

Larger Invertebrate Fossils of the Woodbine Formation (Cenomanian) of Texas

By LLOYD WILLIAM STEPHENSON

With Decapod Crustaceans From the Woodbine Formation of Texas

By H. B. STENZEL

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LARGER INVERTEBRATE FOSSILS OF THE WOODBINE FORMATION (CENOMANIAN) OF TEXAS

By LLOYD WILLIAM STEPHENSON

ABSTRACT

Larger invertebrate fossils from 230 surface localities in the Woodbine formation of Texas are interpreted to indicate deposition in areas of nearshore shallow marine waters, which were at times locally converted into swamps where nonmarine organisms could live. The fauna includes 140 genera, with 281 species and varieties. Thirty-one of these genera are proposed as new, and newly described species and varieties number 230.

The basal unit of the Woodbine formation is the Dexter member which consists chiefly of nonmarine sands interbedded with clays, but it includes also important marine fossil-bearing zones in Tarrant and Denton Counties. The Dexter is overlain in different areas by the nearly contemporaneous nonmarine carbonaceous shales and tuffaceous sandstones of the Red Branch member and the marine shaly beds of the Euless member. These in turn are overlain by the marine sandy shales and sandstones of the Lewisville member, and these by the marine shales and minor sands of the Templeton member. The marine sediments are generally more or less calcareous.

The fauna of the Woodbine formation as a whole is compared with that of equivalents in other parts of the Coastal Plain and with the faunas of equivalents in other parts of the United States and in areas outside the United States. The fauna of each of the members of the Woodbine is listed and compared with that of the other members. The traditional assignment of the Woodbine formation to the early Late Cretaceous (Cenomanian) is accepted.

The fauna is distributed as follows: Spongiae, 2; Anthozoa, 1; Annelida, 1; Molluscoidea, 3; Pelecypoda, 135; Scaphopoda, 4; Gastropoda, 117; Cephalopoda, 16; Arthropoda, 3. Of these forms, 249 are named species, 17 are named varieties, and 15 are designated by letters. In addition, 63 forms are listed only by generic assignment. Two new subgeneric names are introduced.

The new generic names are: a sponge, *Spccus* (Clionidae); a bryozoan, *Graysonia* (Vinellidae); 14 pelecypods, *Panis*, *Phelopteria*, *Pollex*, *Dentonia*, *Sexta*, *Pharodina*, *Sinonia*, *Nelltia*, *Senis*, *Priscomactra*, *Aliomactra*, *Geltena*, *Opertochasma*, and *Terebrimya*; and 14 gastropods, *Ambrosia*, *Dathmila*, *Lirpsa*, *Craginia*, *Monroca*, *Macrocerithium*, *Levicerithium*, *Vascellum*, *Voysa*, *Hillites*, *Carota*, *Tovula*, *Fictouactcon*, and *Pirsila*; 1 decapod, *Woodbinax* Stenzel. The new subgenera include *Sanoarca*, a subgenus of *Breviarca*, and *Larma*, a subgenus of *Callistina*.

INTRODUCTION

The Woodbine formation of northeastern Texas has yielded a large invertebrate macrofauna, mainly Mollusca, but including also a few representatives of Porifera, Coelenterata, Annelida, Molluscoidea, and Arthropoda. Descriptions of a few of the species have appeared in previous publications, dating back as far as 1860, but about 88 percent of the species here described are new, and new names are given to about 12 percent of the recognized genera. The large percentage

of the fauna not heretofore recorded and the stratigraphic position of the fauna between the better known faunas of the Comanche series below (mainly Lower Cretaceous) and the Gulf series above (Upper Cretaceous) were the principal incentives for undertaking this study.

Most of the animal organisms whose remains have been recovered from the Woodbine formation were inhabitants of shallow marine waters. A few of them probably lived in the brackish waters of marginal estuaries and lagoons and a few, typified by *Unio* (a bivalve mollusk) and *Cyzicus?* (a small crustacean), lived in the fresh waters of coastal plain rivers or lakes.

The work of preparing and describing the Woodbine fauna was begun in December 1940. During the war years, December 1941 to August 1945, I gave as much time as possible to the study because of its bearing on the search for additional supplies of petroleum, but other official duties more directly connected with the war effort interfered considerably. From the close of the war until the spring of 1949 most of my time was given to the preparation of this paper. During these same postwar years W. H. Monroe, working chiefly in Denton County, and H. R. Bergquist, working in Cooke, Grayson, Fannin, Lamar, and Red River Counties, have given part time to mapping the Woodbine formation in detail and subdividing it into member units.

The earlier available collections of fossils from the Woodbine formation were made in the eighties and nineties of the last century by R. T. Hill, J. A. Taff, C. A. White, S. Leverett, W. F. Cummins, and Frank Burns. Authors who described fossils in these early collections from the Woodbine formation were B. F. Shumard, F. W. Cragin, and C. A. White. Since 1900, collections, in addition to those made by me (beginning in 1911), have been made by T. W. Stanton, J. B. Reeside, Jr., W. B. Sprague, H. S. Cave, C. H. Dane, W. P. Popenoe, R. T. Hazzard, B. W. Blanpied, W. C. Spooner, H. H. Gray, W. H. Monroe, and H. R. Bergquist.

Type specimens in the collections of the University of Texas and the Texas Bureau of Economic Geology have been placed at my disposal for description and illustration, through the courtesy of F. L. Whitney, E. H. Sellards, H. B. Stenzel, and J. T. Lonsdale. Several specimens from the Woodbine formation in Tar-

rant County, in the private collection of James P. Conlin, Fort Worth, Tex., were lent to me by Mr. Conlin, who also generously donated to the United States National Museum three specimens that have been made the holotypes of new species.

My first field work on the Woodbine formation of northeastern Texas was done during the early fall of 1911. T. W. Stanton of the United States Geological Survey accompanied me for about one week on this trip. Localities were examined in 1924, again in 1925, and in company with C. H. Dane in 1926. W. P. Popenoe was with me in the area for several weeks in 1927. Some work was done in 1928, and in March 1929 T. W. Stanton and J. B. Reeside, Jr., were with me on a trip from Texarkana along the belt of outcrop of the Woodbine and Eagle Ford formations to Austin. Several localities in Grayson County were visited in 1935, and several weeks were spent in the area in the spring of 1940 and again in 1941. Field studies were renewed in 1944, at which time during May and June, Henry H. Gray of the United States Geological Survey accompanied me as an assistant. Several weeks were spent in the area that year and in each of the two following years. During these periods I was joined in the field on several week ends by Roy T. Hazzard and B. W. Blanpied of the Gulf Refining Company and W. C. Spooner, consulting geologist, all of Shreveport, La. My association with these geologists was both informative and stimulating. Although their opinions and conclusions did not conform in all respects to mine, and to those of my associates, we all benefited from their friendly criticisms and frank discussions. We found that by examining the material facts on the ground, we were able to come to an agreement on some, though not all, of the subjects in dispute. Others who visited us for brief periods in the field were H. B. Stenzel, W. S. Adkins, the late Gayle Scott, S. A. Thompson, J. D. Moody, J. T. Rouse, A. M. Lloyd, and F. E. Lozo. To all of these contemporaries I am indebted for valuable information, opinions, and suggestions. C. L. Moody contributed a copy of a road map of Fannin and Lamar Counties that was very helpful at a time when no other reliable road map of these counties was available.

Grateful acknowledgment is made to my associates in the U. S. Geological Survey and the United States National Museum for assistance received in connection with the identification, taxonomy, and stratigraphic significance of the fossil organisms under study. Among the persons to whom I am thus indebted are J. B. Reeside, Jr., R. S. Bassler, H. A. Rehder, Julia A. Gardner, J. B. Knight, G. A. Cooper, H. E. Vokes, R. W. Brown, R. W. Imlay, R. B. Stewart, W. P. Woodring, and D. H. Dunkle.

I am indebted to many members of the Geological Survey staff for their skillful technical and editorial

assistance in the preparation of the text and illustrations.

HISTORICAL SKETCH

One of the early references, if not the earliest, to deposits belonging to the Woodbine formation is that of Francis Moore, Jr. (1859, p. 97), who mentions the occurrence of so-called Tertiary strata at the head of Chambers Creek in Johnson County. B. F. Shumard (1860a, pp. 582-590) recognized the Cretaceous age of these beds, but his treatment is confusing because he regarded his "Arenaceous Group" and "Marly Clay or Red River Group" as of Lower Cretaceous age, stratigraphically beneath the Comanche series which he assigned to the Upper Cretaceous, and he apparently included the Eagle Ford shale in Grayson County in his Arenaceous Group. The same year (1860b, pp. 590-610) he described Cretaceous fossils from Texas, some of which were from the Woodbine formation, and additional fossils from the same formation were described the following year (1861, pp. 188-205). Both papers lack illustrations, his type specimens are no longer available, and only a few of his specific names have been satisfactorily established. He acknowledged indebtedness to his brother, George G. Shumard, for the field data and the collections on which these papers were based.

Further confusion about the stratigraphic position of the Woodbine formation resulted from a paper by G. G. Shumard (1886, pp. 127-131), in which he described the "Tertiary System" of Grayson County. He divided the so-called system into an upper arenaceous group, a middle or green sandstone group, and a lower or gypseous clay group. The geographic positions assigned to these subdivisions in the northwestern, northern, and northeastern parts of the county identify them with the Woodbine formation, at least in part.

In the year after the appearance of G. G. Shumard's paper, Robert T. Hill published a paper (1887, pp. 291-303) that clarified the existing misunderstandings as to the stratigraphic position of the Woodbine formation, which at that time Hill designated the Timber Creek group. He showed that this unit overlies the Comanche series and is of early Gulf series age (=early Late Cretaceous as now used in the United States). The same year C. A. White (1887b, pp. 39-47) correlated the "Timber Creek Beds" at least in part with the Dakota group of the Western Interior.

An important contribution to knowledge of the "Red River series" (=Woodbine formation) was made by J. A. Taff in a paper published by the Texas Geological Survey (1893, pp. 284-298, geologic map). The areal distribution of the formation from McLennan County in the south to the eastern edge of Grayson County in the north is shown with generalized boundaries, and numerous sections are described in greater or less detail.

F. W. Cragin's well-known paper on the paleontology of the Cretaceous of Texas is also an important contribution (1893, pp. 139-294). Some of his Woodbine type specimens are available at Austin and in the United States National Museum at Washington, and a few have been illustrated; it has therefore been possible to preserve a considerable number of his specific names.

In a monographic treatment of the Cretaceous formations of the Black and Grand Prairie region published by the United States Geological Survey, Hill (1901, pp. 293-322) described and mapped the Woodbine formation in the fullest detail known to him at that time. It was here that he introduced the name Woodbine formation (to replace Timber Creek, preoccupied), derived from a small village in east-central Cooke County on the belt of outcrop of the Dexter member of the formation. Hill recognized a lower or Dexter member and an upper or Lewisville member of the formation. The name Dexter, derived from a small village in northeastern Cooke County, was introduced by Taff in 1893, and the name Lewisville, derived from the town of Lewisville in southeastern Denton County, was first used by Hill in 1901.

In the same volume, Hill quoted reports by F. H. Knowlton (1901, pp. 314-318) on a few fossil plants from Lamar, Cooke, and Grayson Counties. The Lamar County collection came from tuffaceous sandstone of the Lewisville member of the Woodbine formation at Arthurs Bluff on Red River; the collection from Cooke County came from near the village of Woodbine, probably from the Red Branch member of the formation; the stratigraphic position of the collection from Rhamey Hill near Denison, in Grayson County, probably is in the Dexter member. With additional collections from Arthurs Bluff at hand E. W. Berry later (1922, pp. 153-181) described the flora from that locality more fully.

With certain exceptions the classification used by Hill in 1901 has been followed by subsequent workers. Although Taff's classification was in essential agreement with that of Hill, he used a different nomenclature for the formation and its members. My associates Monroe and Bergquist and I have found it necessary to make some modifications in the Hill-Taff classification and to disagree with the interpretations of some subsequent workers on some points. A few pertinent examples may be mentioned.

A new unit, the Red Branch member, composed of more or less sandy, carbonaceous shales and tuffaceous sandstones, has been differentiated by Bergquist in Grayson County between the Dexter member below and the Lewisville member above.

Taff collected marine mollusks from dark shale, correlated by him with the Eagle Ford shale, from localities within 3 or 4 miles east of Whitesboro, Grayson County. These shales form part of the unit that we

now call Tempelton member of the Woodbine formation.

In Tarrant and Denton Counties several lenses or tongues of ferruginous sandstone carrying marine fossils have been found interstratified with the more typical sandstones and shales of the Dexter member. One of these is at the very base of the formation, resting disconformably upon the Grayson marl of the Comanche series. These lenses are treated as marine facies of the Dexter member which is predominantly of fresh-water origin or, possibly in part, of brackish-water origin.

In Tarrant County a shale unit containing interbedded ferruginous, fossiliferous layers, underlain by typical sandstones of the Dexter member and overlain by sandstones of the Lewisville member, is here classed as the Euless member of the Woodbine formation. The name Euless, derived from a small crossroads settlement on State Highway 183 in the eastern part of the county, has been used by R. T. Hazzard and his associates in a broader sense, as explained on a subsequent page.

In eastern Tarrant County the upper 18 feet of the Woodbine formation (upper part of Lewisville member as here interpreted) consists of more or less sandy and calcareous shale with interbedded calcareous sandstone lenses, carrying a large molluscan fauna. The late Gayle Scott included these beds in the Eagle Ford formation (1926b, pp. 617-619), as did also W. L. Moreman, who gave to them the name "Tarrant formation" (in Adkins, 1933, pp. 424, 425). Moreman correlated these beds with a basal flaggy member of the Eagle Ford formation in Bell County (1942, pp. 193, 196), but the "Tarrant" is older and stratigraphically lower than the beds in Bell County. Adkins accepted Moreman's interpretation, but later he stated orally that he no longer regarded the "Tarrant" as basal Eagle Ford. The "Tarrant" unit has yielded a large molluscan fauna, fully 50 percent of whose species are common to the typical Lewisville member of the Woodbine on Timber Creek in Denton County. A thin conglomerate composed mainly of dark, partly oxidized pebbles of siderite, but including also fish teeth and bones, at the base of the "Tarrant" unit is here considered to be only of local extent within the Lewisville member and not a basal conglomerate of the Eagle Ford shale. Because of the close faunal relationship, and also because of certain physical characteristics and relationships, the "Tarrant" unit is here included in the Lewisville member of the Woodbine formation.

In a recent paper (1946b, pp. 1764-1770) I described the occurrence of stringers of alunite nodules at the extreme top of the Woodbine formation, immediately below the basal bed of the Eagle Ford shale, at localities distributed along the line of the contact from Fannin County in the north, to Johnson County in the south, a

distance of 135 miles. The presence of these nodules serves as an important physical criterion in the recognition of this contact.

In the same year (1946, chart) Monroe discussed the correlation of the Woodbine formation with the lower part of the Tuscaloosa group of Alabama; he indicated the probable synchronicity of the Lewisville member of the Woodbine with the Eoline formation of the Tuscaloosa group.

A radical change in the classification of the early Upper Cretaceous deposits of the Gulf region was proposed by Hazzard, Blanpied, and Spooner in a recent paper (1947, pp. 472-481). They expand the application of the name Woodbine to include the original Woodbine and the Eagle Ford units of Hill and give to the Woodbine, as thus expanded, the rank of group. To many geologists a change of this sort is confusing and, if generally accepted, would call for frequent explanation of its new meaning. In several stratigraphic subsurface charts appearing in the volume cited, the Woodbine and Eagle Ford units are shown separately, apparently indicating that the two units are readily separable in the subsurface. The need for a group term to cover the two units would seem, therefore, to be questionable. But if really needed, a new name for the group would prevent confusion.

The Woodbine formation as originally defined is made up of deposits laid down in fresh, brackish, and very shallow marine waters; a large invertebrate macrofauna, numbering about 270 identifiable species, is carried by the marine facies of the formation. The formation intervenes between the deeper marine facies of the Comanche series below and the Eagle Ford and younger formations of the Gulf series above. It would seem therefore wholly appropriate to continue the use of the well-defined and well-understood name Woodbine, which has been the accepted designation for nearly half a century. It is significant that, with the possible exception of one or two species, none of the 270 odd Woodbine species is known to be present in the overlying Eagle Ford shale; and this statement applies equally to the shallow-water sand and shale facies into which the Eagle Ford shale passes laterally in Lamar and Red River Counties in the northeast.

Hazzard, Blanpied, and Spooner divide the original Woodbine unit into a lower Eules formation with a Dexter sand member and an upper Lewisville formation with a Pine Bluff member. As used in this paper, the so-called Pine Bluff member is a part of the Lewisville member, and the name Eules member is restricted to an upper shale unit between the Dexter member below and the Lewisville member above. The retention of the name Dexter for the lower unit seems desirable because that unit is predominantly composed of fresh-water sands and clays to which the name was originally applied. Eules is a settlement in Tarrant

County on the eastern edge of the belt of outcrop of the shale to which the name is applied.

The classification of the Woodbine formation recently adopted by Bergquist (1949, U. S. Geological Survey Oil and Gas Investigations, Preliminary Map 98) for Cooke, Grayson, Fannin, Lamar, and Red River Counties is accepted in this paper.

In "A Symposium for the 1951 Field Trip sponsored by the East Texas Geological Society" Adkins and Lozo (1951, pp. 105-164) present evidence that the Pepper shale (Adkins, 1933, pp. 417-422) represents the continuation of the Lewisville member of the Woodbine formation from McLennan County southward to and somewhat beyond Austin, Travis County.

WOODBINE FORMATION IN TEXAS

GENERAL FEATURES AND RELATIONS

The Woodbine formation, named for the village of Woodbine in Cooke County, is composed of sediments of fresh-water, brackish-water, and shallow-marine origin. The materials include shales, sandy shales, and fine to coarse sands and sandstones. Carbonaceous shales and thin beds of lignite are present in places. Tuffaceous sands and sandstones, characterized by differing contents of water-laid volcanic ejectamenta, make up important percentages of certain parts of the formation, as explained on following pages. Coarse gravels or conglomerates are present locally at the base of the formation, and thin beds of relatively fine gravel or conglomerate are in places intercalated among the sediments in higher parts of the formation. The sediments laid down in shallow marine waters are as a rule calcareous in greater or less degree, and some of them are glauconitic. The maximum thickness of the formation in the area of outcrop is estimated to be 290 to 300 feet.

In general, the sediments of the formation are characterized by an irregularity of bedding, which has made it difficult to subdivide the formation into members. Hill recognized two subunits, a lower or Dexter member and an upper or Lewisville member of the formation. Bergquist, in the northern counties, and Monroe, in Denton and Tarrant Counties (manuscript), have succeeded in dividing the formation into fairly well defined subunits. Bergquist's field studies in eastern Cooke, northern Grayson, and northwestern Fannin Counties have resulted in the recognition of four members, which he designates in ascending order, Dexter, Red Branch, Lewisville, and Templeton (1949, U. S. Geological Survey Oil and Gas Investigations, preliminary map 98). The accompanying map (pl. 1), adapted from the map prepared by Bergquist, shows Woodbine fossil localities in eastern Cooke, northern Grayson, and northwestern Fannin Counties, and the map (pl. 3) also prepared by Bergquist, shows the fossil localities, mainly in the Templeton member, in eastern

Fannin, northern Lamar, and northwestern Red River Counties. Monroe in Denton County, recognizes essentially the same sequence and, with the exception of the Red Branch, uses the same member names; instead of Red Branch, he uses the name Eules (restricted), which appears to be approximately, though not necessarily exactly, at the same stratigraphic position as the Red Branch. Accompanying maps show the position of fossil localities in Denton County (fig. 1) and in the Timber Creek area in the same County (fig. 2).

In Tarrant County the succession is Dexter, Eules (restricted), and Lewisville members; as here interpreted, the Templeton member is wanting in this county, having been removed by post-Woodbine erosion. Fossil localities in Tarrant County are shown on the map (pl. 2). The members of the Woodbine formation, though fairly well differentiated in Denton and Tarrant Counties, have not been traced and mapped in detail.

Less is known of the extension of the members south of Tarrant County, but the available information seems to indicate that the Dexter and Eules members pinch out southward against the eroded surface of the underlying Comanche series, and that the overlying Templeton member has been removed by erosion, leaving only beds of the Lewisville member to represent the Woodbine formation in southern Johnson, Hill, and McLennan Counties. In these counties the Eagle Ford shale rests directly on the Lewisville member. In the northeast, in Lamar and Red River Counties, the Woodbine formation is represented by tuffaceous sands and sandstones of the Lewisville member, which have yielded fossil leaves and a few invertebrate fossils, and by the Templeton member, which has yielded a large and representative fauna.

The accompanying chart shows the subdivisions of the Woodbine formation in the belt of outcrop in Texas, as here recognized.

Subdivisions of the Woodbine formation in central and northeastern Texas, as interpreted by Bergquist, Monroe, and Stephenson.

