack of sufficient specimens prevents definite taxonomic placement.

Dimensions: 0.63 x 0.42 mm. (left valve)

Genus ORTHONOTACYTHERE Alexander, 1933

ORTHONOTACYTHERE HANNAI (Israelsky), 1929

Plate VIII, figure 1


Cytheropteron hannai Alexander, 1929, Texas University Bulletin 2907, p. 105, pl. 9, fig. 16.

Orthonotacythere hannai Alexander, 1933, Journal of Paleontology, vol. 7, p. 22, pl. 25, figs. 1a-c; pl. 26, figs. 6a, b; pl. 27, figs. 14a, b.


Orthonotacythere hannai Skinner, 1956, Transactions, Gulf Coast Association of Geological Societies, 6th Annual Meeting, p. 202, pl. 4, figs. 9a, b.

Orthonotacythere hannai Butler and Jones, 1957, Louisiana Department of Conservation, Geological Survey, Bulletin 32, p. 21, pl. 4, fig. 2.


DIAGNOSIS: A species of the genus Orthonotacythere characterized by seven to eight spinose tubercles and a pronounced caudal process at dorsal margin.

DESCRIPTION: In lateral view oblong, ovate, highest anteriorly; anterior margin compressed, broadly and obliquely rounded bearing seven to eight blunt spines; posterior margin narrow, compressed, sloping upward to a pronounced, blunt caudal process at dorsal margin; dorsal
margin straight, pronounced glassy eye spot extends slightly above dorsal margin; ventral margin strongly convex; surface finely reticulate with seven to eight spinose tubercles located in front of, behind, and below a slightly arcuate median sulcus; hingement merodont, right valve with crenulate terminal teeth and a narrow crenulate median groove, left valve complimentary; line of concrescence coincident with inner margin.

Dimensions: 0.64 x 0.36 mm.

Locality: F-5.

ORTHONOTACYTHERE cf. O. SCROBICULATA Alexander, 1934

Plate VIII, figure 2


DIAGNOSIS: A small, quadrate species of the genus ORTHONOTACYTHERE.

DESCRIPTION: In lateral view small, quadrate; narrow keel developed along anterior, ventral, and posterior margins and forms an indistinct, upturned caudal process at postero-dorsal angle; anterior margin broadly and obliquely rounded; posterior margin narrower and roundly angulate postero-dorsally; dorsal outline nearly straight;
ventral outline strongly convex; glassy eye spot prominent at antero-dorsal angle; surface finely reticulate with a well developed median sulcus; three prominent tubercles located along ventral margin just below median sulcus with a fourth, indistinct tubercle just in front of these three, two prominent tubercles located above median line, one on each side of sulcus, the anterior of which is connected to the eye spot by a low ridge, below this tubercle is a short vertical ridge parallel to anterior margin, an indistinct tubercle located at postero-dorsal angle; internal features not observable.

REMARKS: Orthonotacythere scrobiculata Alexander typically displays four well developed tubercles along ventral margin while this species has only three prominent tubercles with an indistinct one in front. Similar to O. scrobiculata in all other respects.

Dimensions: 0.42 x 0.25 mm.

Locality: H-4.

ORTHONOTACYTHERE SP.

Plate XI, figure 3

DIAGNOSIS: A species of the genus Orthonotacythere characterized by eight to nine spinose tubercles on surface of carapace and the lack of a caudal process.
DESCRIPTION: In lateral view sub-rhomboidal, highest anteriorly; anterior margin broadly and obliquely rounded; posterior margin narrower, sloping strongly upward; both anterior and posterior margins bear well developed keels; dorsal outline nearly straight, glassy eye spot prominent; ventral outline strongly convex; surface indistinctly pitted with eight to nine large, spinose tubercles located in front of, behind, and below a shallow median sulcus; hingement merodont, left valve with terminal crenulate sockets and a narrow crenulate median bar; marginal area narrow; line of concrescence coincident with inner margin.

REMARKS: The only specimen of this species in the writer's collection resembles Orthonotacythere hannai (Israelsky) in all respects except caudal process is lacking.

Dimensions: 0.53 x 0.36 mm.

Locality: A-1.

Subfamily BYTHOCYTHERINAE Sars, 1926
Genus MONOCERATINA Roth, 1928
MONOCERATINA SP.
Plate XI, figures 6a, b

DIAGNOSIS: A species of the genus Monoceratina characterized by an oval outline in lateral view, a
short, blunt latero-ventral spine, and several rows of low, rounded nodes on ventral surface.

DESCRIPTION: In lateral view oblong, ovate, highest anteriorly; anterior margin compressed, broadly rounded, rimmed below middle; posterior margin narrower, acutely rounded, indistinctly rimmed; dorsal outline straight; ventral margin convex with a slight invagination in front of middle, bears a prominent rim; carapace inflated latero-ventrally, a prominent, laterally projecting, blunt spine located at posterior margin of inflated area, a well defined median sulcus located just in front of spine, ventral surface of inflated area bears several longitudinal rows of low, rounded nodes; surface of carapace smooth; left valve larger than right overlapping slightly along anterior margin; internal features not observable.

REMARKS: Differs from Monoceratina sagitta Butler and Jones in that it lacks a strongly sagittate outline in dorsal view and median sulcus not as well developed as in M. sagitta. Resembles Monoceratina nitida Alexander but lacks swelling in front of median sulcus. Lack of sufficient specimens prevents the specific placement of this species.

Dimensions: 0.63 x 0.32 mm.
Locality: CC-1.
Subfamily BRACHYCYThERINAE Puri, 1953

Genus BRACHYCY THERE Alexander, 1933

BRACHYCY THERE LEDAFORMA (Israelsky), 1929

Plate VIII, figure 3

Cytheropteron ledaforma Israelsky, 1929, Arkansas Geological Survey, Bulletin 2, p. 8, pl. 1A, figs. 5-7.

Cythere acutocaudata Alexander, 1929, Texas University Bulletin 2907, p. 87, pl. 7, figs. 5, 6.

Brachycythere ledaforma Alexander, 1933, Journal of Paleontology, vol. 7, p. 206, pl. 25, fig. 9, pl. 27, fig. 20.

Brachycythere ledaforma Jennings, 1936, Bulletin of American Paleontologists, vol. 23, no. 78, p. 49, pl. 6, fig. 15.

Brachycythere ledaforma Calahan, 1939, Shreveport Geological Society, Guide Book, 14th Annual Field Trip, p. 41, pl. 3, fig. 2.


DIAGNOSIS: A species of the genus Brachycythere characterized by an inflated, punctate, latero-ventral surface and a strongly compressed, slightly downturned posterior.

DESCRIPTION: Carapace in lateral view oblong, narrowing posteriorly, highest anterior of middle and just
behind eye spot; anterior margin compressed, obliquely rounded; posterior strongly compressed, angulate in postero-ventral direction; dorsal outline arched; ventral margin slightly concave, partially obscured by latero-ventral swelling; surface of latero-ventral swelling ornamented by punctae and several longitudinal striations which are most pronounced on ventral surface of inflated area, latero-ventral swelling is delineated anteriorly by a shallowly incised line extending from just in front of middle of ventral margin to just behind eye spot where it terminates in a more pronounced depression; left valve larger than right overlapping along all margins except at antero-ventral and postero-ventral angles; line of concrescence coincident with inner margin; hingement amphidont.

Dimensions: 0.69 x 0.44 mm.


