NEW EXOGYRAS FROM THE INDIDURA FORMATION, MEXICO

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INTRODUCTION

Determination of the stratigraphic position of a small collection of fossils from one locality near the western side of the Sierra de Tlahualilo in southwestern Coahuila is of unusual interest and importance because of its location on an outlying hill of limestone west of the main mountain front. We found no other fossils on similar outliers elsewhere along the west side of the range. This collection furnishes data necessary to determine the age of the rocks in the outlier and for the interpretation of structure at the margin of the range. The present investigation adds three new species of Exogyra to the fauna of the Indidura formation.

The authors recognize the limited value of naming new species of Ostreidae, but the occurrence of large and distinctive specimens not heretofore reported from the Indidura formation makes it seem useful to record their presence and morphological characters, in the hope that they may be found elsewhere and aid in correlation.

The fossil locality is some 30 miles north of the village of Tlahualilo de Zaragoza, Durango, which is about 40 miles north of Torreón, the industrial center of southern Coahuila (see inset on Fig. 1). An unimproved road from Tlahualilo extends northward along the valley west of the Sierra de Tlahualilo. The village of Tlahualilo was formerly owned by the Compañía Agrícola, Industrial, Colonizadora, Limitada del Tlahualilo, S.A., which had its headquarters there. Most of the lands of the company were taken over by the Mexican Government in 1936 and its buildings sold. Gasoline and basic supplies can be purchased at the country stores and market in Tlahualilo or ordered to be sent from Torreón by truck, which makes the round trip to the city daily.

In 1953 University of Michigan geologists had a camp in the Cañon de Guayule about 2 miles east of the fossil locality designated
53-K-20. The senior author was assisted in the field by Robert M. Linsley, a graduate student, who collected some of the fossils.

The field work in 1953 was financed by grants made in November and December 1952 by the Executive Board of the Horace H. Rackham School of Graduate Studies of The University of Michigan and by the Executive Committee of the Michigan Memorial-Phoenix Project (Faculty Research Fund Project 874 and Michigan Memorial-Phoenix Project No. 62). This study is a contribution to a larger research program which was supported earlier by grants from the Geological Society of America and the Horace H. Rackham School of Graduate Studies (G.S.A. Project 386-41 and University of Michigan Research Project No. 115).

Previous Work

The fossils discussed in this report were discovered by the senior author in the course of planetable mapping in the Sierra de Tlahualilo. The only publication that refers specifically to the locality is one by him published in 1956. There (p. 207) it is included in a list of fossiliferous localities along the western side of the range. The number and location are followed in parentheses by this statement: “The fauna, mostly ostreidae, is not diagnostic of age.” The location is on the map of fossil localities (Fig. 1) accompanying the report and its position shown with reference to the Arroyo Guayule and to two abandoned camps of migrant workers harvesting the wild candelilla and guayule plants in this arid region.

Elsewhere Kellum (1956, p. 208) says, speaking of the Aurora Limestone, “The fauna belongs to three distinct zones and to one locality, the stratigraphic position of which with reference to the others is not known.” The one exception referred to is the locality 53-K-20, which yielded the fossils listed or described in the present report. Species listed from the locality 53-K-20 in table I of Kellum’s 1956 report were: Pecten indiduraensis Jones, Pecten spp., Nerinea?, and Kingena wacoensis (Roemer). Kingena wacoensis occurs abundantly in the zone of Gryphaea mucronata, widely distributed in the Sierra de Tlahualilo, and has not previously been reported from the Indidura formation. Pecten indiduraensis is known only from the Indidura formation. Since the faunule of Collection 53-K-20 was predominantly made up of large exogyras not found in either the Aurora or the
Indidura formations elsewhere in the Sierra de Tlahualilo, the author considered it to be undiagnostic.

The Indidura fauna, collected in other ranges of southern Coahuila, was described by T. S. Jones in 1938. He divided the formation into three members. The lowest, Member 1 of Middle and Upper Albian age, he correlates with formations in the north Texas section ranging from the Kiamichi formation of the upper Fredericksburg group, at the base to the Pawpaw formation of the middle Washita group at the top. Member 2 of Upper Albian, Cenomanian, and Lower Turonian age, he correlates with strata from the Main Street formation of the Washita group to the Lower Eagle Ford formation of the Gulf Series, including the Woodbine sand. Member 3, the highest, he correlates with the upper part of the Eagle Ford formation. Two species of Exogyra were reported: E. pleza Cragin from Member 1 and E. arietina Roemer var. Coahuilaensis Jones from Member 2.