South							North
Woodbine formation		Hill County	Tarrant County	Denton County	Grayson and Fannin Counties	Lamar County	
		Wanting	Wanting	Wanting	Templeton member	Templeton member	Templeton member
		?	?	?			
		Lewisville member	Lewisville member	Lewisville member	Lewisville member	Lewisville member	
		?			?		
			Eules member (Shallow marine beds)	Eules member (Shallow marine beds; some fresh-water beds)	?	Red Branch member (Fresh- and brackish water sediments)	Undifferentiated beds of the Woodbine formation north of Red River in Oklahoma.
		Wanting	Dexter member (Fresh-water beds with interbedded marine tongues or lenses)	Dexter member (Fresh-water beds with interbedded marine tongues or lenses)		Dexter member (Fresh-water beds)	

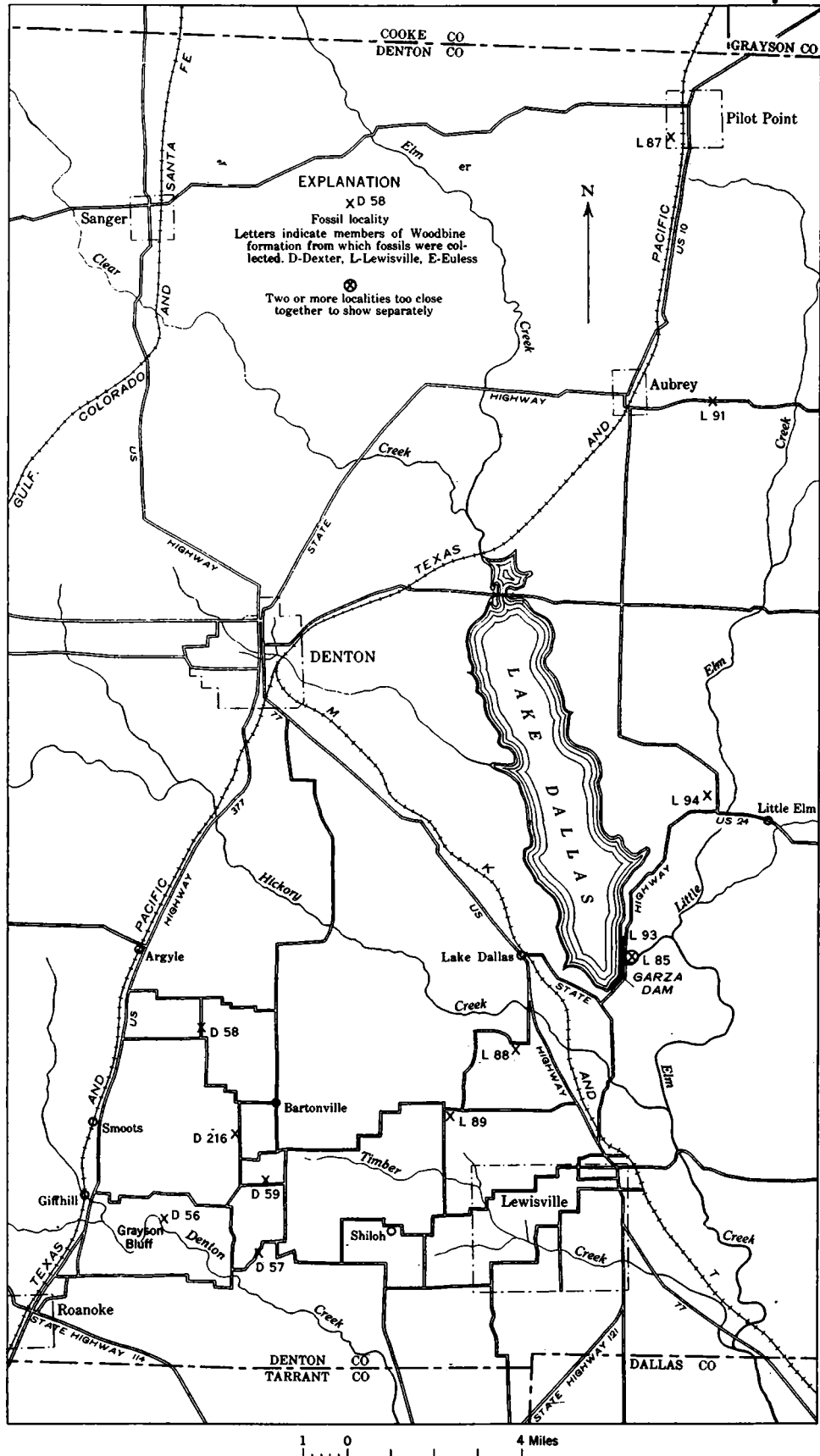


FIGURE 1.—Sketch map of part of Denton County, showing fossil localities in the Woodbine formation. The numbers are map reference numbers. Letters preceding the numbers indicate the member from which the collection was made: D=Dexter member; L=Lewisville member. Crosses in circles, as \otimes , indicate two or more localities too close together to show separately on the map.

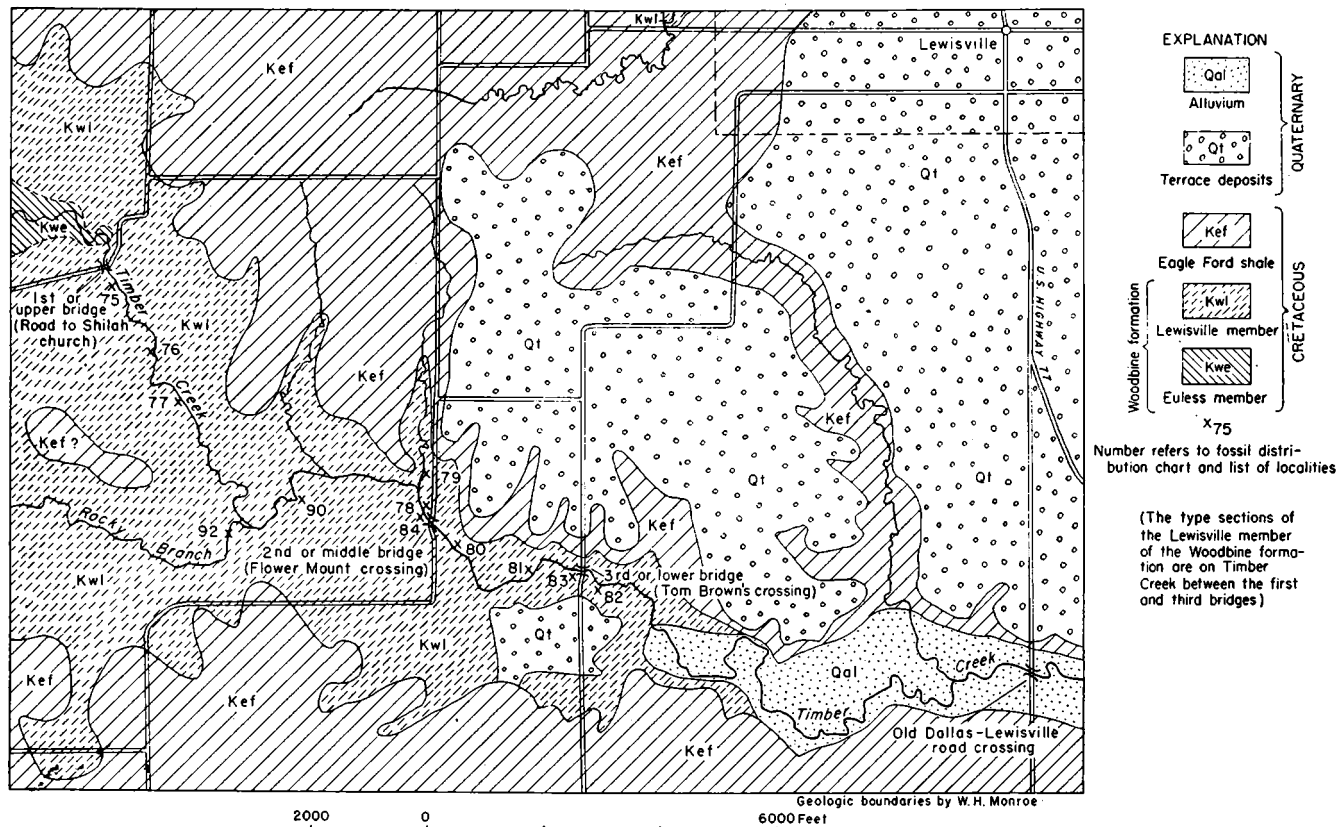


FIGURE 2.—Map of the Timber Creek area, Denton County. The map shows the places on Timber Creek at which the later collections of the United States Geological Survey were made from the Lewisville member of the Woodbine formation. Earlier collections were made on Timber Creek somewhere between the first and third bridges; at localities 61-64 and 66-74. All of these earlier collections came from the Lewisville member.

Throughout the length of the belt of outcrop of the Woodbine formation in Texas the formation rests upon beds referable to the Washita group of the Comanche series. At most places the Grayson marl lies immediately below the contact of this group, but at a few places several feet of limestone bearing characteristic fossils of the Buda limestone intervenes between the Grayson and the Woodbine. At most places where I have examined this contact the relationship appears to me to be that of unconformity. The contact between the calcareous marl of the Grayson or the Budalike limestone, as the case may be, and the overlying noncalcareous shale or sand of the Woodbine is generally sharp, and, locally, the basal bed of the Woodbine is conglomeratic. In places in Grayson County the relative thinness of the underlying Grayson marl indicates that the upper part of that formation was removed by erosion before the overlying Woodbine sediments were laid down, and at one place, near Cedar Mills in northwestern Grayson County, on the south flank of the Preston anticline, coarse basal conglomerate of the Woodbine fills an erosion channel that was cut completely through the Grayson marl into the upper part of the underlying Main Street limestone. The relationships at the Cedar Mills locality have been ably described by Bailey, Evans, and Adkins (1945, pp. 181-183), whose observations agree with my own in essential details. An accompanying

sketch (fig. 3) shows the unconformable relationship of the Main Street limestone and the Grayson marl to the overlying Dexter member of the Woodbine. Bergquist has studied a section near Cherry Mound in northeastern Grayson County, which appears to show a transition from the Grayson marl of the Washita group to the Dexter member of the Woodbine formation. Granting that it is transitional, the Cherry Mound section would be an exception to the otherwise nonconformable relationship of the Comanche series to the Woodbine formation. The beds that appear to be transitional consist of several feet of interbedded shale and sand containing a few arenaceous foraminifers like those found in the underlying uppermost beds of the Washita group. Immediately beneath the transition beds at the top of the Grayson marl is a bed of weathered claystone several feet thick which contains the following molluscan species believed to be of Buda (uppermost Washita) age: *Exogyra clarki* Shattuck, *E. whitneyi* Böse, *Lima wacoensis* Roemer?, *Pholadomya roemeri* Shattuck?, and *Homomya austinensis* Shattuck?.

The Woodbine formation is overlain in Texas by the Eagle Ford shale of the Gulf series. There has not been unanimous agreement as to the true position of the Woodbine-Eagle Ford contact in the section. According to my interpretation, the contact is marked at most places by a hard, irregularly bedded, platy, sandy lime-

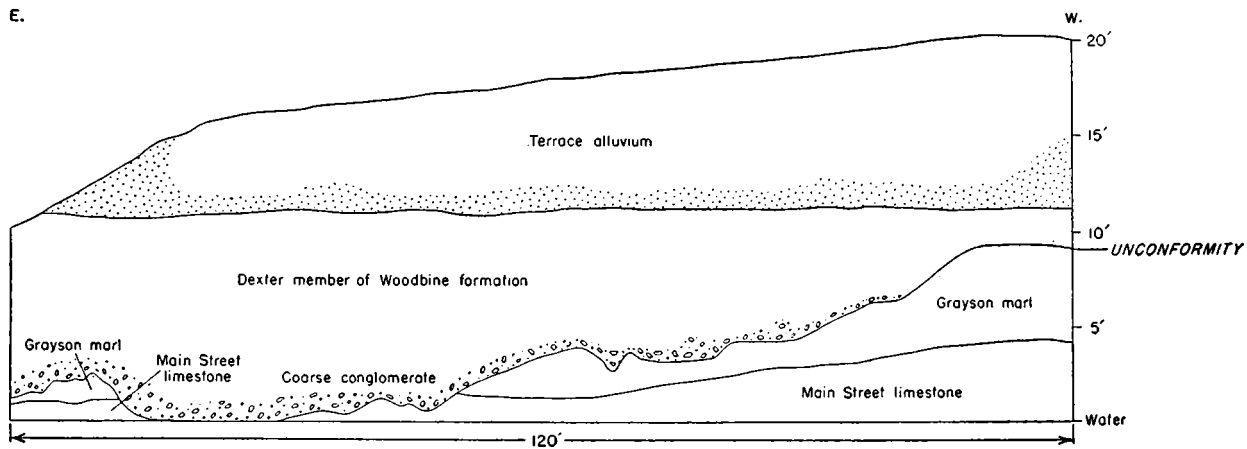


FIGURE 3.—Details of section on Sandy Creek, 0.3 mile northwest of Cedar Mills, in northwestern Grayson County (viewed from the north), showing pronounced unconformity between the Washita group (Comanche series) and the overlying Dexter member of the Woodbine formation. Main Street limestone; nodular fossiliferous limestone carrying *Exogyra arietina* Roemer, *Turritites brazaensis* Roemer, and other fossils. Grayson marl; gray marl with small calcareous concretions carrying *Exogyra arietina* Roemer and other fossils. Dexter member of Woodbine formation; gray compact sand and interbedded subordinate lenses of sandy clay, with an exceedingly irregular bed of coarse conglomerate along base; conglomerate is wanting but contact is sharp where it is at a high position at the right. Terrace alluvium (Pleistocene); unconsolidated ferruginous sand with a thin line of gravel along base.

stone ranging in thickness from 1 inch or less to 2 feet, which forms the basal bed of the Eagle Ford. At most of the localities examined this limestone is underlain by fine sand or shale of the Woodbine formation, in the upper 3 to 15 inches of which are stringers of alunite nodules (pl. 7 C, D). At a few places at which the limestone layer was wanting, the alunite stringers were present and proved useful in determining the position of the contact. (Stephenson, 1946b, pp. 1764-1770.) From northern Denton County northward to Grayson County, thence eastward to northeastern Lamar County, the Templeton member of the Woodbine immediately underlies the Eagle Ford shale. The relationship between the Templeton and the Eagle Ford is believed to be that of unconformity, though the time represented may be relatively short, and the thickness of sediments removed by erosion during the interval may be small. From Tarrant County southward sediments representing the Templeton member are wanting, presumably because of removal by erosion, and the Eagle Ford rests upon the Lewisville member of the Woodbine. In central Tarrant County, the Eagle Ford rests upon the subunit that Moreman called the Tarrant formation of the Eagle Ford group, but which is here included in the Lewisville member of the Woodbine.

Adkins has described an ammonite fauna in a so-called flag member (2 or 3 feet thick) at the base of the Eagle Ford shale in Bell County (1928, pp. 239-248), which includes species of *Turritites*, *Eucalycoceras*, *Mantelliceras*, and several species of *Acanthoceras*. This assemblage has been interpreted by Stanton, Reeside, Adkins, and others as an upper Cenomanian fauna having analogous species at the same stratigraphic position in Europe and other parts of the world. Moreman and Adkins correlated this flag member with a so-called Tarrant unit in Tarrant County (1933, pp. 400-439). The "Tarrant" is, however, stratigraphically lower,

forming the uppermost part of the Woodbine formation, as that formation is locally represented in that county, as that formation is locally represented in that county. The flag member is traceable northward from Bell County at the base of the Eagle Ford shale, having been recognized lithologically at that position at many places as far north as Lamar County; faunally it is represented at several places between Bell County and east central Tarrant County. The flag member in the north is everywhere thinner and less fossiliferous than it is in Bell County, and in places is absent as such, being represented by shale with usually a few interbedded platy calcareous sandstones.

The fauna of the flag member is well represented in sandy calcareous concretions at the base of the Eagle Ford shale, 2.5 miles north-northeast of Alverado, Johnson County (U.S.G.S. coll. 14583), where it includes such forms as *Acanthoceras bellense* Adkins, *Acanthoceras* aff. *A. turneri* Adkins, *Acanthoceras* aff. *A. stephensoni* Adkins, and *Mantelliceras* cf. *M. sellardsi* Adkins. Essentially the same fauna, but including also *Acanthoceras lonsdalei* Adkins, was collected by T. W. Stanton from calcareous sandstone concretions within 10 feet of the base of the Eagle Ford shale on Walnut Creek about 5 miles downstream from Mansfield, Tarrant County (U.S.G.S. coll. 11740). That the fauna of the flag member maintains its position at the base of the Eagle Ford shale at least as far north as east central Tarrant County is indicated by a few ammonite impressions found by Watson H. Monroe near Dorothy Siding on the Chicago, Rock Island and Pacific Railroad. These fossils appear to be the external molds of fragments of shells such as were referred to *Metacalycoceras* or *Eucalycoceras* by Adkins.

The presence of this upper Cenomanian fauna in the basal beds of the Eagle Ford shale from Bell County to Tarrant County, the stringers of alunite nodules in the uppermost beds of the Woodbine formation from

Johnson County to Fannin County, and a series of well-developed bentonite beds in the lower 30 or 40 feet of the Eagle Ford shale above the flag member nearly everywhere along the belt of outcrop are believed to afford satisfactory evidence that the basal beds of the Eagle Ford are essentially synchronous at the outcrop throughout their extent in northeastern Texas. C. S. Ross states (oral communication) that in his opinion the alunite nodules were formed under surface weathering conditions such as would have resulted from uplift and erosion following the deposition of the Woodbine formation.

DEXTER MEMBER

The name Dexter sands was first used by Taff (1893, pp. 285-298) for ferruginous sandstones exposed in the vicinity of Dexter, a small village in northeastern Cooke County. He excluded from the unit certain clays that Hill later included in the base of his Dexter member. As used by Bergquist and accepted in this paper, the so-called basal clays are considered to be a facies of the underlying Grayson marl and are excluded from the Dexter. Bergquist (1949, text) has also excluded certain higher beds that he has differentiated under the name Red Branch member.

The Dexter member in Cooke and Grayson Counties, as restricted and redefined by Bergquist, consists of a maximum of 120 to 140 feet of irregularly bedded non-calcareous sands, sandstones, and interbedded clays and shales. Many of the sandstones are thick bedded and friable. At many places both the sandstones and clays are characterized by an abundance of small limonitic grains probably derived by oxidation from grains of siderite evenly distributed through the rock, to which they give a speckled appearance. In general the sediments of this member are light in color, presenting gray, tan, and brownish tints. According to Bergquist, the upper 20 to 45 feet of the member, from northwestern Fannin County westward through Grayson County and southward in Cooke County to about the latitude of Collinsville, consists of light-colored silty gray to tan clays with mottled red bands (so-called rainbow clays) forming an easily recognized subunit. South of the latitude of Collinsville this varicolored band is not traceable as such. These sediments present no evidence of having originated in marine waters and are believed to have been deposited on the flood plains of streams flowing seaward across a coastal plain in early Upper Cretaceous time and in fresh-water lakes and lagoons on the coastal plain.

South of Grayson County, in Denton and Tarrant Counties, the nonmarine sediments of the Dexter are interbedded with shales and fossiliferous ferruginous sandstones of shallow marine origin; the latter are probably in the nature of relatively thin tongues extending shoreward from larger bodies of downdip marine sediments now covered by the overlap of

younger sediments. These interbedded marine and nonmarine beds constitute the lower part of the Eules formation of Hazzard, Blanpied, and Spooner (1947, pp. 472-481).

The interbedded marine facies are of particular interest in this paper because of the fossils which they carry. Places at which fossils have been obtained from these beds are mentioned below.

In the ditch of a north-south road on a northwesterly facing slope of Village Creek Valley, 2.4 miles (air line) southeast of Everman and 2.8 miles (air line) southwest of Kennedale, Tarrant County, a poorly exposed bed of ferruginous calcareous sandstone a foot or so thick, containing typical elongated shells of *Ostrea soleniscus* Meek and shells of *Brachidontes fillisculptus* (Cragin) (loc. 13¹), rests directly upon the Grayson marl of the Washita group. Inasmuch as *Ostrea soleniscus* is recorded from all of the three higher members of the Woodbine formation its presence at the base of the Dexter member indicates that it ranges throughout the formation.

Another place at which a fossiliferous marine bed of the member lies within 3 or 4 feet above Grayson marl is at a crossroad 1.5 miles northeast of Handley, Tarrant County. There a weathered fine red ferruginous sandstone a foot or so thick yielded a fairly large marine fauna in the form of prints (loc. 11).

A similar bed or orange, brown, and red ferruginous sandstone, packed with the prints of fossils, forms the bed of a small branch of Rush Creek near a dairy plant, 3 miles east by south of Handley, 1 mile south of the United States Highway 80, Tarrant County (loc. 14). The relation of this bed to the Grayson marl was not seen, but from its geographic and hypsographic position it must be low in the Dexter member and not far above the contact.

The section described below includes two fossiliferous beds that are estimated to lie 40 or 50 feet above the base of the member.

Section in the west-facing slope of Rush Creek Valley in a field north of an east-west road, 3.2 miles east-southeast of the center of Handley, Tarrant County

	Feet
Concealed by soil drift.....	9
Woodbine formation:	
Dexter member:	
Sandstone, ferruginous, weathered brown and red, with prints of fossils (loc. 16).....	½
Shale, light gray, with a thin platy sandstone about 3 feet above base.....	6½
Sandstone, fine, red, hematitic, with vast numbers of prints of <i>Caryocorbula? ovisana</i> , n. sp., and a few other species (loc. 15).....	½
Shale, gray, with a thin seam of lignite about 10 feet above base, poorly exposed.....	20
Sandstone, light gray, poorly exposed.....	10
Concealed to bed of Rush Creek.....	20
	66½

¹ Locality numbers are given on maps, on the chart of distribution (in pocket), and in the list of fossil collecting localities (pp. 35-44).

A bed of poorly exposed fossiliferous red ferruginous sandstone a foot or so thick caps a steep slope more than 100 feet high overlooking Denton Creek Valley, 3.7 miles northeast of Roanoke, Denton County. Fossils are abundant in the form of prints in the ferruginous sandstone which lies a few feet above the base of the Dexter member; individuals are abundant, but only a few species are represented (loc. 56). Below the fossiliferous sandstone are several feet of weathered yellowish sand, poorly exposed, that presumably makes up the actual base of the Dexter member. Below the Dexter in succession down the slope are: Buda limestone, about 1 foot; Grayson marl, about 80 feet; and Main Street limestone with *Evogyra arietina* Roemer.

Monroe has collected a few fossils in marine facies of the Dexter member at each of the following four localities in Denton County:

A 6-inch layer of ferruginous sandstone resting on Buda limestone and overlain by carbonaceous clay is exposed in a road 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville. The sandstone yielded a few imperfectly preserved pelecypods and gastropods, some of which show affinities with species in the Comanche series below and some with species in the higher members of the Woodbine formation above (loc. 57).

Limonitic concretions in plastic gray clay exposed about 0.2 mile north of a road corner, 2.4 miles southeast of Argyle, 2.4 miles northwest of Bartonville, 3.2 miles northeast of Smoots, yielded a few species of pelecypods and gastropods (loc. 58); Monroe estimates the stratigraphic position of this bed to be about 65 feet above the base of the member.

Small hematitic and limonitic concretions in the upper part of the member, 1.7 miles south by west of Bartonville, 4.1 miles east-southeast of Smoots, contained many imprints of mollusks representing only a few species (loc. 59).

Porous ferruginous sandstone near the top of the member, 1 mile southwest of Bartonville, yielded a meager fauna, which included the gastropod *Neritina* (*Velatella*) sp. (cf. *N. (V.) bellatula* Meek), the imprints of a crocodilian plate and teeth, and what may be a turtle plate (loc. 216, coll. 20042).

EULESS MEMBER

The name Euless was first proposed by Hazzard, Blanpied, and Spooner (1947, pp. 472-481; see discussion, p. 4 of this paper). As proposed, the name was given formation rank and included all the beds between the Comanche series below and the Lewisville formation above; the Dexter is treated as a member of the Euless. In the present paper the name Euless is given member

rank and is restricted to a shale unit, in part carbonaceous, with interbedded sandstone lenses, that form the upper part of the Euless formation of the authors cited. The member is typically exposed in the vicinity of Euless, Tarrant County, and is estimated to be 45 or 50 feet thick. As thus defined, the member has been recognized in Tarrant County as far north as the north-facing slope of Denton Creek Valley, north of Grapevine, and as far south as a point 2.4 miles west of Mansfield and 1.2 miles north of the Johnson County line. The member has yielded a fairly large marine fauna mainly from ferruginous sandstones interbedded with the shales. At one locality, 3.5 miles northwest of Grapevine, internal molds of fresh-water shells (*Unio*) were found weathered out on a slope, mixed with loose molds of marine mollusks; this locality is tentatively correlated with the Euless member (loc. 31).