BRACHYCYTHERE SPHENOIDES (Reuss), 1854

Plate VIII, figure 6


Cytheropteron sphenoides Jones and Hinde, 1890, Paleontographical Society of London, vol. 43, p. 33, pl. 1, figs. 18-20.
Cythere sphenoides Alexander, 1929, Texas University Bulletin 2907, p. 81, pl. 7, f1gs. 9, 14.


Brachycythere sphenoides Alexander, 1933, Journal of Paleontology, vol. 7, p. 205, pl. 25, f1gs. 3a-c; pl. 26, f1gs. 72, b; pl. 27, fig. 19.


Brachycythere sphenoides Calahan, 1939, Shreveport Geological Society, Guide Book, 14th Annual Field Trip, p. 41, pl. 3, f1gs. 5a-c.


Brachycythere sphenoides Butler and Jones, 1957, Louisiana Department of Conservation, Geological Survey, Bulletin 32, p. 27, pl. 3, fig. 1.

Brachycythere sphenoides Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, Louisiana State University Press, pp. 91-92, 3 f1gs.

DIAGNOSIS: A large species of the genus Brachycythere characterized by an arched dorsal outline which is angulate at antero-dorsal and postero-dorsal angles and a pronounced latero-ventral inflation which bears an alar ridge.

DESCRIPTION: Carapace in lateral view oblong, ovate, strongly inflated latero-ventrally, highest in front of middle and behind glassy eye spot; anterior margin compressed, broadly and obliquely rounded, denticulate in well preserved specimens; posterior margin compressed,
rounded angulate; dorsal outline arched, angulate at antero-dorsal and postero-dorsal angles; ventral margin gently convex, partially obscured by latero-ventral swelling; slight depression located behind glassy eye spot; moderately well developed alar ridge marks lateral extremity of latero-ventral swelling, carapace shallowly depressed just above alar ridge, ventral surface of inflated portion of carapace bears several indistinct longitudinal striations; surface finely perforate; left valve largest, greatest overlap along dorsal margin; marginal area widest anteriorly with numerous, slightly sinuous radial pore canals which tend to branch near outer margin; line of concrescence departs slightly from inner margin anteriorly and posteriorly; hingement amphidont, posterior tooth in right valve is elongate and crenulate, left valve complementary with an accommodation groove; muscle scar pattern consists of a crescent shaped scar below which is a triangular group of three ovate scars, in front of these are two scars, the upper being heart shaped and the lower ovate.

Dimensions: 1.05 x 0.67 mm.

BRACHYCYHERE cf. B. TAYLORENSIS (Alexander), 1929

Plate VIII, figures 7a-c

Cythere taylorensis Alexander, 1929, Texas University Bulletin 2907, p. 82, pl. 7, figs. 3, 4.


DIAGNOSIS: A species of the genus Brachycythere characterized by a latero-ventrally inflated carapace and a thickened dorsal rim developed in anterior of left valve.

DESCRIPTION: In lateral view, elongate, ovate, highest near middle; anterior compressed, margin broadly and obliquely rounded, finely denticulate; posterior compressed, narrow, angulate at center, finely denticulate with one or two large, backward directed spines at point of angulation; dorsal outline arched with a slight concavity in posterior portion; ventral margin convex, central portion obscured by latero-ventral swelling; left valve largest, greatest overlap along dorsal margin; surface smooth with a well developed glassy eye spot beneath which is a shallow depression; each valve with a low alar ridge above which is a row of shallow, indistinct pits, a thickened dorsal rim developed in anterior of left valve; marginal area widest anteriorly with numerous, slightly sinuous
radial pore canals; line of concrescence departs slightly from inner margin anteriorly and posteriorly; hingement amphidont with an elongate, crenulate posterior tooth in right valve, left valve complementary with an accommodation groove; muscle scar pattern not observable.

REMARKS: Closely resembles *Brachycythere taylorrensis* as figured and described by Alexander (1929) in all respects except alar ridge is not sharp and abruptly terminated. No type species of *B. taylorrensis* was available for comparison.

Dimensions: 0.78 x 0.53 mm.

Localities: F-2, F-5, T-4, T-6.

**BRACHYCYTHERE N. SP. 1**

Plate VIII, figures 4a-c

**DIAGNOSIS:** A species of the genus *Brachycythere* characterized by the *B. ledaforma* (Israelsky) shape and the development of a pronounced alar ridge on the right valve.

**DESCRIPTION:** In lateral view carapace is oblong, ovate, narrowing posteriorly; greatest height anterior of center and just behind eye spot; anterior compressed, margin obliquely rounded; posterior compressed, angulate in a postero-ventral direction; dorsal outline nearly straight, sloping posteriorly, meets anterior and
posterior margins with a distinct angulation; ventral margin slightly convex, partially obscured by latero-ventral swelling; a pronounced thickened ridge developed at lateral margin of inflated portion of right valve, lacking in left valve; surface punctate, latero-ventral swelling ornamented by several longitudinal striations and larger punctae; left valve with several diagonally arranged striations in central portion of carapace just above longitudinal striations; anterior edge of latero-ventral swelling delineated by a weakly incised line extending from just in front of middle of ventral margin to behind eye spot where it terminates in a more pronounced depression; eye spot more conspicuous in right valve; marginal area widest anteriorly with numerous straight, fine radial pore canals; line of concrescence coincident with inner margin; muscle scar pattern indistinct but apparently consists of a vertical row of four irregular ovate scars, middle two of which are side by side, with a crescent shaped scar in front; hingement amphidont, posterior tooth in right valve is elongate and crenulate, accommodation groove in left valve; left valve larger than right overlapping along all margins except at postero-ventral angle.

REMARKS: This species is extraordinarily distinct in the dissimilarity of the ornamentation of the valves, particularly diagnostic in ventral view. Resembles
Brachycythere ledaforma (Israelsky) in essentially all respects except has distinct alar ridge developed on right valve. This species based on over thirty complete carapaces.

Dimensions: 0.61 x 0.40 mm.


BRACHYCYTHERE N. SP. 2
Plate VIII, figure 5

DIAGNOSIS: A small species of the genus Brachycythere of the B. ledaforma (Israelsky) shape characterized by the lack of longitudinal striations on the ventral surface of the latero-ventral swelling.

DESCRIPTION: Carapace in lateral view oblong, ovate, narrowing posteriorly, greatest height just behind eye spot; anterior compressed, margin broadly and obliquely rounded; posterior compressed, roundly angulate in a postero-ventral direction; dorsal margin straight, sloping posteriorly and meeting posterior margin with a slight angulation; ventral margin straight, partially obscured by a pronounced latero-ventral swelling; left valve largest overlapping right valve along all margins except at postero-ventral and antero-ventral angles, greatest overlap along dorsal margin; surface punctate, punctae arranged in diagonal rows sloping antero-ventrally; a short, indistinct,
diagonal depression located near anterior edge of latero-ventral swelling, anterior edge of inflated portion delineated by an indistinct incised line extending from just in front of middle of ventral margin to behind eye spot where it terminates in a more pronounced depression; both valves bear a poorly developed alar ridge; marginal area widest anteriorly; radial pore canals fine, numerous, and straight; line of concrescence coincident with inner margin; muscle scar pattern indistinct but apparently consists of a vertical row of four irregular ovate scars, the middle two of which are side by side, with a crescent shaped one in front; hingement is amphidont, posterior tooth in right valve is elongate and crenulate.

REMARKS: This species is more compact, has a less pointed posterior and has smaller dimension than Brachycythere ledaforma (Israelsky). Also differs from B. ledaforma in lacking the longitudinal striations on the latero-ventral swelling. This species based on six complete carapaces.