Geologic Observations at Locality Where the Fossils Were Collected

Collection 53-K-20 was made at the southeast end of a small outlying area of limestone hills, about one quarter mile square, having a relief of some 50 feet. It is bordered on the southwest by a much larger area of volcanic deposits into which the limestone hills merge and on the other three sides by alluvium of the valley floor. That the limestone hills were formerly covered by volcanics is suggested by the fact that the contiguous volcanic hills rise to a higher elevation than the limestone hills.

The limestone is well stratified in beds varying up to several feet in thickness. At the northwest side of the outlying hills the beds on a dip slope strike northeast and dip at $25^\circ$ to the northwest. The limestone is light gray with thin ferruginous layers and ferruginous nodules distributed irregularly in it. On the southeast side of the hills, where the fossils were found, the limestone is yellowish gray, hard and brittle. It weathers reddish and yellowish gray with exogyras projecting abundantly from its surface. The beds here strike northeast and dip at $30^\circ$ to the southeast. The dip in opposite directions on the two sides indicates that the limestone hills comprising this small outlier are anticlinal.

Fossils in these outlying hills were, with one exception, found only at the one locality on a low ridge at the southeast side. The
importance of the fossils in determining the age of the outlying limestone hills, and therefore for the interpretation of structure, was recognized and a careful search of every outcropping layer made. The only other fossil found was a single specimen of *Alectryonia* in a limestone layer on the east side of the same ridge, but evidently from a somewhat lower stratigraphic level.

The fossils of Collection 53-K-20 at planetable station 105 were weathering out of the limestone and scattered over the surface. The conspicuous element of the fauna was the large exogyras, most of which were fragments. Smaller exogyras were better preserved and more abundant but difficult to break out of the hard rock. Therefore most of the collection was made from the float on, and in the immediate vicinity of, the small outcrop of the fossiliferous layer. Besides the exogyras, only half a dozen other forms were found, and some of these were discovered later in the limestone matrix when the specimens were being studied under a microscope in the laboratory.

With the exception of the exogyras the specimens are poorly preserved. The two gastropods are fragmentary casts. The single brachiopod has the original shell material preserved but most of the pedical valve is missing. The fragments of *Pecten* have the shell badly weathered. The two specimens of *Inoceramus* are pieces of valves, one of which has the shell material deeply weathered and the other is a mold of the exterior. The three fragmentary specimens of *Plicatula* are single valves with the shell badly pitted by weathering. The ostreidae have the original shell material and are in a much better state of preservation. However, the poorly preserved specimens associated with the ostreidae proved to be the more important for determining the stratigraphic position of the assemblage.

**Geologic Relations to the Villareal Uplift**

The Villareal uplift is a dome on the western side of the Sierra de Tlahualilo anticline, about 28 miles north of the south end of the range (Fig. 1). The dome extends about six miles in its north-south diameter, from the Gonzalez Basin on the north to the Guayule Embayment on the south. The gentler north flank is nearly twice as long as the south flank so that the apex is about 4 miles from the syncline on the north and 2 miles from the syncline on the south. On the east the Villareal Uplift merges with the major northward trending anticline of the range. Its western flank is cut by a normal fault which
begins here and extends northward along the front of the Sierra de Tlahualilo.

The surface expression of the uplift is developed principally in the middle member of the Aurora limestone, with a thickness of 1,040 feet along Cañón Guayule. The upper member, about 420 feet thick in the same section, is present in the synclines in three widely separated areas on the north, on the southeast, and on the west.

The outlier, from which the small collection of fossils described in this paper was derived, lies on the south flank of the Villareal Uplift. A fault separates it from the nearby outcrops of the Middle Aurora limestone. This outlier and several smaller limestone hills are somewhat farther isolated from the extensive outcrops of the Upper member of the Aurora exposed in the Guayule Embayment.

Lithologically the limestones of the outlier resemble some of those in the Upper Aurora member. Their geographic position on the south flank between areas of outcrop of the Upper Aurora on the southeast and on the west flanks of the Uplift suggest this stratigraphic correlation. The outlier had been so mapped until the fossils occurring there, described in the present report, proved to belong to the overlying Indigalura formation. The Upper Aurora member is therefore absent from this part of the south flank. Evidently it has been dropped beneath the surface of the ground by the fault that separates the outlier from the main range. The fault that brings the Indituda formation down next to the middle member of the Aurora limestone therefore has a displacement of more than 400 feet.