Collections were made by Roy T. Hazzard and his associates from layers of yellow, brown, and red ferruginous sandstone, interbedded in shale, at four localities on State Highway 183 within 1.2 miles west-southwest of Euless (locs. 27-30).

The lower 10 feet of the member is exposed in a shallow cut on the Arlington-Grapevine highway, 1 mile west by south of Euless, 0.2 mile north of State Highway 183 (pl. 4D). The section here is as follows:

Section in cut of Arlington-Grapevine Highway, 1 mile west by south of Euless, Tarrant County

Woodbine formation:

	Feet
Euless member:	
Soil and subsoil, residual.....	2
Sandstone, soft, fine, stratified.....	2
Sand, soft, gray argillaceous.....	¼-½
Sandstone, hematitic and limonitic, very irregular, weathered reddish brown, medium- to coarse-grained, containing many prints of fossils (loc. 25).....	½-1
Clay, finely sandy, light gray, sticky.....	5
Sand and sandstone, thin-bedded, ferruginous, with an irregular base.....	½-1
Unconformity (?)	
Dexter member:	
Sandstone, fine, massive, sugary, light gray, with thin clay streaks in lower part.....	7
	18±

In a bluff on the right side of the first small branch east of Dorothy Siding (Chicago, Rock Island and Pacific Railroad) just south of the railroad, 25 feet of dark shale is exposed below a basal massive sandstone of the Lewisville member. A few poorly preserved specimens of *Ostrea soleniscus* Meek, *Brachidontes* sp., and *Caryocorbula? ovisana*, n. sp.?, were obtained in a layer 19 to 21 feet below the sandstone (loc. 26). This shale forms the upper part of the Euless member.

RED BRANCH MEMBER

Bergquist has recently differentiated a member unit between the Dexter member (restricted) below and the Lewisville member above, which he designates the Red Branch member. The following data are abstracted from his published account of the member (1949, text sheet). The name is derived from Red Branch, a small settlement in northwestern Grayson County about 11 miles north of Whitesboro, in the vicinity of which are typical exposures of this unit. The member consists of irregularly bedded carbonaceous shales and tuffaceous sandstones having a maximum thickness of 60 to 70 feet; lignite beds are present locally. Tuffaceous sandstone cropping out south and southeast of Dexter, Cooke County, belongs in this member. Bergquist has traced and mapped this unit from the northwestern part of Fannin County westward to the vicinity of Red Branch, thence southward into Denton County. The member has yielded a meager fauna at a few places. Some of the fossils are of fresh-water and others of brackish-water or shallow-marine origin. The fossils occur mainly in sideritic concretions and in ferruginous and carbonaceous shales and sandstones. Fossil leaves are present and are abundant in places in the lower beds of the member. The member appears to be a transition from the non-marine Dexter member below to the marine Lewisville member above. Hill included the beds of this member in part in the Dexter member and in part in the Lewisville member. The member occupies approximately the stratigraphic position of the Euless member in Tarrant County.

LEWISVILLE MEMBER

The name Lewisville was introduced by Hill (1901, p. 297) for the upper of the two members into which he divided the Woodbine formation. It is probable that his Lewisville unit included part of the Red Branch member and part of the Templeton member of Bergquist. Both Hill and Taff included part of the Templeton member in the Eagle Ford shale. The type area of the member, as designated by Hill, is Timber Creek from a point about 2 miles south of the center of Lewisville, Denton County, upstream to a point about 3 miles west by south of the center of Lewisville and no more than a mile above the crossing of the road to Shiloh Church. Hill's description of the member on Timber Creek is based mainly on data furnished by Taff. The beds of the member are exposed in the banks of this creek at many places throughout this stretch. The dip of the beds is only slightly greater than the stream gradient.

The member in its type area is composed mainly of irregularly bedded, medium-grained sands, sandstones,

and gray sandy shales, but includes minor components of lignite and carbonaceous sandstones and shales. Some of the sandstones and sands are slightly tuffaceous, and some are glauconitic. The bedding may be massive, lenticular, or laminated. The fresh materials range in color through dark-, light-, and bluish- or greenish-gray, but when exposed they are usually weathered to yellowish, brownish, and reddish tints, owing to the oxidation of iron-bearing minerals. The unweathered sandstones are as a rule calcareous and glauconitic in greater or less degree, and fossils, chiefly mollusks, are of common occurrence. Locally some beds and lenses are abundantly fossiliferous, and reefs of oyster shells, mainly of *Ostrea soleniscus* Meek, are conspicuous, in places reaching thicknesses of 6 or 7 feet. Figure 2, page 7, is a sketch map of the Timber Creek area showing the fossil localities whose exact positions along the creek are known. The localities of many of the older collections are inadequately described and could not be indicated on the map. In the Timber Creek area the thickness of the Lewisville member is estimated to be 35 or 40 feet. Within the limits of the map the general eastward dip of the beds corresponds rather closely to the gradient of the stream.

The exposed sections at which fossils have been collected along Timber Creek are all relatively low, none of them showing the full thickness of the member. Descriptions of several of the more important fossil localities are given below.

Large masses of gray sandstone are exposed in the bed and banks of Timber Creek below the bridge of the Shiloh Church road (first bridge), 3 miles west by south of Lewisville (pl. 5B). Collections were made from abundantly fossiliferous lenses of sandstone on top of larger unfossiliferous masses in the creek bed about 100 yards downstream from the bridge (loc. 75).

Rocky Branch joins Timber Creek from the west about a mile downstream from the first bridge. On the branch about 500 feet upstream from the junction, specimens of *Acanthoceras tarrantense nitidum* Stephenson and *A. wintoni* Adkins, were collected from calcareous sandstone in the bank of the branch (loc. 92). These ammonites are believed to have an important bearing on the correlation of the so-called Tarrant formation of Moreman with the typical Lewisville on Timber Creek.

A small branch from the north joins Timber Creek about 600 feet upstream from the second or middle bridge (Flower Mount Crossing), and about 200 feet upstream from the junction an oyster reef closely associated with a ledge of sandstone of the Lewisville member forms a low waterfall in the branch. Good collections of pelecypods and gastropods were obtained here (loc. 79), (pl. 5A). Some of the older collections

labeled as coming from Timber Creek may have come from this locality.

Within 100 feet upstream from the second, or middle bridge, the following section is exposed in the right bank:

Section on Timber Creek within 100 feet upstream from the second bridge (Flower Mount Crossing)

(Altitude at top of section about 507 feet)

Woodbine formation:	
Lewisville member:	Feet
Reef of <i>Ostrea soleniscus</i> Meek in a sandy matrix-----	4
Sandstone, irregularly bedded, fossiliferous (loc. 78)-----	1
Sandstone and sand, irregularly bedded, fossiliferous, indurated above, soft below-----	2-3
Shale, gray-----	¼
Sandstone, soft, yellow-----	1½
Shale, compact, gray-----	1¼
Sandstone, soft, yellow-----	1¼
Shale, gray-----	2

	14±

About 0.25 mile upstream from the third or lower bridge (Tom Brown's Crossing), a 1.5-foot bed of prolifically fossiliferous calcareous, in part nodular, in part platy, more or less conglomeratic sandstone is exposed in the bed of the creek (loc. 81). This fossil-bearing sandstone is overlain at one place by a poorly exposed reef of *Ostrea soleniscus* Meek about 3 feet thick. The fossil-bearing sandstone is limited upstream at this immediate locality by a fault of several feet displacement, but in a bluff on the upthrown side of the fault, about 400 feet farther upstream, the sandstone lies about 13 feet above the stream bed.

Downstream from the third, or lower bridge, the following section is exposed in the right bank of the creek.

Section in right bank of Timber Creek 400 feet downstream from the third, or lower bridge (Tom Brown's Crossing)

Woodbine formation:	
Lewisville member:	Feet
Sandstone, gray-----	3
Sand, fine, greenish gray to yellowish-----	8
Clay, sandy, dark, laminated, weathered-----	7
Reef of <i>Ostrea soleniscus</i> Meek, soft, crumbly, with a matrix of clay, sand, and marl (loc. 82)-----	7

	25

The Lewisville member has the greatest geographic extent of any of the members of the Woodbine formation in the belt of outcrop. As heretofore recognized it appears at the surface in a relatively narrow belt from McLennan County, Texas, near Bosqueville west of Waco, northward to Grayson County, thence east-

ward down Red River Valley, where it is partly in Texas and partly in Oklahoma, thence eastward into Arkansas as far as the valley of the Little Missouri River. South of Denton County the member maintains a thickness of 35 or 40 feet as far as the Tarrant Station area in Tarrant County. The member continues at about the same thickness into Hill County, has been definitely identified at old Bosqueville, about 6 miles northwest of Waco, McLennan County (pl. 4A), and, according to Adkins and Lozo (1951, pp. 105-164), the member is represented by the Pepper shale from McLennan County southward to and somewhat beyond Austin in Travis County. The Pepper shale is described as a black noncalcareous, noncarbonaceous shale decreasing in thickness from 55 feet in McLennan County to 25 feet at its type locality in Bell County, to less than 4 feet at Austin in Travis County, beyond which it has not been recognized either at the surface or in wells. The shale has yielded a few poorly preserved pelecypods, gastropods, and ammonites, and a few underdeveloped arenaceous foraminifers, none of which afford positive evidence of the age of the shale. (See Adkins, 1933, pp. 419, 420.)

Section on Keyes Branch near old Bosqueville, 6 miles northwest of Waco, McLennan County

Woodbine formation:	
Lewisville member:	Feet
Sand and sandstone, brownish irregularly bedded, and some layers of clay; the lower 1 foot is conglomeratic, including hematitic pebbles derived from concretions of iron carbonate, limestone pebbles, and fragments of oyster shells; the sandstone contains a few poorly preserved shells of <i>Ostrea soleniscus</i> Meek (loc. 1)-----	3
Unconformity:	
Buda limestone:	
Limestone, hard, gray, massive, spotted with red; containing a few poorly preserved fossils of Buda aspect, including: <i>Idonearca?</i> sp., <i>Pteria?</i> sp., <i>Trigonia</i> sp., <i>Protocardia</i> sp., <i>Callistina?</i> sp., and <i>Mactra?</i> sp. (loc. 1)-----	2
Limestone, interbedded with nodular, light-gray calcareous clay, and marl, with a few fossils of Buda aspect-----	3

	8

At locality 1 *Ostrea soleniscus* Meek appears to have been inadvertently included with the Buda fossils.

Northward from Denton County the Lewisville member increases in thickness to 90 or 95 feet in northwestern Grayson County, thence thins again to 70 or 80 feet in eastern Grayson County and thins further in western Fannin County. In Lamar and Red River Counties the alluvium and terrace deposits of Red River Valley cover the member, except at a few places in the banks and bluffs of the river and on slopes where

the surficial deposits have been removed by erosion, and the thickness of the member has not been determined. In Arkansas the member probably becomes thicker again, but there it has not been differentiated from the Woodbine formation as a whole, which has a reported maximum thickness of 350 feet. The Lewisville member is certainly represented in the tuffaceous portion of the formation in Arkansas.

In Lamar and Red River Counties, Texas, and in Oklahoma and Arkansas the member differs markedly in lithologic character from that of the typical beds on Timber Creek in Denton County, in that water-laid volcanic ejectamenta make up an important part of the sediments. Inasmuch as the amount and coarseness of the volcanic materials decrease westward and south-westward, becoming unimportant in southern Tarrant and Johnson Counties, it is assumed that their source was to the east in southwestern Arkansas. The diamond-bearing volcanic necks in the vicinity of Murfreesboro are the only obvious sources at present exposed at the surface. Other sources now concealed by younger Upper Cretaceous and Tertiary sediments may exist in the same general area. Conspicuous outcrops of tuffaceous sandstones of the formation are on the south side of Red River at Silver City, Rock Ferry, and Pine Bluff in northwestern Red River County, Golden Bluff and Arthurs Bluff in Lamar County, Hyatts Bluff in Fannin County, and Dugans Chapel in northeastern Grayson County. According to Bergquist, the tuffaceous sandstones are not restricted to a single zone in the member but are more or less lenticular and occupy different stratigraphic positions within the member. They are known to be fossiliferous at only a few places, one place in particular being the Dugans Chapel locality (loc. 122), where the tuffaceous sandstone forms the upper part of the member.

A few of the more important localities at which fossils have been obtained from the member are described on following pages.

Exposures of the Lewisville member along and near the Chicago, Rock Island & Pacific Railroad, 1 to 1.5 miles east of Tarrant Station, in the immediate vicinity of Dorothy Siding (pl. 4C), have been studied by several geologists. The conclusions reached by some of them in regard to the age and stratigraphic position of the beds making up the section have not coincided with my own in certain important respects. (See also pls. 4B and 5C).

Below is a composite section made up from exposures in railroad cuts at and near Dorothy Siding, in a borrow pit east of the siding and south of the railroad, in a road cut 1 mile north-northeast of Tarrant Station, along two small branches of the West Fork of Trinity River intersecting the railroad within 0.2 mile east of Dorothy

Siding, and in the vicinity of Eules; the beds dip gently to the east, the strata of the Woodbine formation passing under the Eagle Ford shale.

Composite section compiled from exposures 1 to 1.5 miles east of Tarrant Station at and near Dorothy Siding and Eules, Tarrant County

Eagle Ford shale:	Feet
Shales, dark, with interbedded thin sandy limestone layers (weathering out as platy fragments) and thin seams of bentonite; poorly exposed.....	20+
Limestone, sandy, thin, platy, poorly exposed in upper part of borrow pit south of the railroad.....	1±
Unconformity:	
Woodbine formation:	
Lewisville member:	
Shale, calcareous, greenish, yellowish, and brownish, more or less sandy, with interbedded discontinuous layers and lenses of platy calcareous sandstone and scattered calcareous concretions; most of the ammonites and other fossils from the vicinity of Dorothy Siding came from this zone (locs. 39, 41, 42, 44, 46, 50).....	18
Conglomerate and conglomeratic sandstone, hard, ferruginous, made up in part of dark phosphatic pebbles, water-worn siderite concretions, bone fragments, and shark teeth; this and the 18 feet of shale and sandstone above constitute the so-called Tarrant formation of Moreman.....	1/2-1/2
Local unconformity:	
Sand, gray, and massive calcareous sandstone, irregularly bedded; contains <i>Protarca? trami-tensis</i> (Cragin), <i>Ostrea soleniscus</i> Meek (locally forming reefs), and other fossils (loc. 45).....	20
Sand, coarse and coarse conglomerate, with pebbles mainly oxidized siderite, up to 3 or 4 inches in length.....	2
Unconformity (probably local):	
Eules member:	
Shale, gray, with subordinate sandstone and with thin zones of ferruginous fossiliferous sandstones in middle and lower parts (locs. 25 and 26).....	50±
Unconformity(?):	
Dexter member:	
Sandstone, light gray, sugary; exposed below Eules shale in north-south road cut 1 mile west by south of Eules (pl. 4D).....	7
	119

The stratigraphic relations of the formations exposed in the vicinity of and eastward from Dorothy Siding are shown in figure 4.

A spectacular display of oyster reefs of the Lewisville member is afforded by an exposure below the spillway of the Lake Dallas dam (Garza Dam) in the valley of Elm Fork of Trinity River, 5 miles north of Lewisville, Denton County (Pl. 6A, B.).

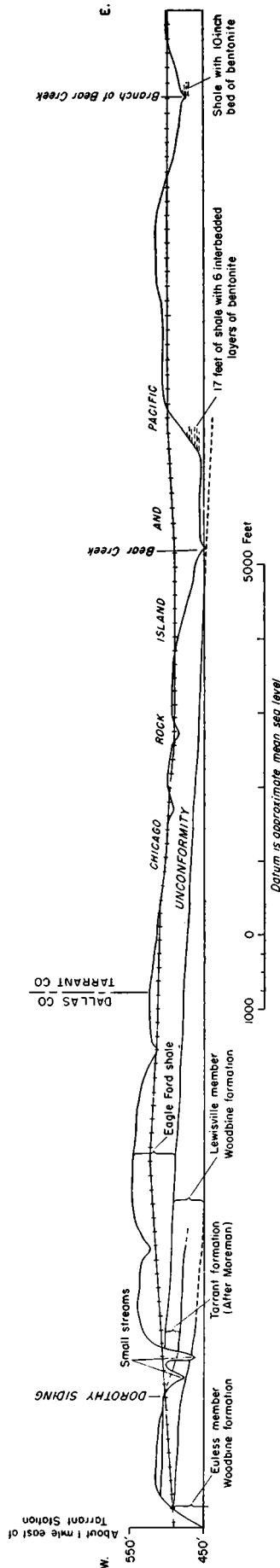


FIGURE 4.—Cross section showing the altitude and stratigraphic relations of the Eules and Lewisville members of the Woodbine formation and the overlying Eagle Ford shale from the vicinity of Dorothy Siding, Tarrant County, eastward into Dallas County, a total distance of about 4 miles.

Section below the spillway of Lake Dallas Dam, Denton County

Pleistocene terrace deposit:	Feet
Sand and gravel, brown-----	3½
Woodbine formation:	
Lewisville member:	
Shale, nonsandy, light gray-----	3
Shale, light gray with sandy streaks-----	5½
Sandstone, fine, soft, sugary, light gray, slightly glauconitic-----	3¾
Sandstone, gray, in hard and soft, fine to coarse interbedded layers, in places pebbly, in part slightly glauconitic, in part fossiliferous (mainly shells of <i>Ostrea soleniscus</i> Meek) and in part unfossiliferous. The abundant oyster shells range from single ones to solid masses 3 or 4 feet thick, the thickest beds being in the lower part of the member. The shells range in size from small round ones an inch or less in diameter to narrow, elongated ones fully 12 inches long; a few other species are associated with the oysters (loc. 85); the reefs are well exposed over an area of 150 square yards or more-----	15
Sandstone, red, ferruginous, somewhat conglomeratic, containing scattered flattish ovate concretions perforated by an undetermined species of boring mollusk; numerous borings that extend from the base of this layer down into the next layer to a maximum measured depth of 25 inches are filled with the red sandstone from above; a few molluscan fossils were obtained from this bed (loc. 93) and also the pavement teeth of the fish <i>Onchopristis</i> cf. <i>O. numidus</i> (Haug), identified by David H. Dunkle-----	1/6-1 1/8
Unconformity (?); contact irregularly undulating in minor detail.	
Eules (?) member:	
Sand, fine, light greenish-gray, somewhat argillaceous, slightly glauconitic-----	3
Sand, greenish gray, and gray laminated clay, thinly interbedded, more or less glauconitic, with scattered small siderite concretions, which in places form thin ferruginous layers; to water level-----	18½
	47 ±

An important, though very inconspicuous, fossil locality is on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County (pl. 7A). Fossils are abundant and well preserved in calcareous concretions in a layer about a foot thick at, and a few inches above, water level (loc. 184). The collections from this locality include 36 identified species, mainly of pelecypods and gastropods.

The richly tuffaceous sandstones, which make up a large percentage of the Lewisville member from Fannin County eastward through southeastern Oklahoma into Arkansas (pl. 6C, D), are as a rule not conspicuously fossiliferous, but at one locality in northeastern Grayson County the shells of mollusks are abundant in thick-bedded rock of this character in the upper part of the

member. The locality was brought to my attention by Roy T. Hazzard in 1944, and is adjacent to a small southwest-flowing branch 0.3 mile southeast of Dugans Chapel (now a private dwelling), 1.05 miles east and 0.2 mile south of Penland (Terrace Station), 8.2 miles southeast of the business center of Denison. Here masses of greenish-gray tuffaceous sandstone, partly exposed at the surface, have been quarried for local use, and fragments of the rock left scattered about made it possible to obtain a good representation of the fauna (loc. 122). Poor exposures along the bank of the branch indicate that the tuffaceous rock fills a channel cut to a depth of 7 or 8 feet in an underlying nontuffaceous, slightly glauconitic, nonfossiliferous sugary sandstone. *Breviarca (Sanoarca) grandis*, *Inoceramus prefragilis*, and *Cymbophora schucherti* are abundant at this locality. A short distance upstream from this locality tuffaceous sandstones underlie the sugary sandstone.

TEMPLETON MEMBER

The Templeton member of the Woodbine formation, a unit differentiated named (and mapped), by Harlan R. Bergquist (1949), is the uppermost member of the formation from central Denton County northward to Grayson County, thence eastward to eastern Lamar County. The name is derived from Templeton Branch of Cornelius Creek, along which stream typical exposures of the member occur north of Bells, Grayson County. The member consists mainly of gray shale with interbedded layers and lenses of fine sand and sandstone, in part glauconitic, having a total thickness along Templeton Branch of about 70 feet. Concretions, many of them with septarian structure, are common, and some of them are abundantly fossiliferous; especially prolific in fossils are concretions in sand 14 or 15 feet above the base of the member. The member probably does not exceed 80 feet in maximum thickness. At most of the localities examined (pl. 7C, D) stringers of alunite nodules are present in the uppermost foot or more of this member, just below its contact with the overlying Eagle Ford shale. The absence of the Templeton member from southern Denton County southward is interpreted to be due to removal by erosion.

Parts, perhaps all, of this member have been included by some authors in the Eagle Ford shale, but the fact that fully 40 percent of its 135 identified species are common to the underlying Lewisville member, whereas few if any of the species range upward into the overlying Eagle Ford shale, is considered satisfactory faunal evidence that the Templeton should be treated as a member unit of the Woodbine formation. Detailed descriptions of the type locality and a few other important localities are given below.

Bergquist has furnished the data on which the description of the member given below is based (1949, text sheet). Templeton Branch is a small south-flowing tributary of Cornelius Creek in eastern Grayson County, north of Bells. The type section is a composite of exposures along the branch.

Composite section of Templeton member compiled from exposures along Templeton Branch from a point 2.3 miles north by slightly west, upstream to a point 2.7 miles north by slightly east of Bells

Eagle Ford shale:	<i>Feet</i>
Shale.....	3+
Sandstone, flaggy.....	1
Woodbine formation:	
Templeton member:	
Sand, soft tan to buff, glauconitic, with a line of alunite nodules in upper two inches.....	14
Shale, smooth, gray.....	12
Sand, fine, gray, glauconitic, with "fucoidal" masses and a few shells of <i>Exogyra columbella</i> Meek	6
Shale, smooth to silty, with flattish ferruginous concretions; contains some poorly preserved mollusk shells.....	15±
Shale and sand, interlensed, with large fossiliferous septarian concretions (loc. 164).....	8-10
Shale, waxy, conchoidal.....	3½
	64±

The base of this section as exposed is estimated to be about 14 feet above the top of the Lewisville member.

A series of exposures of the Templeton member similar to those on Templeton Branch is afforded by bluffs on another branch of Cornelius Creek, centering about 3.3 miles N. 16° W. of the railroad intersection at Bells. Here the lower part of the member is seen to consist of 10 feet of greenish-gray shale underlain by 4 feet of tan tuffaceous clay, resting in turn on sandy shale and sandstone of the Lewisville member, the latter carrying abundant shells of *Ostrea soleniscus* Meek. A large collection of fossils (loc. 165) was obtained from calcareous concretionary masses in a sandy layer 14 or 15 feet above the base of the member.