Dimensions: 0.57 x 0.38 mm.

Localities: H-5, B-1.

BRACHYCYTHERE N. SP. 3

Plate VIII, figures 6a, b
DIAGNOSIS: A species of the genus *Brachycythere* characterized by a distinctive ovate lateral outline and a pronounced, rounded, latero-ventral swelling.

DESCRIPTION: In lateral view oblong, distinctly ovate, highest just behind eye spot; anterior compressed, margin broadly rounded; posterior less compressed, narrower, more acutely rounded, dorsal outline arched, meets posterior margin with a slight angulation; ventral margin convex, partially obscured by pronounced latero-ventral swelling; surface finely punctate, anterior edge of latero-ventral swelling delineated by an incised line extending from just in front of middle of ventral margin to behind eye spot where it terminates in a more pronounced depression, eye spot bears a shallow, triangular depression; left valve largest overlapping right valve along dorsal margin; hingement amphidont, posterior tooth crenulate, accommodation groove in left valve; marginal area moderately wide anteriorly with numerous fine, straight radial pore canals; line of concrescence departs from inner margin anteriorly; muscle scars not observable.

REMARKS: Differs from *Brachycythere ovata* (Alexander) in having a shorter length in relationship to width, a more bluntly rounded anterior, and a straighter dorsal outline. Differs from *Brachycythere darensis* Swain in lacking an alar ridge and in its smaller dimensions. Incised line along anterior margin of latero-ventral
swelling is considered to denote a relationship to Brachycythere ledaforma (Israelsky). This species based on numerous individual valves and complete carapaces.

Dimensions: 0.72 x 0.48 mm.


Genus ALATACYTHERE Murray and Hussey, 1942

ALATACYTHERE cf. A. PONDEROSANA (Israelsky), 1929

Plate X, figures 2a-c

Cythereopteron ponderosana Israelsky, 1929, Arkansas Geological Survey, Bulletin 2, p. 9, pl. 2A, figs. 1a-c.

Cythereis thomasi Israelsky, new name in Alexander, 1933, Journal of Paleontology, vol. 7, p. 211, pl. 25, figs. 16a-b.

Cythereis thomasi Calahan, 1939, Shreveport Geological Society, Guide Book, 14th Annual Field Trip, p. 41, pl. 3, fig. 3.


Pterygocythereis thomasi Hill, 1954, Journal of Paleontology, vol. 28, p. 816, pl. 98, figs. 5a-c; pl. 99, figs. 2a-c.

Alatacythere ponderosana Butler and Jones, 1957, Louisiana Department of Conservation, Geological Survey, Bulletin 32, p. 29, pl. 2, figs. 4a-c.


DIAGNOSIS: An elongate species of the genus

Alatacythere which tapers posteriorly and has well developed latero-ventral ala.
DESCRIPTION: Carapace in lateral view oblong, ovate, highest at glassy eye spot; anterior margin compressed, broadly and obliquely rounded, rimmed, coarsely denticulate below middle; posterior margin narrower, roundly angulate slightly above median line, rimmed, coarsely denticulate below point of angulation; dorsal outline almost straight, dorsal margin partially obscured by dorsal ridge; low hinge ear developed over eye spot and a low triangular process located at postero-dorsal angle in left valve; dorsal ridge sharp, slightly sinuous, extends from just behind eye spot to postero-dorsal angle, in left valve is separated from triangular process at postero-dorsal angle by a shallow sulcus; ventral margin straight, rises posteriorly, partially obscured by latero-ventral ala; ala wide, terminating in blunt points, a row of sub-rectangular pits located on upper surface of ala near lateral margin; surface of carapace smooth; hingement amphidont, right valve with smooth anterior tooth, postadjacent socket, smooth median groove, and crenulate posterior tooth, left valve complementary; marginal area narrow with widely spaced, straight radial pore canals; line of concrescence coincides with inner margin; muscle scars not visible.

REMARKS: The specimens of this species collected from the Browns' town formation differ slightly from Alatacythere ponderosana (Israelsky) in that the dorsal
ridge is not as high and sharp and the posterior margin is more angulate. However, an examination of numerous topotypes of *A. ponderosana* showed that considerable variation exists within this species and the Brownstown specimens were considered to fall within the limits of variation.

**Dimensions:** 0.85 x 0.44 mm.


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**ALATACYTHERE TOKIANA** *(Israelsky), 1929*

:late X, figures 3a, b

_Cytheropteron tokiana* Israelsky, 1929, Arkansas Geological Survey, Bulletin 2, p. 9, pl. 1A, figs. 8, 9a, b.

? _Cythereis tokiana* Loetterle, 1937, Nebraska Geological Survey, Second Series, Bulletin 12, p. 55, pl. 9, figs. 4a, b.

Not _Cythereis* (Pterygocythereis) *tokiana* Bold, 1946, *Contribution to the Study of Ostracoda...*, J. H. DeBussy, Amsterdam, p. 100, pl. 6, fig. 9.


**DIAGNOSIS:** A large species of the genus _Alatacythere_ characterized by a sub-rhombooidal lateral outline, a
triangular process at postero-dorsal angle of left valve, and short, blunt, latero-ventral ala.

DESCRIPTION: Carapace in lateral view sub-rhomboidal, highest at eye spot; anterior margin compressed, broadly and obliquely rounded, rimmed; posterior margin narrower, compressed, roundly angulate above median line, rimmed; both anterior and posterior margins bear numerous, small, rounded nodes; dorsal margin straight, partially obscured by dorsal ridge, prominent hinge ear developed in left valve over glassy eye spot, a well developed triangular process located at postero-dorsal angle of left valve; ventral margin nearly straight bearing a low, sharp rim; dorsal ridge short, rounded, slightly sinuous, separated from postero-dorsal triangular process and eye spot by well developed sulci; carapace inflated latero-ventrally, lateral margin of inflated portion bears a pronounced alar ridge which terminates posteriorly in a rounded boss, anteriorly, ridge is confluent with anterior marginal rim, a row of sub-rectangular depressions located on upper surface of ridge; surface of carapace smooth with widely spaced, large, normal pore canals; hingement amphidont, posterior tooth in right valve is crenulate; marginal area moderately wide bearing large, widely spaced, straight, radial pore canals which terminate in the small marginal nodes; line of concrescence coincident with inner margin; muscle scar pattern consists of a vertical row of four
elongate, crescent shaped scars with a U-shaped one in front; left valve largest, overlapping at hinge ear and at posterior cardinal angle.

Dimensions: 1.03 x 0.56 mm.

Localities: E-4, E-5, C-1, DD-1, DD-2.

ALATACYTHERE ? N. Sii. 1
Plate IX, figures 6a-c

DIAGNOSIS: A species questionably of the genus Alatacythere characterized by a smooth, hyaline carapace and four to five flattened spines projecting from the lateral margin of the latero-ventral swelling.

Carapace in lateral view elongate, tapering markedly posteriorly, highest anteriorly, anterior margin broadly rounded, compressed, rimmed, bearing numerous, large, flattened spines; posterior margin narrow, compressed, produced, acutely angulate, rimmed, bearing five to six large, flattened, blunt spines, spines at point of angulation fused to form a caudal process; dorsal margin straight, bearing several flattened, posteriorly directed spines, a well developed hinge ear above eye spot in left valve, in right valve an irregular, bifid spine developed over eye spot; ventral margin gently convex with a low, sharp rim along its central portion; carapace hyaline,
smooth, inflated latero-ventrally, lateral extremity of inflated portion bears four to five flattened spines which increase in length posteriorly resulting in an arrow-head-like outline in dorsal view; marginal area narrow with numerous, straight, radial pore canals; line of concrescence coincides with inner margin; hingement modified amphidont and weakly developed, both anterior and posterior teeth in right valve are crenulate; muscle scar pattern consists of a vertical row of four, closely spaced, irregular elongate scars with a heart shaped one in front.