A belt of Tertiary volcanics west and south of the limestone outlier forms low rugged hills connected with it. The volcanics are erosion remnants of a once widespread deposit of tuffs and lavas laid down on the eroded surfaces of Cretaceous rocks. Small patches of the volcanics are preserved today in the topographic and structural re-entrants of the western flank of the Sierra de Tlahualilo.

**Correlation**

The stratigraphic range of species related to those identified at locality 53-K-20 is shown in Table I and Fig. 2. They range from Upper Aptian to the Middle Turonian. Only one specimen, however, *Kingena wacoensis*, ranges as low as the Aptian. Three others, *Pecten indiduraense*, *Gryphaea washtaensis*, and *Plicatula subgurgitis*, range as low as the Middle Albian (Fredericksburg); they range as
high as the mid-Turonian (Eagle Ford). One species, *Exogyra whitneyi*, ranges from the Upper Albian into the Lower Cenomanian. Another, *Exogyra clarki*, is known only from the Buda Limestone (Lower Cenomanian). Two species, *Exogyra acroumbonata* and *Exogyra columbella*, range from the Cenomanian into the Turonian.

### TABLE I

**GEOLOGIC RANGE OF FOSSILS RELATED TO SPECIES DETERMINED FROM LOCALITY 53-K-20**

<table>
<thead>
<tr>
<th>Species at Locality 53-K-20</th>
<th>Nearest Allied Species</th>
<th>Occurrence of Allied Species in Texas and Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Kingena wacoensis</em> (Roemer)</td>
<td><em>K. wacoensis</em> (Roemer)</td>
<td>Common in Washita Division, rare in Fredericksburg and Trinity divisions in Texas. Widespread in <em>Gryphaea mucronata</em> zone in Sierra de Tlahualilo, Coahuila</td>
</tr>
<tr>
<td><em>Pecten indiduraensis</em> Jones <em>Gryphaea washitaensis</em> Hill</td>
<td><em>P. indiduraensis</em> Jones <em>G. washitaensis</em> Hill</td>
<td>Members 1, 2, &amp; 3 of Indidura fm. Kiamichi to Main St. fms. in Texas; Members 2 &amp; 3 of Indidura fm.; Subdivisions 5 &amp; 6 Cerro de Muleros, Chihuahua</td>
</tr>
<tr>
<td><em>Exogyra acroumbonata</em> Kauffman <em>E. acroumbonata</em> Kauffman</td>
<td>Woodbine and Eagle Ford Buda Ls. in Texas</td>
<td></td>
</tr>
<tr>
<td><em>E. columbella Meek</em> <em>E. clarki</em> Shattuck</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>E. tlahualiloensis</em> Kellum &amp; Shubak <em>E. suborbiculata</em> Lamarck, Stanton</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>E. extenda</em> Kellum &amp; <em>E. whitneyi</em> Böse</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>E. robusta</em> Kellum &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Plicatula subgurigitis</em> Böse <em>P. subgurigitis</em> Böse</td>
<td>Graneros Shale (Colorado)</td>
<td></td>
</tr>
<tr>
<td>Subdivisions 7 &amp; 8, Cerro de Muleros Chih. (= Main Street and Grayson in Texas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Members 1, 2, &amp; 3 Indidura Fm.; Subdivisions 2, 5, &amp; 6, Middle &amp; Upper Albian, Cerro de Muleros, Chihuahua Denton fm., Texas</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trigonarca sp. cf. T. depressa</em> (White) <em>T. depressa</em> (White)</td>
<td>Colorado fauna in N. M. Pugnellus Sandstone</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 2. Stratigraphic range of species collected at locality 53-K-20.
Two other species, *Trigonarca depressa* and *Exogyra suborbiculata*, are known only from the Turonian.

Since only four long-ranging species and one other of more limited known range extend below the Cenomanian, all the species range into the Cenomanian, two have a range from mid-Cenomanian into mid-Turonian, and two are limited to the mid-Turonian, the weight of the paleontologic evidence is that the fauna from locality 53-K-20 is of Cenomanian age. In the Sierra de Tlahualilo the upper part of the Aurora Limestone has been correlated (Kellum, 1956, p. 215) with the Georgetown limestone (Upper Albian) of Texas. The lower part of the overlying Indidura formation is at least as low as the Del Rio Clay (Lower Cenomanian) and its upper part as high as the Eagle Ford (Upper Cenomanian and Turonian) of Texas.

In the type area of the Indidura formation (Sierra de Santa Ana) it ranges from the Middle Albian to the top of the Turonian. Its middle member ranges from the Upper Albian through the Cenomanian and into the lower Turonian. The limestones which contain the fossils at locality 53-K-20 are therefore correlated with the middle member of the Indidura formation in the type area.