The member, partly covered by soil drift, may be seen in a series of exposures in, and north and south of the old Sherman road, 2.8 to 3 miles east by south of the center of Whitesboro, Grayson County. The basal bed of the Eagle Ford shale appears in the road at the crest of the hill 3 miles from town, and the other parts of the section are exposed down slope in gullies south of the road and in a small branch north of the road leading from the gullies to a headwater branch of Mustang Creek, a few hundred feet to the north. The measurements and part of the detailed descriptions of this section were furnished by Bergquist.

Section in and near the old Sherman road, 2.8 to 3 miles east by south of the center of Whitesboro, Grayson County

Eagle Ford shale:	Feet
Sandstone, calcareous, platy, fine-grained, buff, with scattered streaks and nodules of alunite in some soft partings-----	1/3
Woodbine formation:	
Templeton member:	
Sand, soft, fine, buff to tan, with nodules and streaks of alunite in lower 6-inch interval----	5/6
Shale, gray, silty, with limonitic partings-----	1
Zone, partly covered, 3 or 4 feet of soft gray sand is exposed in a gully south of the road, about midway of this zone-----	34
Shale, smooth, gray, with sulfurous yellow and tan streaks along partings; ammonites and a few other fossils (loc. 154) were obtained in gullies south of road in a zone about 4 feet thick, about 25 feet above base; arenaceous Foraminifera, identified by E. R. Applin, were found in the shale north of the road-----	36
Shale, gray, smooth, in thin layers, alternating with thin layers of fine-grained soft buff sand; crystals of gypsum in upper part-----	10
Lewisville member:	
Sand, massive, fine, gray mottled yellow, tan, and dark gray, indurated in part to large concretions of calcareous, glauconitic sandstone attaining maximum dimensions of 4 by 7 by 10 feet-----	4

86±

The ammonite zone 25 to 29 feet above the base of the member is the type zone of the following species described by Cragin (1893): *Yoldia septariana* Cragin (p. 218), *Natica striaticostata* Cragin (p. 225), *Anchura modesta* Cragin (p. 218), *Hillites septarianus* (Cragin) (p. 230), "*Volutomorpha*" *graysonensis* (Cragin) (p. 224), and *Metengonoceras dumbli* (Cragin) (p. 243). J. A. Taff, who collected these fossils, mistakenly correlated the zone with the Eagle Ford shale. The exact locality at which he made the collection is not known, but it was possibly at, or certainly within less than a mile of the locality described above.

An abundantly fossiliferous locality, formerly well exposed at low-water stage along the south bank of Red River but now effectively concealed by the shifting alluvium of the river, is 2.8 miles by road east of Womacks Gin (= old Tinnin; called Slate Shoals on a recent army map), 8 miles east of Arthur City, Lamar County. My attention was called to this place by H. S. Cave in October 1924, and the exposure as it appeared in November of that year is shown in the accompanying photograph (pl. 7B). Red River in the vicinity of Womacks Gin and eastward, frequently shifts its channel and redistributes its flood plain deposits. Because of these changing conditions, I have not been able to determine the exact position in the river of the shoals which gave the name Slate Shoals to a stretch of the river and its bordering terrace flat

within 3 miles east of the gin. The fossiliferous rocks were exposed in an area about 1,000 feet long and 100 feet or more wide. The Cretaceous materials consisted of 4 or 5 feet of greenish, more or less sandy shale irregularly interbedded with lenses of fine gray calcareous sandstone and with reefs of *Ostrea soleniscus* Meek closely associated with the sandstone. These beds were overlain along the south bank of the river by about 20 feet of late Pleistocene terrace alluvium. The sandstones and shales yielded more than 50 species of mollusks (loc. 201). The locality was visited and collections made several times between 1924 and 1929, but in 1941 the fossiliferous beds were concealed beneath a blanket of Recent river alluvium supporting a thick growth of young willow trees. The active channel of the river had shifted to the east and north in its flood plain. The fossiliferous rocks at this locality are estimated to occupy a stratigraphic position 25 or 30 feet above the base of the member.

A section at the lower end of Golden Bluff on Red River, 3 miles east of Arthur City, shows the relation of the Templeton member to the tuffaceous sandstone forming the upper part of the underlying Lewisville member.

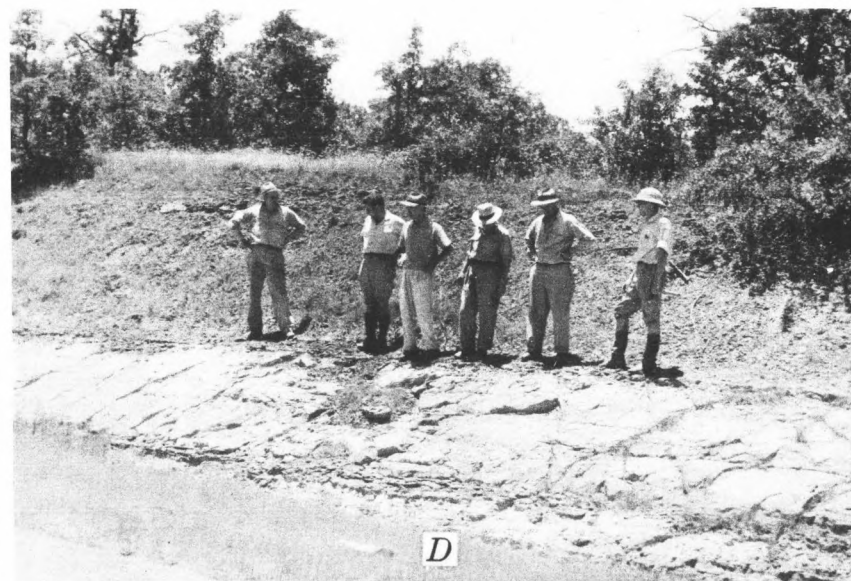
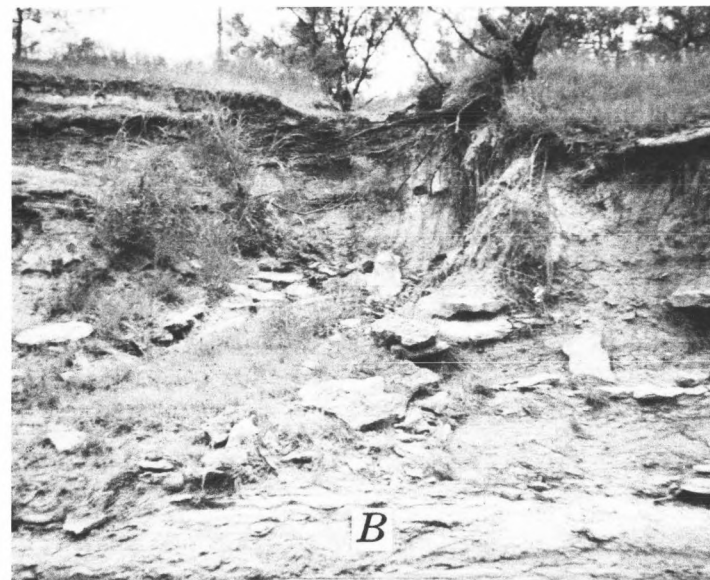
Section at lower end of Golden Bluff, Red River, 3 miles east of Arthur City, Lamar County

Pleistocene terrace deposit:	Feet
Sand, alluvial, poorly exposed-----	35
Woodbine formation:	
Templeton member:	
Shale, gray, more or less sandy crumbly, with comminuted plant fragments-----	25
Sandstone, soft to hard, fine glauconitic fossiliferous in places (loc. 203)-----	1/2
Shale, sandy, and interbedded fine sand, pebbly at base in places-----	30
Lewisville member:	
Sand and sandstone, coarse, irregularly bedded, tuffaceous, pebbly at base in places; a few leaf impressions observed near top at upstream end of bluff-----	15-18

108±

The beds rise upstream (westward) from the lower end of the bluff, and at one place 8 feet of harsh sandy clay, becoming shaly in lower part, was observed below the tuffaceous rock. The fossiliferous sandstone 30 feet above the base of the Templeton member appears to correspond approximately in stratigraphic position to the fossiliferous beds at the old Slate Shoals locality (loc. 201).

Nearly all the lower half of the member is exposed in a cut of State Farm Road 197, just east of Sanders Creek, 2.2 miles west of Arthur City, Lamar County. The section given below is a composite of beds seen in the cut and in a borrow pit (below road level) north of the road at west end of the cut.



VIEWS OF THE LEWISVILLE, DEXTER, AND EULESS MEMBERS OF THE WOODBINE FORMATION

A. Buda limestone overlain by Lewisville member of Woodbine formation (locality 1) in bed and bank of Keyes Branch near old Bosqueville, McLennan County. *J. B. Reeside, Jr.*, standing at contact. *B.* Shale and interbedded calcareous sandstone of the upper part of the Lewisville member (locality 55) in a small branch of Big Bear Creek near Eules, Tarrant County. Photo by James P. Conlin. *C.* Typical thick-bedded sandstone of the Lewisville member overlain by shale and interbedded sandstone (= Tarrant unit

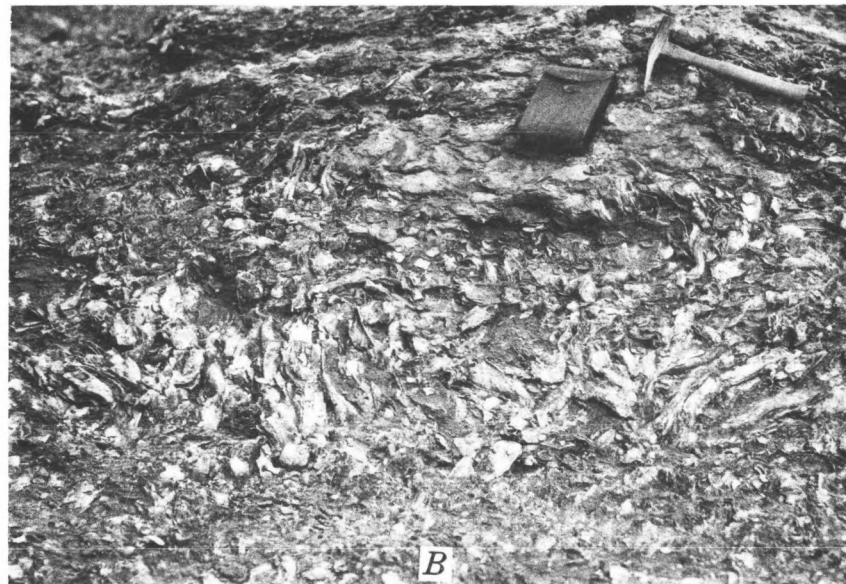
of Moreman) of the same member (locality 39) in cut of Chicago, Rock Island and Pacific Railroad at Dorothy Siding, Tarrant County. *D.* Light gray massive sandstone of the Dexter member overlain by shale of the Eules member (locality 25) in highway cut west of Eules, Tarrant County. Standing at contact, left to right, are *W. B. Blanpied, I. B. Hamilton, A. M. Lloyd, W. C. Spooner, R. T. Hazzard, and H. H. Gray.*



IEWS OF SANDSTONES OF THE LEWISVILLE MEMBER OF THE WOODBINE FORMATION

A, Fossiliferous sandstone of the Lewisville member (locality 79) in a small south-flowing branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton County. *B*, Sandstone of the Lewisville member, in part fossiliferous, in bed of Timber Creek (locality 75), 3 miles west by south of Lewisville, Denton County. *C*, Thick-bedded sandstone of the

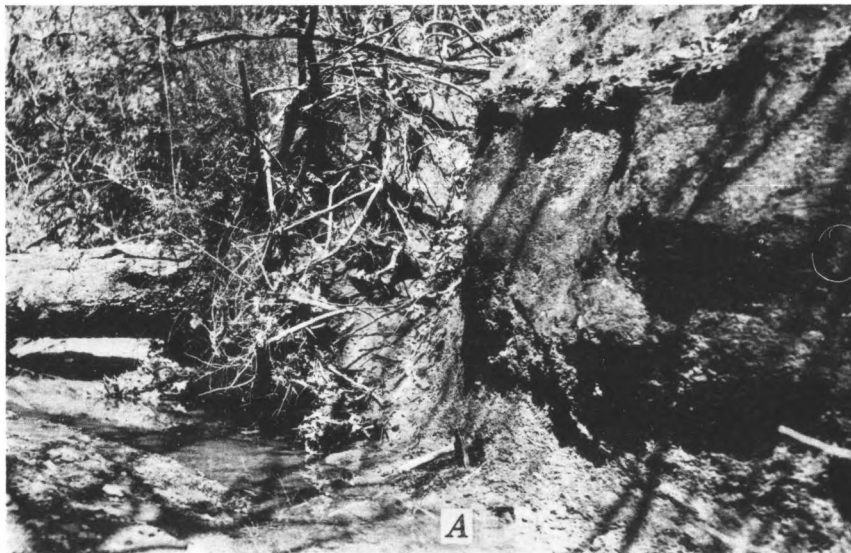
Lewisville member overlain by fossiliferous shale (locality 42) and interbedded sandstone beds in road cut northeast of Tarrant station, Tarrant County. *D*, Friable brown ferruginous sandstone of the Lewisville member in branch of Sandy Creek, north of Sadler, Grayson County; contains abundant prints of fossils (locality 132).



VIEWS OF OYSTER REEFS AND SANDSTONE OF THE LEWISVILLE MEMBER OF THE WOODBINE FORMATION

A, Sandstone and, in foreground, reefs of *Ostrea soleniscus* Meek of the Lewisville member (locality 85) below spillway at Lake Dallas Dam (Garza Dam), 5 miles north of Lewisville, Denton County. *B*, Detail of one of the oyster reefs shown in *A*: the elongation of the oyster shells in a crowded habitat is a conspicuous feature in the reefs in this locality. *C*, Tuffaceous sand, partly indurated to concretionary sandstone masses, of

the Lewisville member, near upstream end of Hyatts Bluff, Red River, 4.5 miles northwest of Ravenna, Fannin County. *D*, Prominent mass of tuffaceous sandstone underlain by dark gray shaly clay and gray calcareous sand (locality 179) of the Lewisville member, at the downstream end of Hyatts Bluff, Red River, 4.5 miles northwest of Ravenna, Fannin County.



VIEWS OF THE TEMPLETON AND LEWISVILLE MEMBERS OF THE WOODBINE FORMATION

A, Massive argillaceous, glauconitic sand of the Lewisville member, in right bank of Sheep Creek, northeast of Savoy, Fannin County: partly indurated calcareous concretionary masses at and a little above water level yielded a large fauna of well-preserved mollusks (locality 184). *B*, Fossiliferous fine gray sandstone and interbedded shale (locality 201) of the Templeton member in the bed of Red River, right side, near old Slate Shoals, Lamar County. This important fossil locality, well exposed from 1924-29, was later abandoned by the shifting river and was covered by alluvial sand; in 1941 the locality

was a flat plain supporting a thick growth of willows. *C*, A stringer of white alunite nodules in fine sand of the Templeton member, a few inches below a bed of hard irregularly bedded, platy calcareous sandstone forming the base of the Eagle Ford shale in a cut of U. S. Highway 82, 4 miles east by south of Whitesboro, Grayson County. *D*, Band of white alunite nodules in dark shale of the Templeton member, overlain by typical calcareous shale of the Eagle Ford shale, in a small branch of Little Elm Creek, about 0.02 mile east of north-south road, 3.65 miles north by east of Navo, Denton County.

Section in cut and borrow pit on State Farm Road 197, 2.2 miles west of Arthur City, Lamar County

Woodbine formation:

Templeton member:	Feet
Sand, weathered, ferruginous.....	3
Sandstone, calcareous, irregular masses, coarse with many casts of borings; contains many shells of <i>Ostrea soleniscus</i> Meek and <i>Cardium (Trachycardium) tinninense</i> , n. sp., and fewer shells of several other species (loc. 206).....	3
Shale, dark gray, more or less sandy, with streaks of platy sandstone and scattered small to large calcium carbonate concretions up to 2 feet in length; locality 231 is in shale 18 to 20 feet below top, and locality 207 is in concretions in the borrow pit less than 10 feet above base.....	34
	40

Bergquist estimates that the base of the preceding section is less than 10 feet above the top of the tuffaceous sandstone that forms the upper part of the Lewisville member. The sandstone is well exposed in a quarry and in the banks of Sanders Creek about half a mile northeast of the cut.

EQUIVALENTS OF THE WOODBINE FORMATION

OKLAHOMA AND ARKANSAS

South of the Preston anticline (Stephenson, 1918, pp. 159-161, pl. 17; Hopkins, Powers, and Robinson, 1922, pt. 2, pp. 7-9, pl. 1) the belt of outcrop of the Woodbine formation trends to the southeast through Grayson County into Fannin County, thence wraps around the southeastward plunging nose of the anticline, and passes to the northwest in the syncline, which borders the anticline on the north in Bryan and Marshall Counties, Oklahoma. From Bryan County the outcrop extends down Red River Valley in southeastern Oklahoma, includes small areas in northeastern Fannin County, northern Lamar and Red River Counties, Texas, and continues eastward through southeastern Oklahoma into Arkansas.

The Woodbine formation has not been subdivided into its members in either Oklahoma or Arkansas and, so far as I am aware, has not yielded invertebrate fossils in either State. Presumably all four members of the Woodbine are represented in the synclinal area north of the Preston anticline. Farther east the highly tuffaceous portion of the formation, which is interpreted to represent the Lewisville member, has been traced from northeastern Texas through southeastern Oklahoma into Arkansas. In northeastern Texas, the Austin chalk is represented by a sand and clay facies, which in Red River Valley transgresses upon and overlaps, first, the Eagle Ford shale and farther east, where it is known as the Tokio formation, probably overlaps the Templeton member of the Woodbine, leaving the

tuffaceous beds (Lewisville member) and a thick bed of basal gravel to represent the formation in Arkansas.

The only paleontologic evidence tending to confirm the synchronicity of the tuffaceous beds of the Woodbine formation in Arkansas with the Lewisville member is afforded by a small collection of fossil plants (12 species) made by H. D. Miser on Mine Creek, 3.5 miles north of Nashville, Howard County, Arkansas, and reported on by E. W. Berry (1917, pp. 167-190). These plants came from the upper part of the so-called lower Bingen (= Woodbine formation), and on their evidence Berry correlated the lower Bingen with a part, "presumably the lower," of the Woodbine formation of Texas, with the lower part of the Tuscaloosa group of the eastern Gulf region, and with the Raritan formation of New Jersey. Two other collections made by Miser in the lower part of the "upper Bingen" (= Tokio formation), Berry correlated with the Woodbine formation of Texas, "presumably the upper part," and with the Eutaw formation of the eastern Gulf area. As at present interpreted, the Tokio formation is of Austin chalk age, and the Eagle Ford shale is represented in Arkansas by the unconformity separating the Tokio from the underlying Woodbine formation. In comparing the Arkansas floras with the Woodbine flora of Texas, Berry had in mind chiefly fossil plants obtained by T. Wayland Vaughan and others from tuffaceous sands and sandstones, now included in the Lewisville member, at Arthurs Bluff, Lamar County.

ATLANTIC AND EASTERN GULF COASTAL PLAIN

MISSISSIPPI

An assemblage of poorly preserved marine fossils obtained from a core sample of gray argillaceous, micaceous sandstone at a depth of 6,151 to 6,153 feet in Helen Morrison well 1 of the Gulf Refining Co., in SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 30, T. 1 N., R. 13 E., Jasper County, included the following forms: *Lingula* cf. *L. subspatulata* Hall and Meek, *Breviarca* sp. (large), cf. *B. (Sanoarca) grandis* Stephenson, *Anomia* sp., *Brachidontes* cf. *B. filisculptus* (Cragin), *Cuspidaria* cf. *C. alaeformis* (Shumard), and *Caryocorbula?* cf. *C.? ovisana* Stephenson. Although the evidence afforded by these fossils is not conclusive, the assemblage strongly suggests that the containing beds are of the same age as the upper part of the Woodbine formation (Stephenson, 1945, pp. 1013, 1016).

ALABAMA

The Tuscaloosa formation (now the Tuscaloosa group) of the eastern Gulf region (Mississippi and Alabama) was correlated by E. W. Berry on the basis of fossil plants at least in part with the Woodbine formation (1917, p. 170; 1919, p. 41; 1922, p. 157). All of the prolific plant localities treated by him were in the lower part of the Tuscaloosa group, that is, in the Cot-

tondale and Eoline formations of Monroe, Conant, and Eargle (1946a, pp. 187-212). Berry's comparison of this basal Tuscaloosa flora with the Woodbine flora was made mainly on the basis of three fossil plant localities in Arkansas and one locality in Texas. As previously stated, only one of the Arkansas localities is in the Woodbine formation as at present understood, the other two being in the Tokio formation (of Austin age). Berry correlated the Woodbine locality with the lower Tuscaloosa of Alabama, the Raritan formation of New Jersey, and a part, "presumably the lower" part, of the Woodbine formation of Texas. The one locality in Texas was at Arthurs Bluff on Red River in the tuffaceous sands and sandy clays of the Lewisville member of the Woodbine formation.

In 1908 I found a few poorly preserved prints of *Ostrea* Linné and *Brachidontes* Swainson associated with leaf fragments in dark carbonaceous, micaceous clay at a locality on the Clanton road, 4 miles east by north of Maplesville, Chilton County, Ala. The containing bed is included in the glauconitic Eoline formation (marine) of the present classification. In 1945 and 1946 Monroe and Conant found several additional fossil localities in the Eoline formation in Chilton and Bibb Counties. The fossils from these localities, although poorly preserved, appear to have a significant relationship to fossils in the Woodbine formation.

One locality on a road, 0.25 mile west of Isabella School, 5 miles northeast of Maplesville, yielded the following forms from weathered glauconitic sands near the top of the Eoline formation:

Bed 3 feet below top of Eoline formation (U.S.G.S. colls. 19356, 19553):

Breviarca? sp.

Ostrea sp.

Laternula? sp.

Brachidontes sp.

Parmicorbula sp.

Bed 15 feet below top of Eoline formation (U.S.G.S. coll. 19552):

Breviarca? sp.

Laternula? sp. (numerous).

At a locality in a road cut, 1 mile south-southwest of Trio, 6 miles east by south of Centerville, Bibb County, at west edge of SW $\frac{1}{4}$ sec. 12, T. 22 N., R. 10 E., L. C. Conant collected the following forms from a bed of weathered glauconitic sand 1 foot thick (U.S.G.S. coll. 19548): *Nuculana* sp., *Pseudoptera* sp., *Leptosolen angustus* Stephenson?, and *Cyprimeria* sp. These forms are very similar to species in the Lewisville member of the Woodbine formation.

In a 25-foot bluff on the left side of Cahaba River, 4 miles south of the courthouse at Centerville, in NW $\frac{1}{4}$ sec. 14, T. 22 N., R. 9 E., Bibb County, L. C. Conant collected the following forms from calcareous sandstone

in the Eoline formation (U.S.G.S. coll. 19547): *Breviarca?* sp., *Ostrea soleniscus* Meek?, *Brachidontes* sp., and *Anomia ponticulana* Stephenson? This assemblage strongly suggests synchronicity with the Lewisville member of the Woodbine formation.