REMARKS: The transparent nature of the carapace, the weakly developed crenulate hingement, and narrow marginal area suggests the possibility that this species is a young molt, probably the last molt state of Alatacythere. However, no larger form occurs with this species which the writer considers to represent the adult form and, in view of this species abundance and stratigraphic importance, this species will be named as new.

Dimensions: 0.59 x 0.32 mm.


Genus PTERYGOCYTHERE HILL, 1954

PTERYGOCYTHERE SP.

Plate XI, figures 7a, b
DIAGNOSIS: A species of the genus *Pterygocythere* characterized by an abrupt narrowing of the carapace behind middle in lateral view and well developed latero-ventral ala.

DESCRIPTION: In lateral view ovate, oblong, highest anteriorly; anterior margin compressed, broadly and obliquely rounded, rimmed, bearing indistinct, low, rounded nodes; posterior margin much narrower, compressed, acutely rounded, rimmed; dorsal outline nearly straight; ventral margin convex, sloping strongly upward in posterior half, bears a well developed, rounded, marginal rim; carapace inflated latero-ventrally to form pronounced ala which bear a well developed marginal ridge, dorsal surface of ridge bears a row of shallow pits; eye spot indistinct; a low, obscure hinge ear developed in left valve; a low, rounded dorsal ridge parallels dorsal margin, turns downward at its anterior and posterior terminations, and is separated from hinge ear by a well defined sulcus; surface of carapace smooth; hingement amphidont, right valve with a smooth, rounded anterior tooth, postadjacent socket, narrow median groove and a low, elongate, crenulate posterior tooth, left valve complementary with a shallow accommodation groove; line of concrescence coincident with inner margin; radial pore canals straight, irregularly spaced and intersecting; muscle scar pattern not discernible.
REMARKS: Closely resembles *Pterygocythere saratogana* (Israelsky) but differs in that latero-ventral ala are not curved backwards when viewed dorsally, dorsal ridge is better developed, and in its smaller dimensions. The lack of sufficient specimens prevents the specific placement of this species for the Upper Cretaceous contains a large variety of forms generally fitting this description and differing only in minor respects.

Dimensions: C = 0.40 x 0.48 mm.

Locality: A-1.

Subfamily TRACHYLEBERINAE Sylvester-Bradley, 1948

Genus CYTHEREIS Jones, 1849

CYTHEREIS BICORNIS Israelsky, 1929

Plate VIII, figures 9a, b


*Cythereis bicornis* Alexander, 1929, *Texas University Bulletin* 2907, p. 100, pl. 8, figs. 4, 5.


*Cythereis niobaensis* Loetterle, 1937, *Nebraska Geological Survey*, Second Series, Bulletin 12, p. 54, pl. 9, figs. 2a, b.


Cythereis cf. C. bicornis Swain, 1948, Maryland Board of Natural Resources, Cretaceous and Tertiary Sub-surface Geology, p. 200, pl. 13, Figs. 15, 16.


DIAGNOSIS: A species of the genus Cythereis characterized by a pronounced laterally projecting spine developed at posterior termination of ventral ridge.

DESCRIPTION: Sexually dimorphous, females shorter and more compact than males. Carapace in lateral view oblong, sub-ovate, narrowing abruptly in posterior portion, highest anteriorly at glassy eye spot; anterior compressed, margin broadly and obliquely rounded, rimmed, denticulate; posterior narrow, compressed, rimmed, angulate at middle, in well preserved specimens denticulate below point of angulation; dorsal margin straight, obscured posterior of middle by dorsal ridge; ventral margin nearly straight; dorsal ridge nearly straight in posterior portion and elevated above dorsal margin behind middle, anterior portion lower and somewhat irregular; sinuous median ridge located just behind distinct muscle node, anterior portion bends downward just behind muscle node; muscle node connected to eye spot by a low ridge; well developed ventral ridge nearly straight, bears small nodes and ridges, terminates posteriorly in a pronounced, laterally
extended spine, anteriorly, ventral ridge is confluent with anterior marginal rim; beneath this ridge is a less well developed ridge which partially obscures ventral margin, this subventral ridge joins ventral ridge anteriorly; surface of carapace between longitudinal ridges bears irregular reticulations; left valve with a low hinge ear which overlaps right valve; marginal area moderately wide anteriorly, bears numerous radial pore canals; line of concrescence coincides with inner margin; muscle scars not observable; hingement amphidont with smooth teeth.

REMARKS: This species differs slightly from the paratype of Cythereis bicornis Israelsky (paratype slide no. 5344, Dr. H. V. Howe's collection, Louisiana State University) in not being as deeply sculptured. Within the Brownstown formation of Arkansas, this species evolves from fairly ornate and deeply sculptured forms near the base of the formation to specimens which are practically smooth at the top of the formation. However, the specimens from the base of the Brownstown are still less deeply sculptured than the type C. bicornis which, according to Israelsky (1929), came from the underlying Tokio formation. No specimens of C. bicornis were observed in the Tokio samples examined.

Dimensions: 0.67 x 0.38 mm. (male-smooth form) 0.55 x 0.34 mm. (female-more ornate form)
Localities: F-2, F-4, F-5, B-1, B-2, E-4, E-5, I-1, I-2, I-3, I-4, H-2, H-3, H-5, G-1, G-3, C-1, C-6, T-6, CC-1.

CYTHEREIS ? HANNAI Israelsky, 1929

Plate IX, figures 2a, b

Cythereis hannai Israelsky, 1929, Arkansas Geological Survey, Bulletin 2, p. 16, pl. 4A, figs. 1a-c.


DIAGNOSIS: A species questionably of the genus Cythereis characterized by the lack of dorsal and ventral ridges and by a somewhat inflated carapace.

DESCRIPTION: Sexually dimorphous, females shorter and more compact than males. Carapace in lateral view oblong, semiquadrate, greatest height anterior at glassy eye spot; anterior compressed, margin broadly and obliquely rounded, rimmed, denticulate; posterior compressed, angulate just below middle, denticulate with a longer spine at point of angulation in well preserved specimens; dorsal and ventral margins nearly straight; central portion of carapace inflated, inflated portion outlined posterodorsally by a short vertical ridge, postero-ventrally by an indistinct swelling; distinct muscle swelling
connected to glassy eye spot by a low arcuate ridge; sur-
face of carapace finely reticulate; left valve slightly
larger than right overlapping at anterior cardinal angle;
marginal area widest anteriorly with numerous radial pore
canals each terminating in a spine on denticulate margin;
line of concrescence coincides with inner margin; muscle
scars not observable; hingement amphidont.

REMARKS: Generic designation uncertain. This species
does not fit the description of the genus *Cythereis* as
given by Triebel (1940) in that it lacks well developed
dorsal and ventral ridges, flattened dorsum and venter,
and a well developed hinge ear.

Dimensions: 0.50 x 0.27 mm. (female)
0.61 x 0.29 mm. (male)

Localities: F-4, F-5, B-1, B-2, I-3,
I-4, H-5.