**Habitat**

In his study of the Indidura fauna of Sierra de Santa Ana and Sierra de la Peña Jones (1938) inferred, primarily on the basis of lithology, a moderately shallow marine environment for the rocks of Member 2. Conditions before and after deposition of Member 2 were characterized by quiet water; accumulation of calcareous mud and organic material rendered the sediments black in color.

The lithology of the strata at locality 53-K-20 is quite different from that of the Indidura formation in the type area. The absence of clastics indicates deposition in clear water. Some idea of the ecology may be obtained from an analysis of published data on the fossil and living genera related to the genera of our faunule. The genera *Ostrea*, *Gryphaea*, and *Exogyra* have long been considered valid criteria for shallow water deposition (Jourdy, 1924; Böse and Cavins, 1927, p. 48, 73; Imlay, 1957, p. 494; Bergquist and Cobban, 1957, pp. 872–871) and although commonly associated together *Gryphaea* and *Exogyra* are usually considered to inhabit more saline and deeper waters than the thick-shelled *Ostrea* (Bergquist and Cobban, 1957, p. 872). Jourdy concludes a shallow marine environment for *Exogyra*
with agitated waters and either muddy or sandy bottoms or near colonies of corals or rudistids. Stephenson (1933) believes the sediments of the *E. cancellata* belt, extending from the northern end of the Atlantic Coastal Plain to the Gulf region, were laid down on a continental shelf in water ranging in depth from 15 to less than 100 fathoms. Rudistids associated with the fauna are believed to indicate a tropical climate.

Individuals of *Gryphaea* and *Exogyra* collected at locality 53-K-20 occur for the most part as unpaired valves. However, a number of specimens are paired, and therefore transportation over any appreciable distance seems unlikely. Both genera are abundant and their association appears to be a natural one.

The genus *Trigonarca* is represented by only a single individual, but its presence is significant in the light of the work of Reinhart (1943) on the Mesozoic and Cenozoic Arcidae from the Pacific Slope of North America. Reinhart concludes that since most of the living arcidae are strictly marine, confined to tropical and temperate seas, inhabit the littoral and sublittoral zones and the shallower part of the neritic zone, the environment of the fossil arcidae could be expected to be similar. *Trigonarca* was the only representative of the family during the Cretaceous from Reinhart’s collection.

*Pecten* is one of the few pelecypods that are found in rudistid reefs (Bergquist and Cobban, 1957). Matthews (1951) reports such an association of single valves in two rudistid reefs in the Lower Cretaceous Edwards limestone. It is assumed that the Pectens were washed into the reef after death. Deposition took place in warm, clear, shallow water (10–20 fathoms) of normal salinity.

It would seem probable then that the Indidura formation at locality 53-K-20 was deposited in warm, shallow (15–100 fathoms) marine water of normal salinity. The water was clear and therefore represents offshore conditions.

**SYSTEMATIC PALEONTOLOGY**

**BRACHIAPODA**

Genus KINGENA Davidson

*Kingena wacoensis* (Roemer)

(Pl. III, Fig. 1)

*Diagnosis.*—This species is represented in the collection by one highly weathered specimen.
Shell of medium size and average thickness, subcircular in outline, lenticular in profile; shell weathered, exposing punctations of inner layer; brachial valve has low convexity; most of pedicle valve missing.

**Dimensions.**—Length 20 mm., width 20 mm., thickness of brachial valve 4 mm.

**Hypotype.**—UMMP 33168.

**Occurrence.**—Common throughout the Washita division, and rare in the Fredericksburg and Trinity divisions in Texas; widespread in the *Gryphaea mucronata* zone in the Sierra de Tlahualilo.

**PELECYPoda**

Genus *PLICATULA* Lamarck

*Plicatula subgurgitis* Böse

(Pl. I, Fig. 16)


**Diagnosis.**—Three fragmentary valves are in Collection 53-K-20.

Specimens badly weathered but show the bifurcating radiating costae. The growth lines, as noted by Böse (1910, p. 100), have developed irregular granulations of the costae and, in our specimens, weathering has further emphasized these, giving the costae a beaded character.

**Dimensions.**—UMMP 42324: length 7 mm., width 5 mm.

**Catalogue number.**—UMMP 42324.

**Occurrence.**—Denton formation, Texas; Cerro de Muleros, Chihuahua; Subdivisions 2, 5, 6, Middle and Upper Albian, Members 1, 2, 3, Indidura formation, Coahuila.