FLORIDA

A few macrofossils that probably indicate Woodbine (=Tuscaloosa) age have been obtained from deep wells in Florida and the Carolinas. Down-dip representatives of the Woodbine formation and of the equivalent parts of the Tuscaloosa group have been differentiated by petroleum geologists in many deep wells in the Atlantic and Gulf Coastal Plain, mainly on evidence afforded by lithologic character, electric logs, and microfaunas, but only those wells yielding significant macrofossils known to me will be mentioned here.

A core sample from a depth of 5,145 to 5,146 feet in Magnolia well 1-A, State Block 5-B, St. Vincent Sound, Franklin County yielded a small smooth *Exogyra*, which appears to be identical with *Exogyra woolmani* Richards, from a well near Norfolk, Virginia (1947, p. 35, pl. 14, figs. 7, 8, 11). This species is related to *Exogyra columbella levis* Stephenson from the Templeton member of the Woodbine formation.

SOUTH CAROLINA

A well on Parris Island, Beaufort County, South Carolina, drilled for the United States Marine Corps in 1940, reached a total depth of 3,454 feet. A. C. Munyan (1943, pp. 600-602) published a descriptive log of the beds penetrated between depths of 2,669 and 3,454 feet. He correlated the part of the section from a depth of 2,704 feet to the bottom of the hole with the Tuscaloosa group. Glauconitic sands and clays between depths of 3,149 and 3,248 feet were considered to be of marine origin and the remainder of the beds of nonmarine or very shallow marine origin. J. B. Reeside, Jr., studied the samples from this well and obtained from cores cut in the glauconitic marine beds a number of poorly preserved shells, which he identified as follows: *Cliona?* sp., *Serpula* sp., *Pteria* sp., *Inoceramus* sp. (prisms), *Ostrea* sp., *Exogyra* sp., *Anomia* sp., *Plicatula* sp., *Pecten* (*Camptonectes*) sp., *Botula* sp., *Brachidontes* sp., "*Cyrena*" sp., *Lucina* sp., *Cardium* cf. *C. paupericulum* Meek, *Crassatella?* sp., "*Corbula*" sp. The following is quoted from Reeside's unpublished report:

From 3,125 to 3,250 feet the cores show marine beds—medium-gray clays and silts and light-gray fine to coarse sands. The macrofauna is fairly large but mostly either new or noncommittal, so far as present knowledge goes. However, a few species suggest an early Upper Cretaceous age, possibly as old as the Lewisville beds of Texas (upper Woodbine).

I have examined the fossils obtained by Reeside from the marine beds and add the following notes.

Among the specimens from a depth of 3,150 feet are: a small smooth bivalve closely resembling the species *Dentonia leveretti* (Cragin), from the Lewisville member of the Woodbine formation; a *Corbula*-like bivalve apparently related to *Corbula manleyi* Weller, from the Raritan formation of New Jersey; and *Hemicerithium?* sp., possibly related to *H. interlineatum* (Cragin), from the Lewisville member.

An internal mold at a depth of 3,168 feet, identified by Reeside as *Pteria*, sp., is probably a *Pseudoptera*. This genus is represented in the Woodbine formation by several species.

A small elongated oyster found at a depth of 3,180 feet, may be a young individual of *Ostrea soleniscus* Meek, and two small crushed bivalves are similar in form to *Fulpia pinguis* Stephenson. These are Woodbine species.

A poorly preserved *Yoldia?* sp. found at a depth of 3,186 feet resembles the species *Yoldia? septariana* Cragin from the Templeton member of the Woodbine.

The small *Exogyra* sp., depth of core 3,212 to 3,232 feet, appears to be closely related to *E. columbella* Meek, from the upper part of the Woodbine and to *E. woolmani* Richards (1947, p. 35), from the subsurface in eastern North Carolina and eastern Virginia, as indicated in subsequent paragraphs. Although the evidence is not conclusive the contained macrofossils seem to point to the Woodbine age of the marine beds penetrated in the Parris Island well between depths of 3,125 and 3,250 feet.

NORTH CAROLINA

Fossils from a core sample taken at depths of 2,565 to 2,575 feet in the Carolina Petroleum Company's H. B. Salter well, 16.5 miles north of Beaufort, North Carolina, submitted by K. D. White, consulting geologist, yielded *Exogyra woolmani* Richards, *Pecten (Camp-tonectes)* sp., and *Plicatula* sp. The *Exogyra* is a smooth form closely related to *E. columbella levis* Stephenson and probably indicates approximate synchronicity with the upper part of the Woodbine formation of Texas.

VIRGINIA

In the Virginia Coastal Plain, beds of Tertiary age (Eocene and Miocene) overlap and conceal the Upper Cretaceous formations, but these strata have been recognized in well borings. At Moores Bridge, 5 miles east of Norfolk, many shells of *Exogyra woolmani* Richards (1947, p. 35), a small smooth species, are present in a layer penetrated at a depth of 755 feet. The same species is recorded by Richards from a well at Drivers, Nansemond County, at a depth of 484 to 489 feet, and from a well at Franklin, Southampton County, at a depth of 265 feet. This species has its closest relationship with *Exogyra columbella levis*

Stephenson, a larger and broader form from the Templeton member of the Woodbine formation in Texas.

MARYLAND

Cretaceous strata, which, as previously stated, are overlapped and concealed by Tertiary formations in Virginia, reappear along the inner edge of the coastal plain in Maryland. According to E. W. Berry (1916, pp. 220-221; 1919, pp. 39-41), the Raritan formation of Maryland, particularly the upper part of the Raritan, is approximately equivalent to the Woodbine formation, as represented by the tuffaceous leaf-bearing sands at Arthurs Bluff in Lamar County, Texas. His correlation is based on fossil plants. No marine invertebrate-bearing beds have been recognized in the belt of outcrop of the Raritan in Maryland. However, deep oil-prospecting wells near the coast in eastern Maryland have penetrated beds interpreted to be downdip marine facies of the Raritan.

Several of the faunal elements from two core samples taken between depths of 1,588 and 1,603 feet in the Larry G. Hammond well of the Ohio Oil Company, located a few miles east of Salisbury, Wicomico County, suggest age equivalency with marine beds in the Raritan formation of New Jersey (Stephenson, 1949, pp. 120-126). These elements include: *Breviarca* sp. (possibly equals *Trigonarca cliffwoodensis* Weller), "*Corbula*" aff. *C. manleyi* Weller, and *Fulpia wicomicoensis* (Richards), which may equal *Astarte veta* Conrad. The *Fulpia* appears to be a fairly close analog of *Fulpia pinguis* Stephenson, from the Woodbine formation of Texas. (See also Stephenson, 1946, pp. 68-71.)

NEW JERSEY

As previously indicated, E. W. Berry (1916, pp. 220-221; 1919, pp. 39-41) accepted the Woodbine age of the Raritan formation, particularly the upper part of the Raritan, of New Jersey. He based his conclusion on fossil floras. Fortunately fossil-bearing beds of marine origin are present in the lower part of the formation in this State. A few species were described by Whitfield (1885, 22-28), a few by Weller (1907, pp. 27-29), and more recently 13 new species and one variety by Richards (1943, pp. 15-32). There still remain a few rather poorly preserved species in the collections of the U. S. Geological Survey at the U. S. National Museum that have not been described.

Described species that are believed to indicate synchronicity with the Woodbine formation include: *Astarte veta* Conrad, which may be a *Fulpia*; *Avellana? raritana* Richards, which may be a *Hillites*; *Turritella bakeri* Richards, a noded form analogous to *T. shuleri* Stephenson; and *Anchura raritanensis* Richards, a fairly close analog of *A. horreana* Stephenson. Undescribed species that have a similar significance include:

Protarca? sp., which is similar to *P.?* *tramitensis* (Cragin), but smaller; *Idonearca?* sp., which has a form suggestive of *I. blampiedi* Stephenson; *Phelopteria* sp., which may be *P. dalli* (Stephenson); a small elongate oyster, possibly a young individual of *Ostrea soleniscus* Meek; *Pollex?* sp. cf. *P. obesus* Stephenson; *Fulpia?* sp.; *Opis?* sp., possibly *O.?* *elevata* Stephenson; *Parmicorbula* sp., similar to *P. vokesi* Stephenson; and *Lispodesthes?* sp. cf. *L. panda* Stephenson.

BANQUEREAU BANK, NOVA SCOTIA

A fauna obtained from a boulder of shell marl, brought up in a fisherman's trawl from the bed of the ocean at a depth of 200 fathoms on the eastern part of Banquereau Bank off Nova Scotia, was reported upon first by Dall (1925, pp. 213-218) and more recently by Stephenson (1936, pp. 384-410, pls. 3-5). A comparison of this fauna with the fauna of the Woodbine group, particularly the Lewisville and Templeton members, reveals some significant similarities.

Phelopteria dalli (Stephenson) appears to be identical with a species in the Woodbine formation to which I have applied the same name; two small specimens of *Exogyra* appear to be related to *E. columbella* Meek; the shells called *Cyclorisma elongata* may be a species related to *Sinonia levis*; *Aphrodina marina* is probably a species of *Callistina* closely allied to *C. lamarensis* (Shumard); *Legumen intermedium* is quite similar to *L. ligula*; *Leptosolen* sp. appears to be essentially identical with *L. angusta*; the two noded species of *Turritella*, *T. macneili* and *T. thomsonina*, are good analogs of *T. shuleri*; *Anchura pontana* is analogous to *A. horreana*; and *Carota venusta* is analogous to *C. pendula*.

The material from Banquereau Bank is interpreted to be from a submerged northeastward extension of the marine facies of the Raritan formation of New Jersey.

WESTERN UNITED STATES

WESTERN INTERIOR

The following statements about the age equivalents of the Woodbine formation in the Western Interior are based in part on published records and in part on unpublished information received orally from J. B. Reeside, Jr., whose examination of more recent collections made by himself and others has enabled him to determine more exactly the stratigraphic position of fossil-bearing beds whose ages have been more or less in question. Information about the fauna of the Coleraine formation of Minnesota is recorded in a paper by H. R. Bergquist (1944, pp. 1-30).

The approximate age equivalents of the Woodbine formation include the following units: (1) The upper part of the Dakota group in the western part of the Great Plains region. This group, as originally defined,

included not only beds of early Upper Cretaceous age but also older beds now known to be of Comanche age and other beds whose exact age equivalencies still remain undetermined. (2) The Graneros shale of early Benton age in the western part of the Great Plains region (northeastern New Mexico, northwestern Oklahoma, western Kansas and Nebraska, eastern Colorado, and southeastern Wyoming). (3) The Newcastle sandstone, Mowry shale, and the Belle Fourche shale of the Black Hills (northeastern Wyoming and western South Dakota). (4) The Aspen shale (southwestern Wyoming). (5) The upper abundantly fossil-bearing part of the Bear River formation (early Upper Cretaceous age) of southwestern Wyoming and southeastern Idaho. (6) The upper part of the Thermopolis shale of central northern Wyoming and central southern Montana. (7) The Mowry shale, which overlies the Thermopolis shale (where present) in Wyoming and Montana. (8) The basal part of the Mancos shale in southwestern Colorado, northwestern New Mexico and adjacent parts of Arizona and Utah. (9) The basal part of the Colorado shale of Montana. (10) The Coleraine formation (Bergquist, 1944) of Minnesota.

Species in the Woodbine formation (mainly in the Lewisville and Templeton members) and identical and closely allied species in the Western Interior that are helpful in determining the age equivalencies are listed in parallel columns on the following page.

CALIFORNIA

There is general agreement that in California, beds belonging in the age of the Woodbine formation (= part of Cenomanian) are present in the lower part of the Chico group, although the lower and upper limits of the beds of Cenomanian age within that group have never been determined. (See Anderson and Hanna, 1935, pp. 5-18.)

OTHER AREAS

GENERAL STATEMENT

Sedimentary deposits of Woodbine age (Cenomanian) have been differentiated at many places well distributed throughout the land areas of the earth. In Texas the Woodbine formation does not embrace the whole of Cenomanian time, because, as generally interpreted, the upper part of the underlying Washita group (Grayson marl, Buda limestone, and their equivalents), and a thin zone at the base of the overlying Eagle Ford shale are included in the Cenomanian. In our present state of knowledge it is not possible to indicate the exact equivalent of the Woodbine at most of their foreign occurrences, and for present practical purposes it is sufficient to indicate roughly the known distribution of beds of Cenomanian age in other lands.

Comparison of species in the Woodbine formation with species in early Late Cretaceous beds in the Western Interior

Species in Woodbine formation	Identical and analogous species in Western Interior formations
<i>Protarca? tramitensis</i> (Cragin) ----- Eules and Lewisville members.	<i>Barbatia micronema</i> (Meek): Bear River formation. Coalville section, Utah, below lowest coal (early Upper Cretaceous age).
<i>Inoceramus prefragilis</i> Stephenson ----- Lewisville and Templeton members.	<i>Inoceramus</i> (unnamed but apparently identical): Belle Fourche shale, northeastern Wyoming. <i>Inoceramus fragilis mesabiensis</i> Bergquist: Coleraine formation (Bergquist, 1944), Minnesota.
<i>Inoceramus arvanus</i> Stephenson ----- Lewisville member.	
<i>Inoceramus eulesanus</i> Stephenson ----- Eules member.	<i>Inoceramus</i> (unnamed but apparently identical): Belle Fourche shale.
<i>Phelopteria dalli</i> (Stephenson) ----- Ranges through the Woodbine formation.	<i>Pteria (Oxytoma) gastroides</i> (Meek): "Pugnellus sandstone" in Huerfano Park, Colo. (late Benton age).
<i>Pseudoptera serrata</i> Stephenson ----- Lewisville and Templeton members.	<i>Gervillia propleura</i> (Meek)?, (of Bergquist): Coleraine formation (Bergquist, 1944), Minnesota.
<i>Ostrea soleniscus</i> Meek ----- Ranges through the Woodbine formation.	<i>Ostrea soleniscus</i> Meek: Bear River formation, Wyoming. Ranges upward through beds of Benton age, into beds of early Niobrara age.
<i>Exogyra columbella</i> Meek ----- Lewisville and Templeton members (Ranges into basal part of the Eagle Ford shale).	<i>Exogyra columbella</i> Meek: Common in beds of early Upper Cretaceous age. Ranges upward into Mosby sandstone member of the Warm Creek shale of middle Benton age in Montana.
<i>Brachidontes fulpensis</i> Stephenson ----- Dexter, Eules, and Lewisville members.	<i>Brachidontes multilingera</i> (Meek): Coalville section, Utah, below lowest coal (early Upper Cretaceous age).
<i>Brachidontes filisculptus</i> (Cragin) ----- Dexter, Eules, and Lewisville members.	<i>Brachidontes arcturusensis</i> Bergquist: Coleraine formation (Bergquist, 1944), Minnesota.
<i>Pholadomya goldenensis</i> Stephenson ----- Templeton member.	<i>Pholadomya papyracea</i> Meek and Hayden: Lower part of Colorado shale, Montana.
<i>Psilomya concentrica</i> (Stanton) ----- Dexter and Templeton members.	<i>Psilomya concentrica</i> (Stanton): "Pugnellus sandstone," Huerfano Park, Colo. (late Benton age).
<i>Senis elongatus</i> Stephenson ----- Lewisville member.	<i>Siliqua huerfanensis</i> Stanton: Coalville section, Utah, below lowest coal (early Upper Cretaceous age), and ranges upward into "Pugnellus sandstone" (late Benton age) in Huerfano Park, Colo. <i>Pharella? dakotensis</i> (Meek and Hayden): "Dakota group" (early Upper Cretaceous age), mouth of Vermillion River, Nebr.
<i>Ursirivus fanninensis</i> Stephenson: Eules and Lewisville members.	
<i>Ursirivus arlingtonanus</i> Stephenson: Dexter, Eules, and Lewisville members.	<i>Ursirivus pyriformis</i> (Meek): Upper part of Bear River formation, Wyoming (early Upper Cretaceous age).
<i>Gyrodes flavianus</i> Stephenson ----- Templeton member.	<i>Gyrodes depressa</i> Meek (Stanton, 1894, p. 135; not Meek): "Pugnellus sandstone" Huerfano Park, Colo. (late Benton age).
<i>Turritella shuleri</i> Stephenson ----- Lewisville and Templeton members.	<i>Turritella whitei</i> Stanton: Upper Kanab, Utah (early Upper Cretaceous age) Huerfano Park, Colo. (late Benton age), Arkansas River above Pueblo at Rattlesnake Butte, and elsewhere in southern Colorado (late Benton age).
<i>Pyrgulifera ornata</i> Stephenson ----- Lewisville member.	<i>Pyrgulifera humerosa</i> Meek: Upper part of Bear River formation, Wyoming (early Upper Cretaceous age).
<i>Anchura turricula</i> Stephenson ----- Templeton member.	<i>Anchura grouti</i> Bergquist: Coleraine formation (Bergquist, 1944), Minnesota.
<i>Lispodesthes panda</i> Stephenson. } <i>Lispodesthes patula</i> Stephenson: } Lewisville and Templeton members. }	<i>Lispodesthes nuptialis</i> White: Five miles west of Mineral Springs, Ariz. (early Benton age)
<i>Carota pendula</i> Stephenson ----- Lewisville and Templeton members.	
<i>Rhytiphorus? sp</i> ----- Dexter member.	<i>Rostellites dalli</i> Stanton: "Pugnellus sandstone," Huerfano Park, Colo. (late Benton age).
<i>Acanthoceras hazzardi</i> Stephenson ----- Lewisville member.	<i>Rhytiphorus priscus</i> Meek. <i>Rhytiphorus meeki</i> White: Bear River formation, Wyoming (early Upper Cretaceous age).
<i>Metengonoceras dumbli</i> (Cragin) ----- Lewisville member.	<i>Acanthoceras amphibolum</i> Morrow: Graneros shale, Smoky River, south of Wilson, Kans.
<i>Metoicoceras swallowii</i> (Shumard) ----- Lewisville and Templeton members.	<i>Epengonoceras aspenanum</i> Reeside and Weymouth: Aspen shale (early Upper Cretaceous age), southwestern Wyoming. Mowry shale (early Upper Cretaceous age), eastern Wyoming. <i>Metoicoceras</i> aff. <i>M. swallowii</i> (Shumard), (of Bergquist): Coleraine formation (Bergquist, 1944), Minnesota.

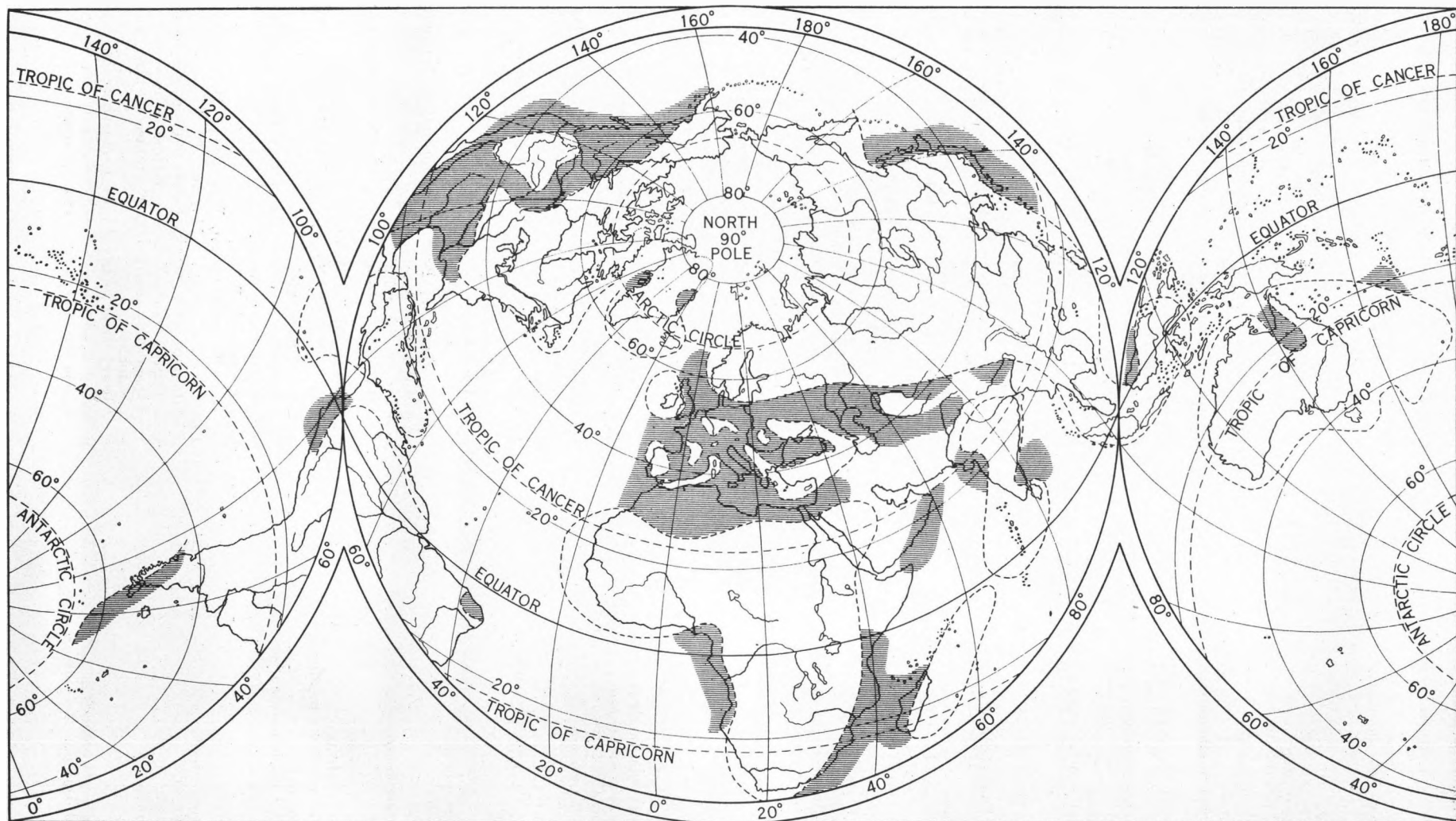


FIGURE 5.—Sketch map showing the world distribution of beds of Cenomanian age. (After de Lapparent, with slight modifications.)

The accompanying map (fig. 5) is a reproduction, with slight modifications, of a world map compiled and published by A. de Lapparent in the fifth edition of his textbook *Traité de géologie* (1906, vol. 3, p. 1385, fig. 671). The French title of the map is *Esquisse de la géographie cénomaniennne*. The map is very much generalized; it shows two main regions in which the deposits of this age were laid down: in North America, the Cenomanian sea covered extensive tracts in the Atlantic and Gulf Coastal Plain, southwestern, central, and western United States, western Canada and central and northern Mexico; and beyond the Atlantic the sea covered most of central and southern Europe and northern Africa and extended eastward in a wide belt through southern Asia. Other occurrences are more restricted in area and widely scattered, as indicated on the map.