**CYTHEREIS ? SPOORI Israelsky, 1929**

Plate IX, figures 5a, b

*Cythereis spoori* Israelsky, 1929, Arkansas Geological
Survey, Bulletin 2, p. 17, pl. 4A, figs. 4, 5.

*Cythereis spoori* Alexander, 1939, Shreveport Geological
Society, Guide Book, 14th Annual Field Trip, p. 66.

*Cythereis ? spoori* Howe and Laurencich, 1958, *Introduction to
the Study of Cretaceous Ostracoda*, Louisiana
State University Press, pp. 235-236, 2 figs.

DIAGNOSIS: A species questionably of the genus
*Cythereis* characterized by a reticulate surface and an
obliquely oriented ventral ridge.
DESCRIPTION: Sexually dimorphous, females shorter and more compact than males. Carapace in lateral view oblong, sub-ovate, greatest height at antero-dorsal angle; anterior margin rounded, rimmed, finely denticulate; posterior narrower, indistinctly rimmed, finely denticulate, roundly angulate in left valve, more pronounced angulation in right; dorsal margin obscured by poorly developed dor­sal ridge, left valve with prominent hinge ear developed just above eye spot; ventral margin nearly straight, slightly concave in right valve, bears a poorly developed marginal ridge; surface coarsely reticulate; muscle node prominent, connected to eye spot by low ridge; median ridge extends posteriorly from muscle node; ventral ridge obliquely oriented, rises posteriorly; left valve slightly larger than right overlapping at hinge ear; marginal area narrow with numerous radial pore canals, many of which apparently bifurcate; line of concrescence coincident with inner margin; hingement amphidont with bifid ante­rior tooth in right valve; muscle scar pattern consists of a vertical row of four sub-parallel scars with a heart shaped one in front.

REMARKS: This species does not entirely fit the description of the genus *Cythereis* as given by Triebel (1940) in that it lacks a flattened venter. The general shape of the carapace and particularly the arrangement of the ridges is somewhat suggestive of the genus *Henryhowella* Puri, 1957.
Cylindrella sp. 1

Plate IX, figures 4a-c

Diagnosis: A species questionably referred to the genus Cylindrella characterized by a sub-rhomboidal outline in lateral view and a recurved ventral ridge.

Description: Sexually dimorphic, females shorter and more compact than males. In lateral view sub-rhomboidal, highest anteriorly; anterior margin compressed, obliquely rounded, rimmed, bearing numerous, short, blunt spines; posterior margin narrow, compressed, tapers upward to an acute angle above median line, rimmed, denticulate below middle; dorsal margin straight, obscured by dorsal ridge; ventral margin convex with a well developed marginal rim; dorsal ridge sharp, high, develops an indistinct tubercle at postero-dorsal angle and then becomes continuous with posterior marginal rim, anteriorly is confluent with anterior marginal rim; median ridge extremely sharp and high, curves slightly downward in anterior portion and sharply downward at posterior termination; ventral ridge is recurved, curves abruptly downward at posterior termination and then curves anteriorly.
just above ventral margin and continues anteriorly as a sub-ventral ridge until it terminates just behind anterior termination of ventral ridge; surface between longitudinal ridges ornamented by sharp, vertical ribs; marginal area narrow; line of concrescence coincides with inner margin; radial pore canals straight, few in number and widely spaced above middle of anterior margin, numerous and closely spaced below middle; muscle scar pattern a closely spaced vertical row of four elongate scars with a larger one in front; hingement amphidont, right valve with a smooth, triangular, anterior tooth, a postadjacent socket, a narrow, apparently finely crenulate median groove, and an elongate, finely crenulate posterior tooth, left valve complementary.

**Remarks:** Differs from *Veenia gapensis* (Alexander) in possessing a distinctive recurved ventral ridge. The supplemental ventral ridge suggests that this species is tending toward the genus *Veenia* Butler and Jones and is apparently intermediate between *Cythereis* and *Veenia*. This species based on twelve specimens.

**Dimensions:**

- Male: $0.55 \times 0.30$ mm.
- Female: $0.48 \times 0.30$ mm.

**Localities:** H-4, H-5.
DIAGNOSIS: A species questionably of the genus *Cythereis* characterized by an elongate muscle swelling separated from the short median ridge by a shallow sulcus giving the impression of a bifid median ridge.

DESCRIPTION: Carapace in lateral view sub-rectangular, tapering posteriorly, highest anteriorly; anterior margin compressed, broadly and obliquely rounded, rimmed, denticulate; posterior margin narrower, compressed, roundly angulate, rimmed, denticulate below middle; dorsal margin straight, sloping slightly downward posteriorly, partially obscured by dorsal ridge, low hinge ear developed over eye spot in left valve; ventral margin nearly straight, sloping upward posteriorly, bears marginal rim; dorsal ridge rounded, sinuous, separated from distinct eye spot by a shallow sulcus, terminates in a low boss at postero-dorsal angle; median ridge rounded, short, slightly concave downward, extends anteriorly to just behind center where it is separated from muscle swelling by a shallow sulcus; muscle swelling elongate, rounded, sloping slightly antero-ventrally; ventral ridge rounded, straight, extends from just above postero-ventral angle to just short of marginal rim at antero-ventral angle; surface between ridges smooth; hingement amphidont with a smooth, triangular anterior tooth, a postadjacent socket, a narrow
median groove, and a smooth, rounded posterior tooth in right valve, left valve complementary; left valve largest overlapping at hinge ear; marginal area moderately wide anteriorly and posteriorly with numerous, slightly sinuous radial pore canals in groups of two and three; line of concrescence coincides with inner margin; muscle scar pattern consists of a vertical row of three to four elongate scars with a U-shaped one in front.

REMARKS: This species belongs to that group of Ostracoda which includes the species that Alexander (1929) considered to be Cythereis semiplicata (Reuss). Alexander's species differs from C. semiplicata (Reuss) in that the dorsal and ventral ridges extend forward beyond the area of muscle swelling and the dimensions are larger (Bonnema, 1940; Howe and Laurencich, 1958). Cythereis n. sp. 1 is generally similar to Cythereis semiplicata of Alexander (1929) but differs in that median ridge is separated from muscle node by a well developed sulcus. Generic designation is in question, lacks the pronounced flattened dorsum and venter and angular ridges characteristic of the genus Cythereis. This species based on eleven specimens.

Dimensions: 0.58 x 0.39 mm.

Locality: T-6.
CYTHEREIS ? SP.
Plate IX, figures 3a, b

DIAGNOSIS: A species questionably of the genus Cythereis characterized by a well developed dorsal ridge which bends abruptly downward at its posterior termination, a well developed ventral ridge which turns abruptly upward at its posterior termination, and the lack of a median ridge.

DESCRIPTION: Carapace oblong, ovate, highest at eye spot; anterior margin compressed, broadly rounded, rimmed, finely denticulate; posterior margin narrower, tapering to an acute angle at middle, rimmed, compressed, bearing several short, blunt spines on lower portion; ventral margin nearly straight, curving upward slightly in posterior portion; dorsal margin straight, sloping slightly downward posteriorly; surface of carapace bears dorsal and ventral ridges but lacks median ridge, dorsal ridge sinuous, develops a low, rounded boss at postero-dorsal angle and then bends abruptly downward, anteriorly is separated from glassy eye spot by a shallow sulcus; ventral ridge develops a low, rounded boss at its posterior termination and then turns abruptly upward, anteriorly is continuous with anterior marginal rim; muscle swelling is developed and medianly located; surface of carapace finely pitted; left valve with a low hinge ear which overlaps right valve slightly; internal characteristics not observable.
REMARKS: Only one specimen of this species is in the writer's collection and this specimen closely resembles no known species. Generally similar to *Cythereis wintoni* Alexander but differs in being shorter, higher, with less pointed posterior and more pronounced dorsal and ventral bosses. Lacks the median ridge characteristic of the genus *Cythereis*.