Genus *INOCERAMUS* Sowerby

*Inoceramus* spp.

(Pl. I, Fig. 14; Pl. III, Figs. 2, 4)

**Description.**—Two very small specimens and one fragment of a larger form, found at locality 53-K-20, clearly belong to three separate species.

UMMP 42323 is the mold of an interior. It is oval in outline, broadly rounded at the ventral margin, and tapering symmetrically to a narrowly rounded dorsal margin; beak elevated and bluntly pointed on mold. Dimensions: Length 8 mm., width 6 mm., height 1 mm.

UMMP 42322 is the cast of an exterior natural mold. It is rounded in outline; concentric undulations irregular, coarser toward the margins, faint toward the umbo; disk elevated near the umbo, flattening toward the margins. Dimensions: Length 3.2 mm., width 2.2 mm., height 0.6 mm.

UMMP 42327 is a small fragment of the cast, near the marginal area, of a fairly large specimen characterized by coarse undulations.
Genus EXOGYRA Say

Exogyra tlahualiloensis Kellum and Shubak n. sp.

(Pl. II, Figs. 2, 3; Pl. III, Fig. 8; Pl. IV, Figs. 1-3)

Description.—Based on four lower valves from locality 53-K-20.

Shell medium to large, ovate in outline, moderately thick in umboonal region, thinner at margins; steeply convex, subtriangular in transverse section (anterior-posterior at the middle of valve); beak conspicuously recurved; prominent angular umboonal ridge curving back from beak over middle of valve and disappearing on the ventral slope; surface covered with rough, lamellose growth lines, also a rugose area on the posterodorsal slope behind beak on the holotype. Interior smooth, deep; hinge narrow, ligamental groove moderately impressed, narrow groove below and posterior to ligamental groove expands to form broadly flattened free margin; semi-circular, impressed adductor scar on the steep posterior slope. Upper valve unknown.

Dimensions of Holotype 42297.—Length 102 mm., breadth 81 mm., convexity 45 mm.

Remarks.—This species differs from Exogyra clarki Shattuck in the absence of radial ribbing and its higher more prominent umboonal ridge. It differs from Exogyra drakei Cragin in its larger size, less strong concentric ornamentation, and absence of extensive radial plications.

Holotype.—UMMP 42297; Hypotypes 42303, 42304, 42305.

Exogyra acroumbonata Kauffman n. sp. in press

(Pl. I, Figs. 1, 2, 8, 9)

Diagnosis.—The description is based on one specimen from the Indidura formation, Sierra de Tlahualilo, Coahuila.

Shell small, thin, outline ovoid; lower valve triangular, beak narrow, laterally recurved, prominent umboonal ridge following spiral of shell from beak across middle of shell to posteroventral margin; posterodorsal part of shell concave, expanding ventrally and becoming convex; shell smooth except for growth lines. Upper valve not visible on our specimen.

Dimensions.—Length 5.5 mm., breadth 5 mm., convexity 2.5 mm.

Remarks.—The specimen agrees well with Kauffman’s species aside from being slightly smaller. Kauffman’s holotype is figured (Pl. I, Figs. 1, 8) for comparison.

Hypotype.—UMMP 42295.

Occurrence.—Indidura formation, Sierra de Tlahualilo, Coahuila; Graneros shale of the Western Interior.

Exogyra columbella Meek

(Pl. I, Figs. 3-7, 10-12, 22, 23)

1876. Exogyra columbella Meek, in Macomb, Rept. Expl. Exped. Santa Fe, N. Mex., to junction of Grand and Green rivers, p. 124, pl. 1, figs. 3a–d.
Exogyras from the Indidura Formation


**Diagnosis.**—Six of these small exogyras were found at locality 53-K-20, Indidura formation, Sierra de Tlahualilo, Coahuila.

Shell small to medium, rather thin−shelled for the genus, outline subcircular with prominent beak; lower valve moderately to steeply convex, beak recurved in plane parallel to posterior slope; umbonal ridge broad and poorly developed; surface with fine costae radiating from the umbonal ridge, or smooth except for growth lines. Upper valve not visible on our specimens although some of the free flat valves may belong to this species.

**Dimensions.**—UMMP 42291, length 22 mm., breadth 19 mm., convexity 13 mm., UMMP 42292, length 18.5 mm., breadth 16 mm., convexity 9 mm., UMMP 42326, length 14.5 mm., breadth 13 mm., convexity 4.5 mm., UMMP 42294, length 12.5 mm., breadth 10.5 mm., convexity 6 mm.