The world-wide distribution of known deposits of Cenomanian age has also been reviewed by Haug in his *Traité de géologie* (1908-1911, vol. 2, pp. 1232-1298). The differentiation of beds of Cenomanian age from earlier and later Cretaceous beds has usually depended on the evidence afforded by one or more species identical with, or analogous to, species in the Cenomanian of the Paris Basin, or on species identical with or analogous to species in known Cenomanian beds in areas nearer than the Paris Basin to the localities under consideration. Species in several genera of ammonites have generally proved to be more useful than species in other groups. The position of the beds in relation to other beds in lower or higher parts of the sections, whose ages have been determined on fossil evidence, has also been useful in determining or verifying the Cenomanian representatives.

CANADA

According to Warren and Stelck (1940, pp. 143-145), the later Cenomanian is definitely represented in the upper part of the Dunvegan sandstone and in the lower part of the overlying Smoky River shale in the Pouce Coupe district, northwestern Alberta and northeastern British Columbia. The correlation is based on the presence of the acanthoceroid ammonites *Dunveganoceras albertense* (Warren) and *D. pouce-coupense* Warren and Stelck. McLearn (1945, pp. 1-4) concurs in this conclusion. (See also Gleddie, 1949, pp. 511-532.)

MEXICO, CENTRAL AMERICA, AND CUBA

The Cenomanian is represented in Mexico, but its exact limits at many places are undetermined or only doubtfully determined (Imlay, 1944, pp. 1016-1037, correlation chart). In Coahuila and Chihuahua, shales and limestones representing the southern extension of the Grayson marl (Del Rio clay of authors), the Buda limestone, and the lower part of the Eagle Ford shale are of Cenomanian age. In the same region undiffer-

entiated lower parts of the Ojinaga, and Indidura formations are considered to be of later Cenomanian age. In other areas in central and eastern Mexico, undifferentiated lower parts of the Indidura, Agua Nueva, and Escamela formations, and unnamed limestones, were formed in later Cenomanian time. Anderson and Hanna (1935), p. 18) doubtfully correlated the Cedros Island beds of Lower California with the Cenomanian. In the region of the Isthmus of Tehuantepec and northern Central America, the Cenomanian is represented by an undifferentiated lower part of the Cobán limestone. In Cuba the lower part of the Provincial limestone is of Cenomanian age.

SOUTH AMERICA

Beds of Cenomanian age have been recognized in several of the countries of South America.

The Cenomanian age of the upper part of the Villeta series of Colombia is indicated by the presence of the following ammonites listed by Gerth (1935, p. 356): *Acanthoceras rhotomagense* (Defrance) (neighborhood of Bogotá), *A. prorsocurvatum* Gerhardt (at Ubaque), *A. newboldi* Kossmann (at Leiva), *Mantelliceras cantianum* Spath (at Leiva), *Schloenbachia subtuberculata* Gerhardt (at Velez), and *S. flexuosa* Gerhardt (at Velez).

Paulecke (1903, vol. 10, pp. 260-286, pls. 15, 16) correlated a portion of the Cretaceous section in Peru with the Cenomanian on the basis of the following fossils: *Plicatula* cf. *P. fourneli* Coquand, *Exogyra africana* var. *peruana* Paulecke, *Exogyra arietina* var. *diceratina* Steinmann, and *Exogyra olisiponensis* var. *duplex* Steinmann. Lists of fossils from Peru considered to be of Vraconian and Cenomanian ages are given by Schlagintweit (1911, vol. 17, pp. 51, 61-69).

Olsson (1934, pp. 11, 17-19) states that the Copa Sombbrero formation of the Amotape region, Peru, contains *Schloenbachia* related to *S. varians* Sowerby, which he believes indicates the Cenomanian age of the formation. He states that the formation overlies limestones containing upper Aptian and Albian fossils (Pananga limestone, overlain by Muerto limestone) and is overlain in the Monte Grande area by quartzitic sandstones and conglomerates which he correlates with the Cenomanian-Turonian.

A table prepared by Kellum (1948, p. 132) based on a discussion by Singewald (1937, p. 1347) of Geological exploration between upper Juruá River, Brazil, and Middle Ucayali River, Perú (the title of a paper by Victor Oppenheim), indicates that part of a limestone unit known as Caliza de Chonta, exposed along the Pichis and Pachitea Rivers in eastern Perú, and part of a shale-limestone series, exposed in the Pongo de Manseriche (Rio Marañon) and on the Ucayali River in eastern Perú, are of Cenomanian age. The correlation is based on the stratigraphic position of these beds in relation to other fossiliferous beds of known age.

Bonarelli and Nagera (1921, Bol. 27, ser. B, pp. 26-30) recognize beds of Cenomanian age in the vicinity of Lago San Martin in southern Argentina (Patagonia).

A fish fauna from the base of Serra do Araripe, in the southern part of the State of Ceará, northeastern Brazil, described by Jordan and Branner (1908 (issued 1910), pp. 1-29), has been referred questionably to the Cenomanian (Gerth, 1935, p. 340).

In Gerth's summary of the deposits of Jurassic and Cretaceous age in South America (1935, pp. 283-389) he indicates in a table (pp. 370, 371) the presence of limestones of Cenomanian age in eastern Venezuela and in Trinidad. However, Harris' analysis of the poorly preserved Trinidad faunas from the older Cretaceous (Parian group) at Stack Rock, Plum Road, and other localities in the faulted belt of Cretaceous rocks extending from Pointe à Pierre on the east-central coast, northeastward to Mananzilla Bay on the Atlantic Coast, points to a Cretaceous age older than Cenomanian (Harris, in Waring, 1926, pp. 91-96).

FRANCE

The name Cenomanian is derived from Cenomanum, an old Latin name for the town of Mans in the Department of Sarthe, France. In the vicinity of Mans, this unit consists mainly of marine sands having a thickness of about 300 feet. Toward the north the sands become interbedded with chalks and marls that gradually replace the sands until, across the English Channel in southern England, the calcareous beds make up the body of the unit, there designated the Lower Chalk. The relationships of the Cenomanian of northern France to the Lower Chalk of England have been treated in considerable detail by Jukes-Browne and Hill (1896, pp. 99-178). Although the Cenomanian of the Paris Basin has yielded an abundant molluscan fauna, none of its species are known to be identical with species in the Woodbine formation. Correlation of the Woodbine formation with the Cenomanian is made on the basis of closely related or analogous species in common genera. Two ammonite species appear to be especially useful as index fossils. *Acanthoceras tarrantense* (Adkins) and *Forbesiceras conlini* Stephenson are considered to be good analogs, respectively, of *A. rhotomagense* (Defrance) and *F. largilliertianum* (D'Orbigny), from the Cenomanian of France.

A sketch map showing the distribution of the Cenomanian sea in France and adjacent areas in England, Spain, and Switzerland is given by Lapparent (1906, vol. 3, p. 1395, fig. 675). He indicates the known occurrence of beds of Cenomanian age in eastern France, in the region of the Jura Mountains, in old Provence in southeastern France, in the region of the Cévennes Mountains, in the Aquitaine region, and on the north flank of the Pyrenees (1906, pp. 1394-1399).

ENGLAND

The Cenomanian of southern England, there designated the Lower Chalk, is a continuation of the Cenomanian of the Paris Basin, France. Where most fully developed it is about 200 feet thick and has been divided in ascending order into three parts: (1) "Chloritic Marl," Glauconitic Marl, and Cambridge Greensand; (2) Chalk Marl; and (3) Grey Chalk of Folkstone and other places. Fossils closely similar to species in the Woodbine formation are: *Inoceramus pictus* Sowerby, analogous to *I. prefragilis* Stephenson; *Exogyra columba* (Lamarck), analogous to *E. columbella levis* Stephenson; *Volsella reversa* (Sowerby), analogous to *V. alveolana* Stephenson; *Acanthoceras rhotomagense* (Defrance), analogous to *A. tarrantense* (Adkins), and *Forbesiceras obtectum* (Sharpe), analogous to *F. conlini* Stephenson. The ammonite zones of the Cenomanian and uppermost Albian are critically treated by Spath (1926a, pp. 420-432, especially p. 425).

CENTRAL AND SOUTHERN EUROPE EAST OF FRANCE

The parts of Europe covered by the Cenomanian sea are shown on a sketch map by De Lapparent (1906, vol. 3, p. 1400, fig. 676). He cites the occurrence of beds of Cenomanian age in Belgium and Denmark, in Westphalia and other parts of northern Germany, in Saxony, Bohemia, Moravia, and Silesia, in the Alpine region, in the Carpathian Mountains, in the Balkans, and in southern Russia.

MEDITERRANEAN REGION

Beds of Cretaceous age are widely distributed about the perimeters of the Mediterranean Sea, and Cenomanian representatives have been differentiated within the Upper Cretaceous series at many places, including Portugal, Spain, Sicily and southern Italy, Algeria, Tunisia, Egypt, and Palestine (Lapparent, 1906, vol. 3, pp. 1402-1407; Lartet, 1869, pp. 136-203; Pervinquière, 1903, 359 pp.). Some of the fossils frequently mentioned as evidence of Cenomanian age are: the echinoid *Holaster subglobosus* Leske; the bivalves *Exogyra olisiponensis* Sharpe and *E. columba* (Lamarck), both of which range upward into the Turoonian; and the ammonites *Acanthoceras rhotomagense* (Defrance), *A. mantelli* (Sowerby), *Neolobites vibrayanus* (D'Orbigny), *Schloenbachia varians* (Sowerby), and *Forbesiceras largilliertianum* (D'Orbigny).

SOUTHERN AFRICA AND MADAGASCAR

The Cenomanian is reported to be present in Zululand (Du Toit, 1926, pp. 316-319; Socin, 1939, pp. 1-15), in Mozambique (Portuguese East Africa), (Lapparent, 1906, vol. 3, pp. 1407, 1408), and on the West Coast of Africa in Angola and farther north in French Equatorial Africa. In Madagascar beds of Cenomanian age have been differentiated on the evi-

dence of a rather extensive ammonite fauna, which includes species related to *Acanthoceras rhotomagense* (Defrance). (Collignon, 1933, pp. 53-80; 1937, pp. 31-72; 1939, pp. 59-105.)

SOUTHERN ASIA

Beds of Cenomanian age have been reported from the south flank of the Caucasus, from Arabia, Syria, Turkistan, and India (Lapparent, 1906, vol. 3, pp. 1404, 1405). In southern India, the lower part of the Ootatoor group, whose molluscan fossils are described in parts of three classic volumes by Stoliczka (1861-1871), and by Kossmat (1895-1898), is considered to be of Cenomanian age. Ammonites of the *Acanthoceras rhotomagense* group are among the recorded fossils.

JAPAN

The presence of beds of Cenomanian age has been recorded in Japan on the islands of Honshu, Kyushu, Hokkaidô, and Sakhalin (Lapparent, 1906, vol. 3, pp. 1405-1406). In terms of the current Japanese classification of the Cretaceous sediments the Cenomanian is represented by the lower part of the Gyliak series, and the Turonian by the upper part of that series. Several species referred to the Cenomanian genus *Acanthoceras* are recorded from beds of lower Gyliakian age (Paleogyliakian) in Hokkaidô (Matumoto, 1942, ser. D, vol. 1, no. 3, pp. 194, 229; 1943, vol. 2, no. 1, pp. 131, 155).

AUSTRALIA AND NEW ZEALAND

Beds of Cenomanian age are reported in Queensland, Australia, and in the islands of New Zealand (Lapparent, 1906, vol. 3, p. 1406).

GREENLAND

Spath (1946, p. 10) reports the existence of beds of Cenomanian age in East Greenland. The correlation is based on two species in the ammonite genus *Schloenbachia* Neumayr, one of the species being *S. subvarians* Spath, which he says may be a synonym of *S. tollotiana* (Pictet).

A very large fossil flora has been obtained in western Greenland, mainly on Disko Island and Nugsuak Peninsula, from the Upper Cretaceous Atane series. Paleobotanists correlate this series with the Cenomanian. Berry compiled a list of 159 species recorded from the Atane beds (1916, pp. 185-192).

ANALYSIS OF THE INVERTEBRATE FAUNA OF THE WOODBINE FORMATION

GENERAL FEATURES

The larger invertebrate fauna of the Woodbine formation, as currently known, includes 249 named species, 17 named varieties, and 15 species designated only by letter. In addition, poorly preserved, unidentified species in 63 genera are listed. One species, *Exogyra columbella* Meek, is known to range above the Wood-

bine formation into the Eagle Ford shale. With this exception none of the named species and varieties here recorded from the formation has been recognized in Texas, either in the Comanche series below or in the younger formations of the Gulf series above. One questionably identified species, *Lithophaga carolinensis* (Conrad), a small, smooth, boring bivalve, is known from the zone of *Exogyra ponderosa* of the Gulf series in Georgia and North Carolina. However, in this connection it should be stated that neither the molluscan fauna of the Washita group (uppermost group of the Comanche series) nor that of the Eagle Ford shale, which overlies the Woodbine formation, has been adequately studied and described. In the Western Interior of the United States the species *Ostrea soleniscus* Meek ranges from the lower part of the Benton group upward at least as far as the lower part of the Niobrara formation, a stratigraphic position higher than its known vertical range in Texas. Numerous Woodbine genera have a range from the Comanche series below into or through the Woodbine formation, and numerous genera continue from the Woodbine into the younger formations of the Gulf series. However, it has been found necessary to propose 31 new genera to contain the species that could not be satisfactorily assigned to previously described genera. A few of these new genera are known to be represented by species from beds of earlier or later age, or from beds of the same or nearly the same age in other series, but most of them, as at present known, are restricted to the Woodbine formation in Texas.

Considered as a whole the fossil organisms of the Woodbine formation constitute a shallow-marine facies fauna, predominantly molluscan, intervening between the older, deeper-marine faunas of the Comanche series below and the younger, deeper-marine faunas of the Gulf series above. The fauna includes a few brackish- and fresh-water species. The marked differences between the Woodbine fauna and these older and younger faunas are doubtless explainable as being due to the environmental differences resulting from the respective shallower- and deeper-water habitat. The need for so many new generic names serves to emphasize the uniqueness of the Woodbine fauna as compared to the older and younger faunas of the Gulf region.

The named species and varieties and the lettered species, 281 in all, are divided among the invertebrate phyla as indicated below: Porifera (Spongiae), represented by two species of sponges preserved in the form of ferruginous casts of borings made by the animals themselves in the thick shells of mollusks. Coelenterata (Anthozoa), represented by one species of compound coral (one small example only). Annelida (Chaetopoda), represented by calcareous tubes, including one named species. Molluscoidea, represented by one named species and one genus of Bryozoa unidenti-

fied as to species, and by one species of Brachiopoda. Mollusca, 272 named species and varieties and lettered species, including 135 of Pelecypoda, 4 of Scaphopoda, 117 of Gastropoda, and 16 of Cephalopoda. Arthropoda (Crustacea), including one named species of Brachiopoda, separated parts of a *Scalpellum*-like species of Cirripedia, and several genera and 2 named species of decapod crustaceans described by H. B. Stenzel in a separate division of this volume.

No representatives of the Echinodermata have been found in the Woodbine formation.

Foraminifera are represented in the Templeton member of the formation by a few arenaceous species. Samples have been collected at twelve or more localities along the belt of outcrop of the member and are under study for Foraminifera by Mrs. Esther Richards Applin. Mrs. Applin has also found in the same member a few very small specimens of calcareous Foraminifera belonging in the genus *Gumbelina*. The species identified by Mrs. Applin from the Templeton member are as follows:

Arenaceous Foraminifera from the Templeton member

Ammobaculites bergquisti Cushman and Applin.

junceus Cushman and Applin.

comprimatus Cushman and Applin.

gratus Cushman and Applin.

adventus Cushman and Applin.

adventus Cushman and Applin, var.

coprolithiformis (Schwager) Cushman.

Ammobaculoides plummerae Loeblich.

Trochammina rainwateri Cushman and Applin.

exigua Cushman and Applin.

Proteonina sp.

Three species of arenaceous Foraminifera recorded by Tappan (1941, pp. 359-361) as coming from basal clay of the Woodbine formation below sandy strata in the southeastern part of Denison, Grayson County, are: *Reophax woodbinensis* Tappan, *Flabellamina brachylocula* Tappan, and *Flabellamina denisonensis* Tappan. The possibility that these species came from an uppermost clay bed of the Washita group (Comanche series), instead of from the basal bed of the Woodbine formation (Dexter member), should be considered.

In addition to the invertebrate fossils, the Woodbine formation has yielded a few scattered vertebrate remains, concerning which David H. Dunkle of the United States National Museum has supplied the following information:

Coll. 11736. Shark vertebra, genus and species indeterminate. Lewisville member (loc. 38).

Coll. 14092. *Osmeroides?* sp. (= *Holcolepis*). While undoubtedly pertaining to the family Elopidae, this scale fragment is given the above generic assignment in a customary and arbitrarily broad sense. *Osmeroides* and closely related genera range throughout and are typical of the Upper Cretaceous in all parts of the world. Templeton member (loc. 154).

Coll. 14580. Ichthyodectida, genus and species indeterminate. In addition to the fragmentary nature of this speci-

men, there seems as yet no entirely satisfactory basis for distinguishing between the scales of the various genera of ichthyodectids. They, however, have a cosmopolitan distribution ranging from Lower to Upper Cretaceous. Templeton member (loc. 154).

Coll. 18253. Branchiostegal ray of indeterminate teleostean fish. Lewisville member (loc. 183).

Coll. 18972. *Lamna* cf. *L. semiplicata* (Agassiz). Previous reports of this species in the United States, under the names *Lamna sulcata* or *Otodus divaricatus*, are limited to the Benton shale of Kansas and to an unknown horizon in Texas. Lewisville member (loc. 122).

Coll. 19023. *Lamna semiplicata* (Agassiz). Lewisville member (loc. 127).

Coll. 19495. *Lamna* cf. *L. appendiculata* Agassiz. A typical Upper Cretaceous form (from Cenomanian to Danian) of worldwide distribution. Lewisville member (loc. 126).

Coll. 19501. *Onchopristsis* cf. *O. numidus* (Haug). A single tooth belonging to an ancient genus related to the modern sawfish. (See Dunkle, 1948, p. 173.) U.S.N.M. 17088, Lewisville member (loc. 81).

Coll. 20042. Indeterminate crocodile plate. Dexter member (loc. 216).

Coll. 20262. Indeterminate spine or raylike impression. Red Branch member (loc. 96).

Coll. 20281. *Coelodus* cf. *C. brownii* Cope. This incomplete left splenial dentition is approximately one-third the size of the type specimen, but exhibits all of its characteristics. The form has previously been known only from the Kiowa shale (Kiamichi age) at Belvidere, Kansas. Lewisville member (loc. 93).

Coll. 20541. One caudal dinosaurian vertebra. Lewisville member (loc. 139).

Coll. 20545. Coprolite. Lewisville member (loc. 94).

Coll. 20551. Includes the following: *Corax falcatus* Agassiz, of Upper Cretaceous and questionably lower Eocene age. Previously reported from the Blossom sand and Pecan Gap chalk member of the Taylor marl of Texas. *Lamna appendiculata* Agassiz, which ranges throughout the Upper Cretaceous. *Lamna* cf. *L. semiplicata* (Agassiz), refer to note under no. 18972 above. Pycnodontidae. Genus and species indeterminate. Indeterminate crocodilian teeth. Miscellaneous fragments which include one palatal fang of *Enchodus?* sp.. This genus is typical of and ranges throughout the Upper Cretaceous. Lewisville member (loc. 142).

Coll. 20879. One tooth of *Lamna appendiculata* Agassiz (see note above) and an indeterminate fragment. Templeton member (loc. 175).

The statements on the following pages in regard to the ranges of the species from the different members of the Woodbine formation are based upon the data compiled in the chart of distribution.

DEXTER MEMBER

The fauna of the Dexter member is found in Tarrant and Denton Counties in lenses or tongues mainly of ferruginous sandstone of shallow-marine origin, interbedded with the typical predominantly nonmarine sandstones and shales of the member. The more prolific fossil localities in Tarrant County are in the middle and lower parts of the member, some of them at or within a few feet of the base; several meagerly fossiliferous localities in northern Tarrant and southern Denton Counties are in the middle and upper parts of the member. North of the latitude of Denton, in Den-

ton and Grayson Counties, marine beds are wanting in the member. The larger invertebrate fossils are listed below.

Invertebrate fossils from the Dexter member

[D=Dexter, E=Eules, L=Lewisville, and T=Templeton. D—T, for example, indicates the fossil ranges from the Dexter to Templeton members.]

Porifera (Spongiae) :	
<i>Cliona retiformis</i> , n. sp.-----	D—L
<i>Specus fimbriatus</i> , n. sp.-----	D—L
Molluscoidea (Bryozoa) :	
<i>Graysonia bergquisti</i> , n. sp.-----	D—L
Mollusca (Pelecypoda) :	
<i>Protarca? tramitensis</i> (Cragin)-----	D?, E—L
? sp.	
<i>Breviarca (Sanoarca) grandis</i> , n. sp.-----	D—T
sp.	
<i>Panis cuneiformis</i> , n. sp.?-----	D?, L, T?
<i>Phelopteria</i> sp.	
<i>Pseudoptera viana</i> , n. sp.-----	D—L
<i>rushana</i> , n. sp.-----	D—L
sp.	
<i>Ostrea soleniscus</i> Meek-----	D—T
<i>Eogyra columbella</i> Meek-----	D?, L—T
<i>Anomia ponticulana</i> , n. sp.-----	D—T
<i>Brachidontes flisculptus</i> (Cragin)-----	D—L
<i>fulpensis</i> , n. sp.-----	D—L
sp.	
<i>Anatimya eulesana</i> , n. sp.-----	D—L
<i>Psilomya concentrica</i> (Stanton)-----	D—T
<i>Cuspidaria alaeformis</i> (Shumard)-----	D—L
<i>Fulpia pinguis</i> Stephenson-----	D—T
<i>Protocardia</i> sp.	
<i>Solya stewarti</i> , n. sp.-----	D—L, T?
<i>Leptosolen angustus</i> , n. sp.-----	D—T
<i>Priscoactra cymba</i> , n. sp.-----	D—L
<i>munda</i> , n. sp.-----	D?, L
<i>Aliomactra</i> sp.	
<i>Geltena subequilatera</i> Stephenson-----	D—L
<i>subcompressa</i> , n. sp.-----	D—L
<i>Caryocorbula? ovisana</i> , n. sp.-----	D—T
<i>varia</i> , n. sp.-----	D?, E—L
<i>Parmicorbula vokesi</i> , n. sp.-----	D?, E—T
<i>sinuosa</i> , n. sp.-----	D—L
<i>rupana</i> , n. sp.-----	D?, E?, T
sp.	
<i>Ursirivus arlingtonanus</i> , n. sp.-----	D—L
"Corbula" sp.	
Mollusca (Gastropoda) :	
<i>Turbo? sp.</i>	
<i>Diadora? bartonvillensis</i> , n. sp.-----	D
<i>Pseudomelania? roanokana</i> , n. sp.-----	D—L
<i>Natica humilis</i> Cragin-----	D—L
<i>Turritella</i> sp.	
<i>Pyrgulifera costata</i> , n. sp.-----	D—L
<i>costata tuberata</i> , n. var.-----	D—L
<i>Vascellum tensum</i> , n. sp.-----	D—L
<i>Voysa planolata</i> , n. sp.-----	D?, E—L
<i>compacta</i> , n. sp.-----	D—L
<i>minor</i> , n. sp.-----	D—L
<i>Anchura whitneyensis</i> , n. sp.-----	D?, E?, L
<i>Paladmete? sp.</i>	
<i>Acteonella? sp.</i>	
<i>Rhytiphorus? sp.</i>	
Crustacea :	
<i>Callianassa? sp.</i> , Stenzel.	