Dimensions: 0.46 x 0.27 mm.

Locality: F-3.

Genus *VEENIA* Butler and Jones, 1957

*VEENIA* cf. *VEENIA GAPENSIS* (Alexander), 1929

Plate IX, figures 1a, b

*Cythere gapensis* Alexander, 1929, *University of Texas Bulletin* 2907, p. 84, pl. 6, figs. 16, 17.


DIAGNOSIS: A species of the genus *Veenia* characterized by prominent vertical ridges between the longitudinal ridges.

DESCRIPTION: Sexually dimorphous, females more compact and shorter than males. Carapace in lateral view sub-rhomboidal, highest anteriorly; anterior margin obliquely rounded, compressed, rimmed, denticulate; posterior narrower, compressed, rimmed, denticulate, roundly
angulate, more rounded in left valve than right; dorsal outline nearly straight, dorsal margin obscured by dorsal ridge, left valve with hinge ear developed over eye spot; ventral margin convex, rimmed, partially obscured by ventral ridge; surface of carapace bears a dorsal ridge, two median ridges, and a ventral ridge; upper median ridge located approximately at median line and is continuous with irregular muscle swelling; lower median ridge located just above ventral ridge and extends from just above postero-ventral angle to anterior marginal rim; surface between longitudinal ridges ornamented by numerous vertical ribs; left valve largest overlapping at hinge ear; marginal area narrow; line of concrescence coincides with inner margin; radial pore canals straight, widely and irregularly spaced; muscle scars indistinct but apparently consists of a vertical row of four with a heart shaped one in front; hingement amphidont, right valve with a pronounced tubular, smooth, anterior tooth, postadjacent socket, a narrow, apparently finely crenulate median groove, and an elongate, low, finely crenulate posterior tooth, left valve complementary.

REMARKS: No type specimen was available for comparison. Identification was made from Alexander's description and illustrations, however, Alexander listed the dimensions of the holotype as 0.70 mm. in length which is considerably larger than the specimens collected from
the Brownstown formation. Arrangement of the ridges and general shape of the carapace place this species in the genus Veenia.

Dimensions: 0.50 x 0.27 mm. (female)
0.56 x 0.29 mm. (male)

Localities: 1-4, F-1, CC-1.

VEENIA ARACHOIDES (Berry), 1955
Plate XI, figures 4a, b

Cythere arachoides Berry, 1925, American Journal of Science, vol. 209, p. 484, fig. 5.

Cythere rectangulapora Berry, 1925, American Journal of Science, vol. 209, p. 483, fig. 4.

Cythere rectangulapora Alexander, 1929, Texas University Bulletin 2907, p. 74.


Cythere multipora Skinner, 1956, Transactions of Gulf Coast Association of Geological Societies, 6th Annual Meeting, p. 90, pl. 2, figs. 4a-c.

Veenia arachoides Butler and Jones, 1957, Louisiana Department of Conservation, Geological Survey, Bulletin 32, p. 46, pl. 5, fig. 4.


Veenia arachoides Howe and Laurencich, 1958, Introduction to the Study of Cretaceous Ostracoda, Louisiana State University Press, p. 310, 1 fig.
**DIAGNOSIS:** A species of the genus *Veenia* characterized by a coarsely reticulate surface.

**DESCRIPTION:** In lateral view semi-ovate, narrowing markedly posteriorly, highest at eye spot; carapace inflated latero-ventrally, compressed anterior margin broadly and obliquely rounded, denticulate; posterior compressed, narrow, margin angulate, denticulate below median line; dorsal outline arched, margin obscured by dorsal ridge; ventral margin convex; dorsal, median, and ventral ridges low and rounded, dorsal ridge turns downward just behind eye spot and is separated from eye spot by a well defined sulcus, a large depression located just behind downturned portion of dorsal margin; prominent hinge ear developed just above eye spot in left valve; median ridge confluent anteriorly with broad, low, indistinct muscle swelling; a low ridge connects muscle swelling to eye spot; ventral ridge indistinct, located just above and parallel to ventral margin; surface of carapace reticulate, reticulations tend to be arranged parallel to the margins; left valve slightly larger than right overlapping only at hinge ear; marginal areas moderately wide anteriorly and posteriorly with numerous straight radial pore canals; line of concrescence coincident with inner margin; muscle scar pattern consists of a vertical row of four elongate, diagonally oriented scars with a heart shaped one in front; hingement amphidont with a slightly crenulate posterior tooth.
Dimensions: 0.71 x 0.42 mm.

Localities: DD-3, DD-4, DD-7, BB-3 (?).

VEENIA OZANANA (Israelsky), 1929

Plate X, figures 1a-d


Cythereis ponderosana Alexander, 1929, Texas University Bulletin 2907, p. 83, pl. 6, fig. 3.


Cythereis ozanana Loetterle, 1938, Nebraska Geological Survey, Second Series, Bulletin 12, p. 64, pl. 11, fig. 6.


Cythereis ozanana van den Bold, 1946, Contribution to the Study of Ostracoda...J. H. DeBussy, Amsterdam, publisher, p. 98, pl. 6, figs. 12a-c.


Veenia ozanana Butler and Jones, 1957, Louisiana Department of Conservation, Geological Survey, Bulletin 32, p. 44, pl. 3, figs. 4a-c.


DIAGNOSIS: A species of the genus Veenia characterized by a smooth surface and the posterior margin sharply pointed at middle.
DESCRIPTION: Sexually dimorphous, females shorter and more compact than males; in lateral view semi-ovate, narrowing posteriorly, greatest height at hinge ear in left valve and near middle in right valve; anterior compressed, margin broadly and obliquely rounded, rimmed, denticulate; posterior compressed, narrow, roundly angulate in left valve, acutely pointed at middle in right, several short posteriorly directed spines at point of angulation; dorsal outline arched, dorsal margin obscured by dorsal ridge; ventral margin convex; surface of carapace bears three well developed, rounded ridges, dorsal ridge slightly sinuous, anterior end separated from eye spot by a shallow sulcus, moderately well developed hinge ear located just above eye spot in left valve; median ridge slightly sinuous, confluent anteriorly with broad, low muscle swelling; muscle swelling connected to eye spot by a low arcuate ridge; ventral ridge located just above and parallel to ventral margin, joins anterior marginal rim; surface between ridges smooth except for several pits adjacent to each ridge and an elongate, shallow depression beneath anterior portion of dorsal ridge; left valve slightly larger than right overlapping only at hinge ear; marginal area moderately wide with numerous, slightly sinuous radial pore canals in groups of two and three; line of concrescence coincides with inner margin; muscle scar pattern a vertical row of four scars with a heart.
shaped one in front; hingement amphidont with smooth anterior and posterior teeth.

Dimensions:  
0.76 x 0.42 mm. (male)  
0.63 x 0.40 mm. (female)

Localities:  
LOCATION OF SAMPLES

The locations of all measured sections from which samples were collected for faunal study are listed below. The stratigraphic position of each sample is shown on Plate II.


Location: 0.83 miles west of 1&NW Railroad crossing on Arkansas Hwy. No. 24 in SE/4, SE/4, Sec. 19, T-0-S, R-25-W in road cut on north side of road in Hempstead County, Arkansas.