**Remarks.**—The specimens from our locality resemble most closely the cotype figured by Meek (1876, pl. I, fig. 3a) showing well−developed costae and a rather prominent umbonal ridge of the lower valve. Our specimens are somewhat more convex than indicated by the side view figured by Meek (1876, pl. I, fig. 3c).

**Hypotypes.**—UMMP 42291−42294, 42301, 42302, 42311, 42325, 42326.

**Occurrence.**—Woodbine formation, Tarrant, Denton, Grayson, and Lamar counties, Texas; in Western Interior, beds of Graneros (Cenomanian) and Benton (Turonian) age; Indidura formation, Coahuila, Mexico.

**Exogyra extend**a Kellum and Shubak n. sp.

(Pl. I, Figs. 18−21, 24, 25, 27−29)

**Description.**—This is the most common species in our Collection 53-K-20.

Shell small to medium thin; subovate in outline; lower valve very convex, with broadly rounded umbonal ridge, extending from the beak to ventral margin. Some specimens are nearly symmetrical, sloping equally anteriorly and posteriorly from the umbonal ridge, others tend to be somewhat asymmetrical with the posterior slope steeper than the anterior. This variation may be emphasized by the state of preservation as the margins flare broadly, are thin, and are broken in most specimens. No posterior or anterior furrows present; beak
small, narrow, distinctly coiled posteriorly at tip; surface smooth except for growth lines, radial costae about umbo present in a few specimens.

Upper valve slightly smaller than lower, undulating, outline subovate, umbo small and spirally coiled; surface marked by fine rather regularly spaced growth lines.

*Dimensions.*—UMMP 42289, length 31 mm., breadth 32 mm., convexity 15 mm.; UMMP 42309, length 35 mm., breadth 38 mm., convexity 20 mm.; UMMP 42310, length 45 mm., breadth 40 mm., convexity 21 mm.

*Remarks.*—This species resembles both *Exogyra suborbiculata* Lamarck and *E. haarmanni* Bose but differs in position of rounded umbo. In *E. suborbiculata* and *E. haarmanni* the crest is nearer the anterior margin rather than the posterior as in ours. Our species also lacks the posterior furrow characteristic of *E. suborbiculata*.

*Holotype.*—UMMP 42290.

*Hypotypes.*—UMMP 36816, 36817, 42289, 42309, 42310.

*Exogyra robusta* Kellum and Shubak n. sp.

(Pl. II, Figs. 1, 4; Pl. III, Fig. 11)

*Description.*—Based on one lower valve from locality 53-K-20.

Shell large, massive, elongate ovate in outline, extremely thick-shelled but thinning somewhat toward margins so that at most places the margin is broken. Valve convex, broadly rounded with anterior and posterior slopes nearly vertical; beak recurved, coiling partially concealed by excessive deposition of shell material over it. Surface marked by thin-edged concentric imbrications; roughly radiating nodes on umbonal region may be the result of weathering; interior smooth and shallow. Upper valve unknown.

*Dimensions of incomplete specimen.*—Length 109 mm., breadth 67 mm., convexity 54 mm.

*Remarks.*—This species differs from *Exogyra whitneyi* Bose in the absence of an excavated area beneath the beak and its less prominent, more compactly recurved beak, and from *E. fervax* Cragin in its more shallow depth of the upper valve interior and in the lesser degree of beak coiling.

*Holotype.*—UMMP 42296.

*Exogyra?* sp.

(Pl. III, Fig. 3)

*Description.*—A fragment of a valve with an unusual structure and type of preservation seems worthy of record. It is part of the beak area of a large flat specimen, but the beak itself is missing.

Shell moderately thick, made up of thin layers varying in texture and color. Surface sculpture of deeply weathered concentric imbrications around an asymmetrical, U-shaped, channeled attachment scar. There are three layers of dense, light gray calcite alternating with thinly laminated, dark gray layers. The light gray layers, although dense, have a transverse fibrous structure on which the
surface sculpture is developed. One layer forms the outer surface of the shell near the attachment scar. Beyond it one of the inner layers of dense gray calcite becomes the outer surface as the intervening darker laminated layer lenses out. The imbrications of the surface sculpture are diagonally transverse to the inner surface of the layer and to the outer surface of the shell. The fibrous structure of the imbrications is perpendicular to their surfaces. In plan the concentric imbrications coalesce to form a smaller number as they approach the hinge line. The surface imbrications are of irregular relief and are pitted and furrowed by solution.

_Hypotype.—_UMMP 42329.