The list contains 39 named species and varieties (one species questioned) and unidentified species in 14 genera. Of the unquestioned species, 18 are present in the overlying Eules member, 29 in the Lewisville member, and 7 in the Templeton member. One species only, *Diadora bartonvillensis*, is restricted to the Dexter member.

The evidence afforded by the larger invertebrate fossils indicates a close faunal relationship between the Dexter member and the younger members of the formation.

EULESS MEMBER

The Eules member is mainly a shale facies best developed in Tarrant and southern Denton Counties. Most of the fossils occur as external and internal molds in interbedded thin layers of fine ferruginous sandstone. A list of the fossils follows.

Invertebrate fossils from the Eules member

[D=Dexter, E=Eules, L=Lewisville, and T=Templeton. D—T, for example, indicates the fossil ranges from the Dexter to Templeton members.]

Porifera (Spongiae) :	
<i>Cliona retiformis</i> , n. sp.-----	D—L
<i>Specus fimbriatus</i> , n. sp.-----	D—L
Annelida (Chaetopoda) :	
<i>Serpula</i> sp.	
Mollusca (Pelecypoda) :	
<i>Protarca? tramitensis</i> (Cragin)-----	D?, E—L
<i>Breviarca (Sanoarca) grandis</i> , n. sp.-----	D—T
(<i>Sanoarca</i>) <i>faucana</i> , n. sp.-----	E—L
<i>Inoceramus eulesanus</i> , n. sp.-----	E
<i>Phelopteria dalli</i> (Stephenson)-----	D—T
<i>Ostrea soleniscus</i> Meek-----	D—T
<i>leveretti</i> , n. sp.-----	E—L
<i>Eogyra</i> sp.	
<i>Unio</i> sp. A (fresh water)-----	E—R
<i>Anomia ponticulana</i> , n. sp.-----	D—T
<i>Volsella modesta</i> , n. sp.-----	E—T
<i>Brachidontes flisculptus</i> (Cragin)-----	D—L
<i>flisculptus microcostae</i> , n. var.-----	E—L
<i>fulpensis</i> , n. sp.-----	D—L
sp.	
<i>Laternula</i> sp.	
<i>Anatimya eulesana</i> , n. sp.-----	D—L
sp.	
<i>Psilomya</i> sp.	
<i>Cuspidaria alaeformis</i> (Shumard)-----	D—L
<i>Pollex</i> sp.	
<i>Fulpia pinguis</i> Stephenson-----	D—T
<i>Solya stewarti</i> , n. sp.-----	D—L, T?
<i>Senis elongatus</i> , n. sp.-----	E?, L
<i>Aliomactra compressa</i> , n. sp.-----	E?, L—T
<i>Geltena subequilatera</i> Stephenson-----	D—L
<i>nitida</i> , n. sp.-----	E—L
<i>subcompressa</i> , n. sp.-----	D—L
<i>Caryocorbula? ovisana</i> , n. sp.-----	D—T
? <i>varia</i> , n. sp.-----	D?, E—L
? <i>tradingensis</i> , n. sp.-----	E?, L
<i>Parmicorbula rupana</i> , n. sp.-----	D?, E?, T
<i>Ursirivus fanninensis</i> , n. sp.-----	E—L
<i>arlingtonanus</i> , n. sp.-----	D—L
"Corbula" <i>dentonensis</i> , n. sp.-----	E?, L
sp.	
<i>Opertochasma venustum</i> , n. sp.-----	E—L

Mollusca (Gastropoda) :

<i>Natica rivulana</i> , n. sp.-----	E—L, T?
<i>Pyrgulifera costata</i> , n. sp.-----	D—L
<i>costata sublevis</i> , n. var.-----	E—L
<i>Vascellum vascellum pressulum</i> , n. var.-----	E
<i>vascellum subornatum</i> , n. var.-----	E—L
<i>vianum</i> , n. sp.-----	E—L
<i>procerum</i> , n. sp.-----	E—L
<i>Voysa planolata</i> , n. sp.-----	D?, E—L
<i>savoiana</i> , n. sp.-----	E—L
<i>compacta</i> , n. sp.-----	D—L
<i>lepada</i> , n. sp.-----	E
<i>eulessana</i> , n. sp.-----	E
? <i>constricta</i> , n. sp.-----	E?, L
<i>Anchura whitneyensis</i> , n. sp.-----	D?, E?, L

The list includes 46 named or lettered species and varieties and unidentified species in 8 genera. Eighteen of the unquestioned species are present in the underlying Dexter member, 34 in the overlying Lewisville member, and 7 in the Templeton member. Only 4 of the species listed are restricted to the Euleless member. The close faunal relationship of this member to both the Dexter member below and the Lewisville member above is obvious.

RED BRANCH MEMBER

The known fauna of the Red Branch member is meager, consisting of a few mollusks of fresh-water, brackish-water, and shallow-marine habitat, one small fresh-water crustacean, one vertebra of fish, and crocodilian teeth. The fauna is restricted geographically to Grayson County and to eastern Cooke County. The member is a zone of intertonguing shallow marine, brackish-water, and fresh-water sediments. A list of the identified animal organisms follows.

Invertebrate fossils from the Red Branch member

Mollusca (Pelecypoda) :

<i>Unio</i> sp. A (fresh water).
sp. B (fresh water).
sp. C (fresh water).

Brachidontes? sp.

Opertochasma? sp.

Mollusca (Gastropoda) :

<i>Acmaea?</i> sp.
<i>Pseudomelania?</i> <i>ferrata</i> , n. sp.
<i>Pyrgulifera costata</i> , n. sp. ? (shallow marine, brackish water, and fresh water).
? sp.

Arthropoda (Crustacea) :

<i>Cyzicus?</i> <i>shupei</i> , n. sp. (fresh water).

Of the named and lettered species listed, *Unio* sp. A is known elsewhere only in the Euleless member in Tarrant County; *Unio* sp. B, *Unio* sp. C, *Pseudomelania?* *ferrata*, and *Cyzicus?* *shupei*, are restricted to the Red Branch member; and *Pyrgulifera costata* ranges from the Dexter member through the Euleless member to the Lewisville member.

LEWISVILLE MEMBER

In Tarrant County the Lewisville member, as here defined, includes the "Tarrant" unit, which Moreman

and Adkins (in Adkins, 1933, pp. 424-426; Moreman, 1942, pp. 192-197) treated as a basal formation of the Eagle Ford "group." As will be shown on a following page, the fauna yielded by this unit relates it so closely to the typical Lewisville as to justify considering it a part of that member. A list of the fossils from the Lewisville member follows.

Invertebrate fossils from the Lewisville member

[D=Dexter, E=Euleless, L=Lewisville, and T=Templeton. D—T, for example, indicates the fossil ranges from the Dexter to Templeton members.]

Porifera (Spongiae) :

<i>Cliona retiformis</i> , n. sp.-----	D—L
<i>Specus fimbriatus</i> , n. sp.-----	D—L

Annelida (Chaetopoda) :

<i>Serpula implicata</i> , n. sp.-----	L
sp.	

Molluscoidea (Bryozoa) :

<i>Graysonia bergquisti</i> , n. sp.-----	D—L
<i>Membranipora</i> sp.	

Molluscoidea (Brachiopoda) :

<i>Lingula subspatulata</i> Hall and Meek?-----	L—T
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Mollusca (Pelecypoda) :

<i>Nucula rivulana</i> , n. sp.-----	L
sp.	
<i>Acila</i> (<i>Truncacila</i>)? sp. a-----	L
<i>Nuculana?</i> <i>mutuata</i> , n. sp.-----	L
? sp.	
<i>Yoldia?</i> <i>septariana</i> Cragin-----	L—T
? <i>subacuta</i> , n. sp.-----	L—T
<i>Protarca?</i> <i>tramitensis</i> (Cragin)-----	D?, E—L
<i>Breviarca habita</i> , n. sp.-----	L—T
(<i>Sanoarca</i>) <i>grandis</i> , n. sp.-----	D—T
(<i>Sanoarca</i>) <i>faucana</i> , n. sp.-----	E—L
sp.	

Linter? sp.

Pinna sp.

<i>Inoceramus prefragilis</i> , n. sp.-----	L—T
<i>arvanus</i> , n. sp.-----	L

Aguilera cummingsi White----- L |

Panis cuneiformis, n. sp.----- D?, L, T? |

Phelopteria dalli (Stephenson)----- D—T |

<i>timberensis</i> , n. sp.-----	L
sp.	

Pseudoptera serrata, n. sp.----- L—T |

hornensis, n. sp.----- L |

viana, n. sp.----- D—L |

rushana, n. sp.----- D—L || sp. | |

Ostera soleniscus Meek----- D—T |

carica Cragin----- L |

subradiata Cragin----- L |

leveretti, n. sp.----- E—L |

Erogyra columbella Meek----- D?, L—T || sp. | |

Pecten (*Camptonectes*) *martinsensis*, n. sp.----- L—T |

Lima, sp.

Anomia ponticulana, n. sp.----- D—T |

Volshella tarrantana, n. sp.----- L |

modesta, n. sp.----- E—T |

Brachidontes filisculptus (Cragin)----- D—L |

filisculptus microcostae, n. var.----- E—L |

fulpensis, n. sp.----- D—L |

arlingtonanus, n. sp.----- L || sp. | |

Mollusca (Pelecypoda)—Continued

<i>Botula carolinensis</i> (Conrad) ?	L
<i>plumosa</i> , n. sp.	L
<i>Laternula virgata</i> , n. sp.	L—T
<i>tofana</i> , n. sp.	L
<i>johnsonana</i> , n. sp.	L
<i>gemmea</i> , n. sp.	L
<i>Anatimya longula</i> , n. sp.	L
<i>eulessana</i> , n. sp.	D—L
sp.	
<i>Psilomya levis</i> , n. sp.	L
<i>Liopistha</i> sp.	
<i>Cuspidaria alaeformis</i> (Shumard)	D—L
<i>Pollex obscus</i> , n. sp.	E?, L
? <i>angulatus</i> , n. sp.	L
<i>Veniella?</i> sp.	
<i>Crassatella</i> sp.	
<i>Fulpia pinguis</i> Stephenson	D—T
? sp.	
<i>Dentonia leveretti</i> (Cragin)	L
<i>Lucina dentonana</i> , n. sp.	L—T
sp.	
<i>Protocardia torta</i> , n. sp.	L
<i>timberensis</i> , n. sp.	L
sp.	
<i>Isocardia slatana</i> , n. sp.	L?, T
<i>Callistina</i> (<i>Larma</i>) <i>munda</i> , n. sp.	L—T
(<i>Larma</i>) <i>taffi</i> (Cragin)	L—T
(<i>Larma</i>) <i>alta</i> , n. sp.	L
<i>Pharodina ferrana</i> , n. sp.	L
? sp.	
<i>Sinonia levis</i> , n. sp.	L—T
<i>Nelltia stenzeli</i> , n. sp.	L
" <i>Tellina</i> " <i>stabulana</i> , n. sp.	L—T
<i>rivana</i> , n. sp.	L
<i>parkerana</i> , n. sp.	L
<i>dugansensis</i> , n. sp.	L—T
sp.	
<i>Linearia</i> (<i>Liothyris</i>) <i>concentrica</i> , n. sp.	L—T
sp.	
<i>Solya stewarti</i> , n. sp.	D—L, T?
<i>Protodonax lingulatus</i> , n. sp.	L
<i>lingulatus tensus</i> , n. var.	L
<i>robustus</i> , n. sp.	L
<i>Leptosolen angustus</i> , n. sp.	D—T
<i>Senis elongatus</i> , n. sp.	E?, L
<i>Cymbophora schucherti</i> , n. sp.	L
<i>spooneri</i> , n. sp.	L—T
<i>securis</i> , n. sp.	L—T
<i>puteana</i> , n. sp.	L
<i>saccellana</i> , n. sp.	L
sp.	
<i>Priscomactra cymba</i> , n. sp.	D—L
<i>munda</i> , n. sp.	D?, L
sp.	
<i>Aliomactra compressa</i> , n. sp.	E?, L—T
<i>Geltena subequilatera</i> Stephenson	D—L
<i>obesa</i> , n. sp.	L
<i>nitida</i> , n. sp.	E—L
<i>prunoides</i> , n. sp.	L
<i>subcompressa</i> , n. sp.	D—L
<i>Caryocorbula?</i> <i>ovisana</i> , n. sp.	D—T
? <i>varia</i> , n. sp.	D?, E—L
? <i>tradingensis</i> , n. sp.	E?, L
? sp.	

Mollusca (Pelecypoda)—Continued

<i>Parmicorbula vokesi</i> , n. sp.	D?, L—T
<i>sinuosa</i> , n. sp.	D—L
? <i>hillensis</i> , n. sp.	L
sp.	
<i>Ursirivus fanninensis</i> , n. sp.	E—L
<i>arlingtonanus</i> , n. sp.	D—L
" <i>Corbula</i> " <i>senecta</i> , n. sp.	L
<i>ponsana</i> , n. sp.	L—T
<i>amniculana</i> , n. sp.	L—T
<i>dentonensis</i> , n. sp.	E?, L
<i>starana</i> , n. sp.	L
<i>pulvinata</i> , n. sp.	L—T
sp.	
<i>Pholas?</i> <i>scaphoides</i> , n. sp.	L
<i>Opertochasma venustum</i> , n. sp.	E—L
<i>subconicum</i> , n. sp.	L—T
<i>Terebrimya lamarana</i> , n. sp.	L—T
Mollusca (Scaphopoda) :	
<i>Dentalium minor</i> , n. sp.	L—T
sp.	
<i>Cadulus praetenuis</i> , n. sp.	L—T
sp.	
Mollusca (Gastropoda) :	
<i>Acmaea pilleolus</i> , n. sp.	L—T
<i>Nerita ornata</i> , n. sp.	L
<i>semilevis</i> , n. sp.	L
sp.	
<i>Neritina</i> (<i>Velatella</i>) <i>ambrosana</i> , n. sp.	L
<i>Pseudomelania roanokana</i> , n. sp.	D—L
<i>Ambrosea nitida</i> , n. sp.	L
<i>Confusiscala?</i> sp.	
<i>Natica humilis</i> Cragin	D—L
<i>dorothiensis</i> , n. sp.	L—T
<i>dorothiensis pendula</i> , n. var.	L—T
<i>dorothiensis alveata</i> , n. var.	L—T
<i>rivulana</i> , n. sp.	E—L, T?
<i>Gyrodes tramitensis</i> (Cragin)	L—T
<i>Turritella shuleri</i> , n. sp.	L—T
<i>Mesalia shumardi</i> , n. sp.	L
<i>Craginia turritiformis</i> , n. sp.	L—T
<i>Gymnentome valida</i> , n. sp.	L—T
<i>valida brevis</i> , n. var.	L—T
<i>Pyrgulifera ornata</i> , n. sp.	L
<i>costata</i> , n. sp.	D—L
<i>costata tuberata</i> , n. var.	D—L
<i>costata sublevis</i> , n. var.	E—L
<i>Monroea castellana</i> , n. sp.	L
? sp.	
<i>Macrocerithium tramitense</i> (Cragin)	L
<i>Levicerithium timberanum</i> , n. sp.	L
<i>planum</i> , n. sp.	L
<i>breviforme</i> , n. sp.	L
<i>basicostae</i> , n. sp.	L
? <i>microtirae</i> , n. sp.	L
? <i>altum</i> , n. sp.	L
? <i>subaltum</i> , n. sp.	L
? sp.	
<i>Hemicerithium interlineatum</i> (Cragin)	L
<i>insigne</i> , n. sp.	L
<i>Vascellum vascellum</i> , n. sp.	L
<i>vascellum subornatum</i> , n. var.	E—L
<i>elegans</i> , n. sp.	L
<i>robustum</i> , n. sp.	L
<i>pingue</i> , n. sp.	L
<i>magnum</i> , n. sp.	L
<i>vianum</i> , n. sp.	E—L

Mollusca (Gastropoda)—Continued

Vascellum—Continued

<i>tensum</i> , n. sp.-----	D—L
<i>procerum</i> , n. sp.-----	E—L
<i>leve</i> , n. sp.-----	L
<i>subleve</i> , n. sp.-----	L
<i>fortispirae</i> , n. sp.-----	L
<i>mundum</i> , n. sp.-----	L
<i>mundum subteres</i> , n. var.-----	L
<i>minusculum</i> , n. sp.-----	L
? <i>rivanum</i> , n. sp.-----	L
sp.	
<i>Voysa planolata</i> , n. sp.-----	D?, E—L
<i>savoiana</i> , n. sp.-----	E—L
<i>compacta</i> , n. sp.-----	D—L
<i>speciosa</i> , n. sp.-----	L
<i>varia</i> , n. sp.-----	L
<i>varia levicostae</i> , n. var.-----	L
<i>varia nodosa</i> , n. var.-----	L
<i>varia extensa</i> , n. var.-----	L
<i>minor</i> , n. sp.-----	D—L
? <i>craticula</i> , n. sp.-----	L
? <i>constricta</i> , n. sp.-----	E?, L
<i>Anchura turricula</i> , n. sp.-----	L?, T
<i>whitneyensis</i> , n. sp.-----	D?, E?, L
sp. A.-----	L, T?
sp. G.-----	L—T
sp. H.-----	L
sp.	
<i>Lispodesthes patula</i> , n. sp.-----	L—T
<i>Hillites multilirae</i> , n. sp.-----	L—T
<i>septarianus</i> (Cragin)-----	L—T
<i>Aliofusus balaniiformis</i> , n. sp.-----	L
<i>Carota pendula</i> , n. sp.-----	L—T
<i>Paleopsephaea decorosa</i> , n. sp.-----	L
<i>patens</i> , n. sp.-----	L—T
<i>sinuosa</i> , n. sp.-----	L—T
sp.	
<i>Parvivoluta venusta</i> , n. sp.-----	L
<i>Paladmete? turbiformis</i> , n. sp.-----	L
? sp.	
<i>Fictoaeteon sazanus</i> , n. sp.-----	L
<i>imlayi</i> , n. sp.-----	L
? sp.	
<i>Pirsila tensa</i> , n. sp.-----	L
<i>simpla</i> , n. sp.-----	L—T
<i>decora</i> , n. sp.-----	L—T
sp.	
<i>Ringicula arlingtonensis</i> , n. sp.-----	L—T
<i>Cylichna? sp.</i>	
Mollusca (Cephalopoda):	
<i>Turrillites dearingi</i> , n. sp.-----	L
<i>Euhoplites? sp.</i>	
<i>Acanthoceras tarrantense</i> (Adkins)-----	L
<i>Acanthoceras tarrantense nitidum</i> , n. var.-----	L
<i>wintoni</i> Adkins-----	L
<i>adkinsi</i> , n. sp.-----	L
<i>eulessanum</i> , n. sp.-----	L
<i>hazzardi</i> , n. sp.-----	L
<i>barcusi</i> Jones-----	L
? sp.	
<i>Forbesiceras conlini</i> , n. sp.-----	L
<i>Metengonoceras dumbli</i> (Cragin)-----	L—T
Arthropoda (Crustacea):	
<i>Scalpellum? sp.</i>	
<i>Woodbinax texanus</i> Stenzel, n. sp.-----	L

As shown by the list, the known Lewisville fauna includes 196 named or lettered species and varieties and unidentified species in 43 genera. Of the unquestioned named species and varieties, 29 are present also in the Dexter member, 34 are present in the Euleless member, and 55 in the Templeton member. Ninety-three species, varieties, and lettered species are restricted to the Lewisville member.

The inclusion of the "Tarrant" unit of Morman and Adkins in the Lewisville member is supported by the following evidence: of 63 species listed from the "Tarrant" in its type area, 33 occur also in the typical beds of the Lewisville on Timber Creek, Denton County, and 31 are among the restricted forms that are not known to range upward into the Templeton member. The species listed below are believed to have special significance in the correlation of the "Tarrant" with the typical beds of the Lewisville.

Significant species in the correlation of the "Tarrant" unit with the typical beds of the Lewisville member on Timber Creek

Protarca? tramitensis (Cragin).
Ostrea subradiata Cragin.
Brachidontes filisculptus (Cragin).
Protocardia timberensis, n. sp.
Nelltia stenzeli, n. sp.
Senis elongatus, n. sp.
Protodonax lingulatus tensus, n. var.
Cymbophora schucherti, n. sp.
Priscomactra cymba, n. sp.
Geltena nitida, n. sp.
Macrocerithium tramitense (Cragin).
Acanthoceras tarrantense nitidum, n. var.
wintoni Adkins.

TEMPLETON MEMBER

The Templeton member is mainly a shale unit but includes interbedded lenses and layers of sand and sandstone and calcareous concretions, some of which are abundantly fossiliferous. The fossils obtained from the member are listed below. The Templeton is present between the Lewisville member below and the Eagle Ford shale above in northern Denton, Grayson, Fannin, and Lamar Counties. The member is wanting, presumably because of removal by erosion, from southern Denton County southward through Tarrant, Johnson, Hill, and McLennan Counties; throughout this distance the Eagle Ford shale rests directly upon the Lewisville member.