SECTION B, samples B-1, B-2, B-3.

Location: 1.9 miles west of F&NW Railroad crossing on Arkansas Hwy. No. 24 in SE/4, SE/4, Sec. 24, T-9-S, R-26-W in road cut on south side of road in Hempstead County, Arkansas.

SECTION C, samples C-1, C-2, C-3, C-4, C-5, C-6.

Location: 0.15 miles east on Arkansas Hwy. No. 24 from intersection with road to Doyle Church, or 5.3 miles east of Nashville on Hwy. No. 24 in SE/4, SE/4, Sec. 22, T-9-S, R-26-W in road cut on north side of road in Hempstead County, Arkansas.

SECTION E, samples E-1, E-2, E-3, E-4, E-5.

Location: 1.1 miles south of Nashville on Arkansas Hwy. No. 4 in center of NE/4, Sec. 1, T-10-S, R-27-W in road cut on east side of road and in gully on west side of road in Howard County, Arkansas.
SECTION F, samples F-1, F-2, F-3, F-4, F-5.

Location: 0.1 miles west of Gravelly Hill Church on road from Ben Lomand to Brownstown in NE/cor., NW/4, NW/4, Sec. 10, T-11-S, R-29-W in road cut and gully on south side of road in Sevier County, Arkansas.

SECTION G, samples G-1, G-2, G-3.

Location: 0.6 miles west of Gravelly Hill Church on road from Ben Lomand to Brownstown in NE/4, NE/4, Sec. 9, T-11-S, R-29-W in creek bank on south side of road in Sevier County, Arkansas.


Location: Intersection of Arkansas Hwy. No. 27 and road to Brownstown in settlement of Ben Lomand in SW/4, SE/4, Sec. 5, T-11-S, R-29-W in Sevier County, Arkansas.


Location: 0.5 miles east of Wilson Creek on road to Ben Lomand from U. S. Hwy. No. 71 in center of NW/4, Sec. 5, T-11-S, R-29-W in Sevier County, Arkansas.

SECTION K, sample K-1.

Location: 1.0 miles north on U. S. Hwy. No. 71 from intersection with road to Ben Lomand in center of S/2, NW/4, Sec. 36, T-10-S, R-30-W in road cut on west side of road in Sevier County, Arkansas.

SECTION L, sample L-1, L-2.

Location: 0.9 miles north on U. S. Hwy. No. 71 from intersection with road to Ben Lomand in SE/4, NW/4, Sec. 36, T-10-S, R-30-W in road cut on east side of road in Sevier County, Arkansas.
SECTION Q, samples Q-1, Q-2, Q-3.

Location: 0.3 miles east of intersection with U. S. Hwy. No. 71 on road to Ben Lomand in S/2, SW/4, Sec. 31, T-10-S, R-29-W in road cut on north side of road in Sevier County, Arkansas.

SECTION P, samples P-1, P-2, P-3, P-4, P-5, P-6, P-7, P-8.

Location: 1.0 miles south of Milford on road to Lyons Church in NW/4, SW/4, Sec. 10, T-10-S, R-29-W in road cut on west side of road in Sevier County, Arkansas.

SECTION Q, samples Q-1, Q-2, Q-3.

Location: 0.3 miles east of intersection with U. S. Hwy. No. 71 on road to Ben Lomand in S/2, SW/4, Sec. 31, T-10-S, R-29-W in road cut on north side of road in Sevier County, Arkansas.

SECTION R, sample R-1.

Location: 0.6 miles north of intersection with road to Ben Lomand on U. S. Hwy. No. 71 in NE/4, SW/4 Sec. 36, T-10-S, R-30-W in gully on west side of road in Sevier County, Arkansas.

SECTION T, samples T-1, T-2, T-3, T-4, T-5, T-6, T-7.

Location: 1.1 miles west of Oklahoma-Arkansas line on Oklahoma Highway No. 21 in road cut on south side of road and in excavation on north side of road in the SW/4 of Sec. 28, T-9-S, R-27-E in McCurtain County, Oklahoma.

SECTION AA, sample AA-3.

Location: 0.14 miles south of center of bridge over Middle Fork Ozan Creek on Arkansas Hwy. No. 4 in SE/4, NW/4, Sec. 20, T-10-S, R-26-W in road cut on west side of road in Hempstead County, Arkansas.
SECTION BB, samples BB-2, BB-3, BB-4.

Location: 1.4 miles north of intersection in Toilette on Arkansas Hwy. No. 55 in SE/4, SW/4, Sec. 33, T-10-S, R-27-W in road cut on west side of road in Howard County, Arkansas.

SECTION CC, sample CC-1.

Location: 1.9 miles north of intersection in Toilette on Arkansas Hwy. No. 55 in S/2, NW/4, Sec. 33, T-10-S, R-27-W in road cut on east side of road in Howard County, Arkansas.

SECTION DD, samples DD-2, DD-3, DD-4, DD-5, DD-6, DD-7.

Location: 0.27 miles east of center of bridge over Bradshaw Creek on Arkansas Hwy. No. 26 in NW/4, SW/4, Sec. 25, T-7-S, R-21-W in road cut on north side of road in Clark County, Arkansas.

SECTION GG, samples GG-1, GG-2, GG-3.

Location: 6.0 miles west of Nashville on Arkansas Hwy. No. 24 in NW/4, NW/4, Sec. 25, T-9-S, R-28-W in Howard County, Arkansas.

SECTION HH, samples HH-1, HH-2.

Location: 5.3 miles west of Nashville on Arkansas Hwy. No. 24 in center of NE/4, Section 25, T-9-S, R-28-W in Howard County, Arkansas.

SECTION JJ, samples JJ-1, JJ-2, JJ-3.

Location: 3.6 miles west of Nashville on Arkansas Hwy. No. 24 in NE/4, NW/4, Sec. 29, T-9-S, R-27-W, Howard County, Arkansas.

SECTION KK, samples KK-1, KK-2, KK-3, KK-4, KK-5, KK-6.

Location: 0.3 miles east of bridge over Ingram Creek on Arkansas Hwy. No. 27 in NE/4, SE/4, Sec. 23, T-10-S, R-28-W in Howard County, Arkansas.
PLATE VI

Figure 1a, b  Cytherella austinensis Alexander. Fig. 1a exterior left valve view of complete female specimen. Fig. 1b exterior left valve view of complete male specimen. Approximately X 40.

Figure 2a, b  Cytherella sp. Fig. 2a dorsal view. Fig. 2b exterior left valve view of complete specimen. Approximately X 40.

Figure 3a, b  Cytherella n. sp. 1. Fig. 3a dorsal view. Fig. 3b exterior left valve view of complete specimen. Approximately X 40.

Figure 4  Cytherelloidea ozanana Sexton. Exterior right valve view, female. Approximately X 40.

Figure 5a, b  Cytherelloidea sp. Fig. 5a exterior left valve view, female. Fig. 5b exterior left valve view, male. Approximately X 40.

Figure 6  Bairdopilata rotunda (Alexander). Exterior right valve view of complete specimen. Approximately X 40.

Figure 7a-c  Haplocytheridea ? n. sp. 1. Fig. 7a dorsal view. Fig. 7b exterior right valve view, complete specimen. Fig. 7c exterior left valve view, complete specimen. Approximately X 40.

Figure 8  Krithe cf. K. postprojecta Schmidt. Exterior right valve view, complete specimen. Approximately X 40.