**Genus GRYPHAEA Lamarck**

_Gryphaea washtensis_ Hill

(Pl. V, Figs. 1-5, 8, 9)


_Diagnosis._—Shell variable in size and shape, medium to small, thin to moderately robust; outline ovate; lower valve moderately convex, triangular wing on posterior margin present on some specimens, fragile and broken off of many specimens; usually separated from rest of shell by a shallow radial sulcus extending from near the beak to the posteroventral margin; beak broad and rounded, commonly obscured by flattened attachment scar; surface marked by fine to coarse concentric growth lines and lamellae; upper valve somewhat smaller than lower, circular in outline, flat but often depressed below umbo; surface marked by concentric growth lines.

_Dimensions._—UMMP 42299, length 35.5 mm., breadth 32 mm., height 12 mm.; UMMP 42312, length 37 mm., breadth 33 mm., height 14.5 mm.; UMMP
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42298, length 31 mm., breadth 30 mm., height 12.5 mm.; UMMP 42300, length 12 mm., breadth 11.5 mm., height 5.5 mm.

_Hypotypes._—UMMP 42298–42300, 42312, 42343, 42344.

_Occurrence._—Indidura formation, Coahuila; Cerro de Muleros, Chihuahua, Subdivisions 5 and 6, Upper Albian; Kiamichi to Main Street formations, Texas.

_Remarks._—As stated by Hill and Vaughan (1898, p. 62) "This species presents an enormous amount of variation. In some the lateral wings are very much developed; in other specimens they are but slightly developed...." The specimens from our locality are poorly preserved. The shell appears to be somewhat heavier and darker in color than specimens from elsewhere in the Sierra de Tlahualilo, the Sierra de Santa Ana and Sierra de la Peña described by Jones (1938, p. 107).

Specimens 42343 and 42344 are the more typical development of _Gryphaea washtoaensis_. Specimen 42300 is close to the variety _kellumi_ Jones. Specimens 42298, 42299, and 42312 are extremes of variation within the species and approach the end form of _G. corrugata_ Say, which, as pointed out by Hill and Vaughan (1898, p. 62), is gradational with _G. washtoaensis_.

Genus PECTEN Muller

_Pecten_ spp.

_(Pl. I, Figs. 13, 15, 17)_

_Diagnosis._—Four coarsely ribbed fragments of _Pecten_ in Collection 53-K-20 are too poorly preserved for specific identification. The beak and hinge areas are missing in all of them. The ribs are slightly wider than the interspaces; both narrow toward the beak.

A plasteline impression of one specimen, an interior of nearly half the valve, shows the tops of the ribs broadly rounded with vertical sides and the bottoms of the interspaces flat. Another specimen has somewhat narrower interspaces which are rounded at the bottom.

_Catalogue number._—UMMP 33148, 36813, 36814, and 36815.

Genus TRIGONARCA Conrad

_Trigonarca_ sp. cf. _T. depressa_ (White)

_(Pl. III, Fig. 5)_

1876. _Idonearca depressa_ White, U.S. Geog. and Geol. Surv. West 100th Meridian, 4: 183, pl. 18, figs. 13a and b.

1893. _Trigonarca depressa_ (White), Stanton, U.S. Geol. Surv. Bull., 106: 93, pl. 19, fig. 2


_Diagnosis._—One rather well-preserved right valve was discovered in the matrix in the course of examining other specimens of the fauna under a binocu-
lar microscope. Its hinge area and interior are concealed, but the recrystallized shell material preserves in detail the shape and exterior sculpture of the valve.

Shell small, gibbous, irregularly trapezoidal to subovate in marginal outline; posterior half of the basal margin broadly arcuate, rounding anteriorly upward, and sharply rounding posteriorly to meet the posterior margin at the posterior radial angulation of the disk. Anterior margin regularly rounded up to the hinge line; posterior margin nearly straight, extending obliquely downward and backward, nearly equal in length to half the height of the shell. The posterior radial angulation is very pronounced on the lower third of the disk but disappears before reaching the middle and is not present in the umbonal region. The umbone, situated just anterior to the center of length of the shell, is gibbous and meets the hinge line at a right angle, extending horizontally from there nearly to the maximum depth of the valve, arching gently to that point which is above the middle of the disk.

Surface marked by 20 flat radiating ribs of nearly equal width, and narrow, sharply impressed interspaces between them; ribs largest near the posterior angulation, becoming obsolete anteriorly and posteriorly on the steep slopes near the margins.

**Dimensions (of single valve).—**Length 4.0 mm., height 3.0 mm., depth 1.2 mm.

**Catalogue number.—**UMMP 42313.

GASTROPODA

Genus TYLOSTOMA Sharpe 1849

*Tylostoma* sp.

(Pl. III, Figs. 6, 7, 9, 10)

**Description.—**Two internal molds are referred to this species. Each consists of the body whorl and the preceding one.

Shell elongate, medium to large, whorls convex, the body whorl constitutes most of the bulk; sutures deeply impressed on internal molds; varices indicated by faint to pronounced grooves in which the transverse edge of shell material is seen in the mold; aperture elongate lunate.

**Dimensions.**—UMMP 32622, height of two anterior whorls 55 mm., breadth of body whorl 33 mm., height of aperture 21 mm.; UMMP 42328, height of two anterior whorls 48 mm., breadth of body whorl 32 mm., height of aperture 25 mm., breadth of aperture 11 mm.

**Hypotypes.**—UMMP 32622 and 42328.

**BIBLIOGRAPHY**


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Exogyras from the Indidura Formation


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Figs. 1 and 8. Exterior and posterior views of left valve (X 2). Holotype UMMPP 42215 from the Graneros formation, Huerfano County, Colorado.

Figs. 2 and 9. Exterior and posterior views of left valve (X 3). Hypotype UMMPP 42295 from the Indidura formation, Sierra de Tlahualilo, Coahuila.

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Fig. 3. Exterior of left valve (X 1). Hypotype UMMPP 42292 showing costae radiating from umbal dome depth of valve and the recurved beak.

Fig. 4. Exterior of left valve (X 1). Hypotype UMMPP 42291, showing symmetrical, smooth variety.

Fig. 5. Interior of right valve (X 1). Hypotype UMMPP 42301, showing slight extension on posterior side.

Fig. 6. Exterior of left valve (X 1). Hypotype UMMPP 42293, showing radial costae.

Fig. 7. Interior of right valve (X 1). Hypotype UMMPP 42302 showing concentric undulations and posterior extension.

Fig. 10. Posterior view of left valve, same specimen as Fig. 3 (X 1), showing recurved beak and depth of valve.

Fig. 11. Posterior view of left valve, same specimen as Fig. 4 (X 1), showing recurved beak and depth of valve.

Fig. 12. Posterior view of left valve, same specimen as Fig. 6 (X 1), showing recurved beak and depth of valve.

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FIG. 13. Interior of valve (× 1) Hypotype UMMP 33148, showing ribs wider than interspaces and both decreasing in width toward the umbo.

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FIG. 14. Cast of natural mold of exterior, (× 4), Hypotype UMMP 42322, showing rounded outline and concentric undulations.

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FIG. 17. Exterior of valve (× 1), Hypotype UMMP 36814, showing ribs and interspaces nearly equal over most of the disk.

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FIG. 18. Exterior of left valve (× 1), Holotype UMMP 42290, showing high beak, and symmetrical flare.

FIG. 19. Posterior of left valve (× 1), Hypotype UMMP 42289, showing recurved beak and depth of valve.

FIG. 20. Exterior of right valve (× 1), Holotype UMMP 42290, showing coil near umbo of right valve and radiating costae on umbo of left valve.

FIG. 21. Posterior of left valve (× 1), Holotype UMMP 42290, recurved beak and depth of valve.

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FIG. 22. Exterior of left valve (× 2), Hypotype UMMP 42294, variety with curved umbonal ridge, narrower umbo, and smooth shell.

FIG. 23. Exterior of left valve (× 2), Hypotype UMMP 42326, showing costae on anterior slope of a broader variety.

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FIG. 25. Dorsal view of left valve (× 1), same specimen as Fig. 24, showing deflection of the umbo.

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FIG. 26. Posterior view of left valve (× 1), Hypotype UMMP 42308, showing irregular, bulbous areas.

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FIG. 27. Exterior of left valve (× 1), Hypotype UMMP 42310, showing elevation of beak and flare of anterior and posterior slopes.

FIG. 28. Posterior view of left valve (× 1), same specimen as in Fig. 27, recurved beak and depth of valve.

FIG. 29. Dorsal view of left valve (× 1), same specimen as in Figs. 27 and 28, showing asymmetrical development of the umbo and disk.
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Fig. 6. Interior of left valve illustrated on Plate IV, Fig. 1, Hypotype UMMP 42303, showing hinge area and free anterior margin.

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Fig. 8. Exterior of left valve (× 2). Hypotype UMMP 42300, variant approaching *G. washitaensis* var. Kellumi Jones.