Figure 9  Cytherelloidea tollettensis Sexton. Exterior right valve view, female. Approximately X 40.
PLATE VII

Figure 1a, b  Eocytheropteron sp.  Fig. 1a exterior right valve view.  Fig. 1b exterior left valve view.  Approximately X 40.

Figure 2a-c  Haploocytheridea ? plummeri (Alexander).  Fig. 2a exterior right valve view of complete female specimen.  Fig. 2b exterior right valve view of complete male specimen.  Fig. 2c details of hingement of left valve.  Approximately X 40.

Figure 3a-c  Ascioocythere n. sp. 1.  Fig. 3a exterior left valve view.  Fig. 3b exterior right valve view.  Fig. 3c dorsal view.  Approximately X 40.

Figure 4a-d  Haploocytheridea ? n. sp. 2.  Fig. 4a exterior right valve view of complete female specimen.  Fig. 4b exterior left valve view, female.  Fig. 4c dorsal view, female.  Fig. 4d exterior left valve view, male.  Approximately X 40.

Figure 5a-c  Cytheridea ? n. sp. 1.  Fig. 5a exterior right valve view, complete specimen.  Fig. 5b dorsal view.  Fig. 5c exterior left valve view.  Approximately X 40.
PLATE VIII

Figure 1  Orthonotacythere hannai (Israelsky). Exterior right valve view. Approximately X 40.

Figure 2  Orthonotacythere scrobiculata Alexander. Exterior right valve view. Approximately X 40.

Figure 3  Brachycythere ledaforma (Israelsky). Exterior right valve view, complete specimen. Approximately X 40.

Figure 4a-c  Brachycythere n. sp. 1. Fig. 4a exterior right valve view, complete specimen. Fig. 4b ventral view. Fig. 4c exterior left valve view. Approximately X 40.

Figure 5  Brachycythere n. sp. 2. Exterior right valve view, complete specimen. Approximately X 40.

Figure 6a, b  Brachycythere n. sp. 3. Fig. 6a dorsal view. Fig. 6b exterior right valve view, complete specimen. Approximately X 40.

Figure 7a-c  Brachycythere cf. B. taylorensis (Alexander). Fig. 7a exterior right valve view, complete specimen. Fig. 7b dorsal view. Fig. 7c exterior left valve view. Approximately X 40.

Figure 8  Brachycythere sphenoides (Reuss). Exterior right valve view, complete specimen. Approximately X 40.

Figure 9a, b  Cythereis bicornis Israelsky. Fig. 9a exterior left valve view, female. Fig. 9b exterior right valve view, male. Approximately X 40.

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PLATE IX

Figure 1a-b  Veenia cf. V. gapensis (Alexander). Fig. 1a exterior left valve view, female. Fig. 1b exterior right valve view, male. Approximately X 40.

Figure 2a, b Cythereis ? hannai Israelsky. Fig. 2a exterior left valve view, male. Fig. 2b exterior left valve view, female. Approximately X 40.

Figure 3a, b Cythereis ? sp. Fig. 3a dorsal view. Fig. 3b exterior right valve view. Approximately X 40.

Figure 4a-c Cythereis ? n. sp. 1. Fig. 4a exterior left valve view, male. Fig. 4b exterior left valve view, female. Fig. 4c exterior right valve view, female. Approximately X 40.

Figure 5a, b Cythereis ? spoori (Israelsky). Fig. 5a exterior left valve view. Fig. 5b exterior right valve view. Approximately X 40.

Figure 6a-c Alatacythere ? n. sp. 1. Fig. 6a exterior left valve view. Fig. 6b dorsal view. Fig. 6c exterior right valve view. Approximately X 40.
**PLATE X**

**Figure 1a-d**  
*Veenia ozanana* (Israelsky). Fig. 1a exterior left valve view, female. Fig. 1b exterior right valve view, female. Fig. 1c exterior left valve view, male. Fig. 1d exterior right valve view, male. Approximately X 40.

**Figure 2a-b**  
*Alatacythere cf. A. ponderosana* (Israelsky). Fig. 2a exterior right valve view. Fig. 2b exterior left valve view. Fig. 2c dorsal view. Approximately X 40.

**Figure 3a-b**  
*Alatacythere tokiana* (Israelsky). Fig. 3a exterior left valve view. Fig. 3b dorsal view. Approximately X 40.
PLATE XI

Figure 1  Paracypris sp. Exterior left valve view. Approximately X 40.

Figure 2a, b Haplocytheridea ? sp. Fig. 2a exterior left valve view. Fig. 2b exterior right valve view. Approximately X 40.

Figure 3 Orthobonotacythere sp. Exterior left valve view. Approximately X 40.

Figure 4a, b Veenia arachoides (Berry). Fig. 4a exterior left valve view. Fig. 4b exterior right valve view. Approximately X 40.

Figure 5a-c Cythereis ? n. s. ? 2. Fig. 5a exterior left valve view. Fig. 5b dorsal view. Fig. 5c exterior right valve view. Approximately X 40.

Figure 6a, b Monoceratina sp. Fig. 6a exterior right valve view. Fig. 6b dorsal view. Approximately X 40.

Figure 7a, b Pterygocythere sp. Fig. 7a exterior left valve view. Fig. 7b dorsal view. Approximately X 40.

Figure 8 Haplocytheridea ? insolita (Alexander and Alexander). Exterior left valve view, complete specimen. Approximately X 40.
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AUTOBIOGRAPHY

The writer was born in New Orleans, Louisiana in October, 1927, and there received his primary and secondary education. After serving in the United States Army, he returned to New Orleans and entered Tulane University in 1947. He received a B.S. degree in Geology from Tulane in 1951 and worked in the Petroleum Industry until he entered the graduate school of Geology at Louisiana State University in September, 1952. Upon completion of the requirements for the M.S. degree in Geology in May, 1954, the writer was employed by The California Company until he re-entered the graduate school of Geology at Louisiana State University in 1955. After completing the residency requirements for the Ph.D. degree in Geology, the writer returned to The California Company in 1957 as an exploration geologist in southeast Louisiana which is the position he holds at the present time.
EXAMINATION AND THESIS REPORT

Candidate: Carl Elmer Thorsen

Major Field: General Geology

Title of Thesis: Stratigraphy and Paleontology of Brownstown and Tokio Formations

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

April 25, 1959
OUTCROP OF TOKIO, BROWNSTOWN AND OZAN FORMATIONS SOUTHWEST ARKANSAS

Carl E. Thorsen

Mod. after Dorn, 1929
PLATE II

ZONE OF CHALK LENSES

LOWEST OBSERVED EXOGYRA PONDEROSA

PLEISTOCENE GRAVEL

GOBER'

LOWEST OBSERVED EXOGYRA PONDEROSA

OZAN F.M.
BROWNSTOWN

LIGNITE

CALC 55 LENSES
LOWEST OBSERVED EXODINA PONDEROSA

ZONE OF CHALK LENSES

ZONE OF LIGNITE

MEASURED SECTIONS
BROWNSTOWN AND TOKIO FORMATIONS
SHOWING
STRATIGRAPHIC POSITION OF SAMPLES
GEOGRAPHIC LOCATION OF SECTIONS SHOWN ON PLATE I

APPROXIMATELY 95 FEET TO BASE OF TOKIO FM.
NORTH-SOUTH STRATIGRAPHIC SECTION
OUACHITA COUNTY, ARKANSAS
TO
CLAIBORNE PARISH, LOUISIANA

Carl E. Thomas
EAST—WEST STRATIGRAPHIC SECTION
DELTA COUNTY TEXAS
TO
CLARK COUNTY ARKANSAS