Invertebrate fossils from the Templeton member

[D=Dexter, E=Euleless, L=Lewisville, and T=Templeton. D—T, for example, indicates the fossil ranges from the Dexter to Templeton members]

Coelenterata (Anthozoa):
 Astrangia (Coenangia) lamarensis Wells----- T
Molluscoidea (Bryozoa):
 Membranipora sp.
Molluscoidea (Brachiopoda):
 Lingula subspatulata Hall and Meek?----- L—T

Mollusca (Pelecypoda) :

<i>Nucula sholsa</i> , n. sp.-----	T
<i>Acila</i> (<i>Truncacila</i>)? <i>chicotana</i> , n. sp.-----	T
(<i>Truncacila</i>)? sp. B.-----	T
<i>Yoldia</i> ? <i>septariana</i> Cragin.-----	L—T
? <i>subacuta</i> , n. sp.-----	L—T
<i>Breviarca minor</i> , n. sp.-----	T
<i>habita</i> , n. sp.-----	L—T
<i>Breviarca</i> (<i>Sanoarca</i>) <i>grandis</i> , n. sp.-----	D—T
<i>Idonearca blanpiedi</i> , n. sp.-----	T
<i>Inoceramus prefragilis</i> , n. sp.-----	L—T
sp. A.-----	T
sp. B.-----	T
<i>Panis cuneiformis</i> , n. sp.-----	D?, L, T?
<i>Gervillella</i> ? sp.-----	
<i>Phelopteria dalli</i> (Stephenson)-----	D—T
<i>Pseudoptera serrata</i> , n. sp.-----	L—T
<i>Ostrea soleniscus</i> Meek-----	D—T
<i>Exogyra columbella</i> Meek-----	D?, L—T
<i>columbella levis</i> , n. var.-----	T
sp.-----	
<i>Pecten</i> (<i>Camptonectes</i>) <i>moodyi</i> , n. sp.-----	T
(<i>Camptonectes</i>) <i>ellsworthensis</i> , n. sp.-----	T
(<i>Camptonectes</i>) <i>martinsensis</i> , n. sp.-----	L—T
(<i>Camptonectes</i>) <i>cavanus</i> , n. sp.-----	T
(<i>Camptonectes</i>) sp.-----	
<i>Plicatula goldenana</i> , n. sp.-----	T
<i>Lima</i> sp.-----	
<i>Anomia ponticulana</i> , n. sp.-----	D—T
<i>Volsella alveolata</i> , n. sp.-----	T
<i>Volsella modesta</i> , n. sp.-----	E—T
<i>Crenella subcircularis</i> , n. sp.-----	T
<i>Pholadomya goldenensis</i> , n. sp.-----	T
sp.-----	
<i>Laternula virgata</i> , n. sp.-----	L—T
<i>scutulium</i> , n. sp.-----	T
sp.-----	
<i>Psilomya concentrica</i> (Stanton)-----	D—T
<i>Opis</i> ? <i>elevata</i> , n. sp.-----	T
<i>Fulpia pinguis</i> Stephenson-----	D—T
<i>Venericardia alveana</i> , n. sp.-----	T
<i>Seata navicula</i> , n. sp.-----	T
<i>ethelana</i> , n. sp.-----	T
<i>Lucina dentonana</i> , n. sp.-----	L—T
<i>aspera</i> , n. sp.-----	T
sp.-----	
<i>Cardium</i> (<i>Trachycardium</i>) <i>tinninense</i> , n. sp.-----	T
<i>Isocardia slatana</i> , n. sp.-----	L?, T
<i>slatana parva</i> , n. var.-----	T
<i>Callistina lamarensis</i> (Shumard)-----	T
(<i>Larma</i>) <i>manda</i> , n. sp.-----	L—T
(<i>Larma</i>) <i>taffi</i> (Cragin)-----	L—T
<i>Cyprimeria patella</i> , n. sp.-----	T
<i>Cyclorisma orbiculata</i> , n. sp.-----	T
<i>Legumen ligula</i> , n. sp.-----	T
<i>Sinonia levis</i> , n. sp.-----	L—T
<i>Flaventia ludana</i> , n. sp.-----	T
" <i>Tellina</i> " <i>stabulana</i> , n. sp.-----	L—T
<i>dugansensis</i> , n. sp.-----	L—T
sp.-----	
<i>Linearia</i> (<i>Liothyris</i>) <i>concentrica</i> , n. sp.-----	L—T
<i>Solyma stewarti</i> , n. sp.-----	D—L, T?
<i>Leptosolen angustus</i> , n. sp.-----	D—T
<i>Cymbophora spooneri</i> , n. sp.-----	L—T
<i>securis</i> , n. sp.-----	L—T
<i>Alomactra compressa</i> , n. sp.-----	E?, L—T
<i>Caryocorbula</i> ? <i>ovisana</i> , n. sp.-----	D—T

Mollusca (Pelecypoda)—Continued

<i>Parmicorbula vokesi</i> , n. sp.-----	D?, L—T
<i>numerosa</i> , n. sp.-----	T
<i>corneliana</i> , n. sp.-----	T
<i>rupana</i> , n. sp.-----	D?, E?, T
" <i>Corbula</i> " <i>ponsana</i> , n. sp.-----	L—T
<i>amniculana</i> , n. sp.-----	L—T
<i>pulvinata</i> , n. sp.-----	L—T
<i>Panope subparallela</i> Shumard-----	T
<i>Opertochasma subconicum</i> , n. sp.-----	L—T
<i>Terebrimya lamarana</i> , n. sp.-----	L—T
Mollusca (Scaphopoda) :	
<i>Dentalium alincatum</i> , n. sp.-----	T
<i>sublineatum</i> , n. sp.-----	T
<i>minor</i> , n. sp.-----	L—T
sp.-----	
<i>Cadulus praetenuis</i> , n. sp.-----	L—T
Mollusca (Gastropoda) :	
<i>Acmaea pilleolus</i> , n. sp.-----	L—T
<i>Turbo</i> ? <i>serratus</i> , n. sp.-----	T
<i>Neritina</i> ? <i>insolita</i> , n. sp.-----	T
<i>Epitonium stellanum</i> , n. sp.-----	T
<i>Dathmilla lineola</i> , n. sp.-----	T
<i>Natica striaticostata</i> Cragin-----	T
<i>dorotheiensis</i> , n. sp.-----	L—T
<i>dorotheiensis pendula</i> , n. var.-----	L—T
<i>dorotheiensis alveata</i> , n. var.-----	L—T
<i>Natica rivulana</i> , n. sp.-----	E—L, T?
<i>Gyrodos tramitensis</i> (Cragin)-----	L—T
<i>fluvianus</i> , n. sp.-----	T
<i>Xenophora</i> ? sp.-----	
<i>Lirpsa cornuata</i> , n. sp.-----	T
<i>teres</i> , n. sp.-----	T
<i>Turritella shuleri</i> , n. sp.-----	L—T
<i>Craginia turritiformis</i> , n. sp.-----	L—T
<i>Gymnentome valida</i> , n. sp.-----	L—T
<i>valida brevis</i> , n. var.-----	L—T
<i>Anchura turricula</i> , n. sp.-----	L?, T
<i>horreana</i> , n. sp.-----	T
sp. A.-----	L, T?
sp. B.-----	T
sp. C.-----	T
sp. D.-----	T
sp. E.-----	T
sp. F.-----	T
sp. G.-----	L—T
sp.-----	
" <i>Anchura</i> " <i>modesta</i> (Cragin)-----	T
<i>Lispedesthes panda</i> , n. sp.-----	T
<i>patula</i> , n. sp.-----	L—T
<i>Trachytriton</i> ? sp.-----	
<i>Hillites multilirae</i> , n. sp.-----	L—T
<i>septarianus</i> (Cragin)-----	L—T
" <i>Fusinus</i> " <i>fuminis</i> , n. sp.-----	T
<i>cornelianus</i> , n. sp.-----	T
" <i>Fasciolaria</i> " sp.-----	
<i>Bellifusus</i> ? <i>parvilirae</i> , n. sp.-----	T
<i>Carota robusta</i> , n. sp.-----	T
<i>pendula</i> , n. sp.-----	L—T
? <i>nodosa</i> , n. sp.-----	T
? <i>biplicata</i> , n. sp.-----	T
<i>Paleopsephaea vadoana</i> , n. sp.-----	T
<i>patens</i> , n. sp.-----	L—T
<i>sinuosa</i> , n. sp.-----	L—T
sp.-----	
" <i>Volutomorpha</i> " <i>graysonensis</i> (Cragin)-----	f
Unidentified volutid	

Mollusca (Gastropoda)—Continued	
<i>Tovula microlirae</i> , n. sp.-----	T
<i>teres</i> , n. sp.-----	T
<i>Caveola pinguis</i> , n. sp.-----	T
<i>bellsana</i> , n. sp.-----	T
<i>Cancellaria?</i> sp.	
<i>Fictoacteon alveolanus</i> , n. sp.-----	T
<i>humilispira</i> , n. sp.-----	T
<i>paucistriata</i> , n. sp.-----	T
sp.	
<i>Pirsila simpla</i> , n. sp.-----	L—T
<i>decora</i> , n. sp.-----	L—T
<i>obtusa</i> , n. sp.-----	T
sp.	
<i>Ringicula arlingtonensis</i> , n. sp.-----	L—T
Mollusca (Cephalopoda):	
<i>Hamites?</i> sp.	
<i>Desmoceras?</i> sp.	
<i>Acanthoceras cuspidum</i> , n. sp.-----	T
? sp.	
<i>Mamites?</i> <i>bellsanus</i> , n. sp.-----	T
<i>Metengonoceras dumbli</i> (Cragin)-----	L—T
<i>Metoicoceras swallowii</i> (Shumard)-----	T
<i>swallowii macrum</i> , n. var.-----	T
<i>latoverter</i> , n. sp.-----	T
<i>crassicostae</i> , n. sp.-----	T
sp.	
Arthropoda (Crustacea):	
<i>Cenomanocarcinus vanstraeleni</i> Stenzel, n. sp.---	T

The listed fauna includes 136 named species, varieties, and lettered species, and unidentified species in 22 genera. Of the unquestioned forms, 7 are present in the Dexter member, 7 in the Eules member, 55 in the Lewisville member, and 72 are restricted to the Templeton member.

FOSSILS FROM LOCALITIES NOT RECORDED ON CHART OF DISTRIBUTION

A few collections made by H. R. Bergquist in Grayson and Lamar Counties and by W. S. Adkins in Hill County were received after the chart of distribution was completed. They have, however, been recorded under "occurrence" in the systematic descriptions and have been included in the summary statements given under the heading "Analysis of the fauna of the Woodbine formation." The localities at which Bergquist made his collections are indicated on the map and are fully described in the section "Fossil collecting localities," pages 35-44.

Bergquist's collections follow:

Locality 219. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Protarca?</i> <i>tramitensis</i> (Cragin).	
<i>Ostrea soleniscus</i> Meek.	
<i>Anatimya eulesana</i> , n. sp.	
<i>Fulpia pinguis</i> Stephenson.	
Mollusca (Gastropoda):	
<i>Craginia turriiformis</i> , n. sp.	
<i>Vascellum mundum subteres</i> , n. var.	
Locality 220. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Breviarca (Sanoarca) grandis</i> , n. sp.	

Locality 221. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Nucula</i> sp. (small, numerous, poorly preserved).	
Locality 222. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Callistina (Larma) alta</i> , n. sp.	
Locality 223. Lewisville member, Grayson County.	
Molluscoidea (Brachiopoda):	
<i>Lingula subspatulata</i> Hall and Meek?	
Mollusca (Pelecypoda):	
<i>Breviarca (Sanoarca) grandis</i> , n. sp.	
<i>Anatimya longula</i> , n. sp.	
<i>Fulpia pinguis</i> Stephenson.	
<i>Geltena obesa</i> , n. sp.	
<i>Senis elongatus</i> , n. sp.	
Mollusca (Gastropoda):	
<i>Voysa minor</i> , n. sp.	
<i>Hillites</i> sp.	
Locality 224. Lewisville member. Grayson County.	
Annelida (Chaetopoda):	
<i>Serpula</i> sp.	
Mollusca (Pelecypoda):	
<i>Protarca?</i> <i>tramitensis</i> (Cragin).	
<i>Breviarca (Sanoarca) grandis</i> , n. sp.	
Mollusca (Gastropoda):	
<i>Craginia turriiformis</i> , n. sp.	
<i>Gymnentome valida brevis</i> , n. var.	
Locality 225. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Phelopteria dalli</i> (Stephenson).	
<i>Ostrea soleniscus</i> Meek.	
Mollusca (Gastropoda):	
<i>Lispodesthes?</i> sp.	
Locality 226. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Breviarca</i> sp.	
<i>Phelopteria dalli</i> (Stephenson).	
<i>Brachidontes fulpensis</i> , n. sp.	
Locality 227. Lewisville member, Grayson County.	
Mollusca (Pelecypoda):	
<i>Breviarca?</i> sp.	
<i>Anatimya longula</i> , n. sp.	
<i>Geltena obesa</i> , n. sp.	
Mollusca (Gastropoda):	
<i>Voysa minor</i> , n. sp.	
Locality 228. Templeton member, Lamar County.	
Mollusca (Pelecypoda):	
<i>Ostrea soleniscus</i> Meek.	
<i>Callistina lamarensis</i> (Shumard).	
Locality 229. Templeton member, Lamar County.	
Mollusca (Pelecypoda):	
<i>Ostrea soleniscus</i> Meek.	
<i>Pecten (Camptonectes) ellsworthensis</i> , n. sp.	
<i>Cardium (Trachycardium) tinninense</i> , n. sp.	
<i>Callistina (Larma) munda</i> , n. sp.	
Mollusca (Gastropoda):	
<i>Lispodesthes patula</i> , n. sp.	
Locality 230. Templeton member, Lamar County.	
Mollusca (Pelecypoda):	
<i>Ostrea soleniscus</i> Meek.	
<i>Ecogyra columbella</i> Meek.	
<i>Cardium (Trachycardium) tinninense</i> , n. sp.	
<i>Callistina (Larma) munda</i> , n. sp.	
<i>Cyclorisma orbiculata</i> , n. sp.	
<i>Opertochasma subconicum</i> , n. sp.	

Locality 230. Templeton member, Lamar County—Continued

Mollusca (Gastropoda):

Natica? sp.

Anchura turricula, n. sp.

"*Volutomorpha*" *graysonensis* (Cragin).

Locality 231. Templeton member.

Mollusca (Pelecypoda):

Breviarca sp.

Callistina lamarensis (Shumard).

Adkins' collections, all from Hill County, follow:

Locality 210. Lewisville member.

Mollusca (Pelecypoda):

Yoldia subacuta, n. sp.

Cuspidaria alaeformis (Shumard).

Sinonia levis, n. sp.

Cymbophora spooneri, n. sp.

Mollusca (Cephalopoda):

Mammites? sp. (fragment showing one saddle).

Locality 211. Lewisville member.

Mollusca (Pelecypoda):

Fulpia pinguis Stephenson.

Sinonia levis, n. sp.

Parmicorbula? sp.

Mollusca (Cephalopoda):

Indeterminate fragments.

Locality 212. Lewisville member.

Mollusca (Pelecypoda):

Sinonia levis, n. sp.

Cymbophora spooneri, n. sp.

Locality 213. Lewisville member.

Mollusca (Pelecypoda):

Yoldia subacuta, n. sp.

Sinonia levis, n. sp.

Linearia (Liothyris) concentrica, n. sp.

Cymbophora spooneri, n. sp.

Parmicorbula? sp.

Mollusca (Gastropoda):

Natica sp.

Anchura whitneyensis, n. sp.

Locality 214. Lewisville member.

Mollusca (Pelecypoda):

Yoldia subacuta, n. sp.

Ostrea sp.

Protocardia sp.

Cymbophora spooneri, n. sp.

Caryocorbula? ovisana, n. sp.?

Parmicorbula? sp.

Mollusca (Gastropoda):

Natica sp.

Anchura whitneyensis, n. sp.

Unidentified gastropods.

Mollusca (Cephalopoda):

Ammonite fragments.

ECOLOGIC CONDITIONS

The organisms composing the fauna of the Woodbine formation, as represented by the material available to me, are mainly those adapted to life in shallow marine waters. The remains of organisms that may have lived far from shore in deeper waters are now deeply buried out under the Gulf Coastal Plain and are not available for examination and cannot be taken into account. Locally the organisms here described may have lived in brackish-water estuaries or lagoons. A few fresh-water

species have been found in the Euless and Red Branch members of the formation. The presence of carbonaceous clays and thin beds of impure lignite in the Euless and Red Branch members, and rarely in the Lewisville member, indicates that sea level swamps existed in places. However, shallow-marine conditions prevailed during most of Lewisville and Templeton times. Probably the Woodbine sea did not exceed a maximum depth of 25 fathoms in the area represented by the collections studied here.

The relatively shallow depth of the Woodbine sea was not uniform from place to place parallel to the shore at any given time. Sediments were brought into the sea by streams entering from the adjacent land, and delta-like masses of sands and clays were built seaward from the mouths of the streams. Partial redistribution of these masses was effected by longshore currents, which resulted in irregularly distributed fillings in the areas of sea bottom between the deltaic masses, and in a consequent lack of uniformity in depth. There was, therefore, a certain diversity of environmental conditions owing to differences in depth. Some diversity of salinity was doubtless caused by the influx of the fresh waters of the streams. It is obvious from the heterogeneity of the sediments and the irregularity of the bedding that sea-bottom conditions must have differed greatly from place to place at any given date in Woodbine time. In places the bottom materials were mainly sand, at other places mainly clay, while intermediate areas presented intermixtures of sand and clay in varying percentages. Further diversity resulted from differing percentages of calcium carbonate in the sands and clays. During periods of vulcanicity in some adjacent area, presumably in southwest Arkansas, especially during Red Branch and Lewisville times, the influx of volcanic ejectamenta brought in by winds or longshore currents probably influenced the character of the faunal assemblages. The paucity of fossils in the tuffaceous sands and sandstones at most places suggests that the volcanic materials produced an inhibiting effect on the development of marine life. However, the abundance of fossils in tuffaceous sandstone at the Dugans Chapel locality in northeastern Grayson County (loc. 122) indicates that life was by no means excluded from a sea bottom composed of tuffaceous sand.

The great diversity in the conditions of sedimentation that existed during Woodbine time in this area doubtless accounts for the absence of well-defined faunal zones that can be traced for more than a few miles.

The ranges of the Woodbine fossil organisms, both stratigraphic and geographic, as shown by the chart of distribution (in pocket), indicate that there was a great difference in the ability of the Woodbine species to adapt themselves to differing environmental conditions on the sea bottom. Some species show by their ranges that they have this ability in high degree. The follow-

ing are examples: *Breviarca (Sanoarca) grandis*, *Phelopteria dalli*, *Ostrea soleniscus*, *Anomia ponticulana*, *Fulpia pinguis*, *Caryocorbula? ovisana*, *Pyrgulifera costata*, and *Voysa compacta*. Of the species listed, *Ostrea soleniscus* ranges stratigraphically throughout the formation, typical elongated shells being present at the base of the Dexter member in Tarrant County and fairly typical specimens in the Templeton member in Grayson County. Geographically the species ranges from the extreme southern limit of the formation (Lewisville member) in McLennan County to northwestern Red River County in the northeast (also Lewisville member). The species has its most prolific development in the Lewisville member, where it forms reefs up to 7 feet thick at different stratigraphic positions within the member and at many places along the belt of outcrop. (See pls. 5C, 6A, B). The reefs are generally found in sand or sandstone, the latter being sometimes referred to as the "oyster-reef sandstones."

At the other extreme of range many species are known from one locality only, at which place the individuals may be few or numerous. Some examples follow: *Astrangia (Coenangia) lamarensis* (one specimen only), *Nucula sholsa*, *Crenella subcircularis*, *Venericardia alveana* (numerous), *Protodonax robustus*, *Parmicorbula corneliana*, *Dentalium alineatum*, *Turbo serratus*, *Diadora? bartonvillensis*, *Neritina insolita*, *Epitonium stellanum*, *Lirpsa cornuata*, *Monroea castellana*, *Paleopsephaea decorosa*, *Caveola bellsana*, *Fictocacteon imlayi*, *Turrilites dearingi*, *Acanthoceras adkinsi*, *Forbesiceras conlini*, *Metoicoceras latoventer*, and *Cyzicus? shupei*.

Some species that are present in Denton County and south of there have not been recorded from the same member north of Denton County. A few examples from the Lewisville member are: *Aguileria cumminsii*, *Ostrea leveretti*, *Brachidontes arlingtonensis*, *Protocardia timberensis*, *Nelltia stenzeli*, *Nerita semilevis*, *Acanthoceras tarrentense*, and *Acanthoceras wintoni*. A few examples from the same member in the northern counties that have not been found in the southern counties are: *Nucula rivulana*, *Inoceramus prefragilis*, *Pseudoptera serrata*, *Callistina (Larma) alta*, *Pharodina ferrana*, *Cymbophora securis*, *Pyrgulifera ornata*, *Vascellum vascellum*, and *Lispodesthes patula*.

Why there should have been a restriction in the geographic ranges of some species as between the northern and southern parts of the area is not clear from the available evidence. It seems improbable that differences in the temperature of the water could have accounted for the restriction. It is generally believed from the evidence afforded by both plant and animal fossil organisms that warm temperatures prevailed in the northern part of the Gulf region and indeed in areas extending far to the north in the Atlantic coastal region during Cretaceous time, a condition which would

seem to insure uniformity of temperature in shallow marine waters in areas so closely adjacent to each other as these northern and southern counties in Texas. The restriction probably resulted from some inhibiting factor not easily determinable from present available data.

Organisms that might be expected to be present in a shallow warm-temperate sea but which are conspicuously rare or absent include echinoids, corals (only one example known), calcareous foraminifers, and decapod crustaceans (several species, each rare). The reason for the paucity of most of these organisms is not known. However, on p. 212 of this volume H. B. Stenzel offers as an explanation of the paucity of decapod crustacean remains the undersaturated condition of the waters of the Woodbine sea with respect to phosphatic and calcareous chemical components.

PLANT REMAINS IN THE WOODBINE FORMATION

The presence of fossil plants in beds now included in the Woodbine formation was first reported by B. F. Shumard in a paper read before the Academy of Science of St. Louis in 1860 and later published in the Transactions of the Academy (1868, p. 140). He records the discovery by his brother, G. G. Shumard, of the imprints of dicotyledonous leaves in Lamar County, in yellowish sandstone which is believed to have been the tuffaceous sandstone of the Lewisville member, exposed in the right bank of Red River at Arthurs Bluff near Arthur City. Robert T. Hill collected leaves at Arthurs Bluff between 1880 and 1885 and sent them to the U. S. National Museum where, according to him, they were lost in storage.

In 1901 F. H. Knowlton (in Hill, 1901, pp. 314-318) listed fossil plants from three localities in the Woodbine formation. The first list included 12 species from a collection made by T. Wayland Vaughan at the Arthurs Bluff locality; the second included 4 species from a collection made by G. H. Ragsdale near the village of Woodbine in Cooke County; and the last included 12 species from a collection made by T. V. Munson at Rhamey Hill near Denison, Grayson County. The location of Rhamey Hill, which is within the corporate limits of Denison, limits the occurrence of these plants to the Dexter member.

A collection of fossil plants made by T. W. Stanton and me in 1911, at the Arthurs Bluff locality, was later described and illustrated by E. W. Berry (1912, pp. 387-406), and subsequently Berry (1922, pp. 153-181) published a critical review of the Woodbine flora based on all the available material from Arthurs Bluff (Lewisville member).

In connection with his recent work in northeastern Texas, H. R. Bergquist collected a few fossil plants from two localities in the Red Branch member of the formation, one in Cooke County and the other in Gray-

son County. He furnishes the following note in regard to the Cooke County locality:

Large flattish blocks of ferruginous sandstone lie scattered over the hill top, and on the weathered surface of many of them are vast numbers of prints of deciduous leaves. Other hills of eastern Cooke County are apparently "held up" by the same horizon of sandstone bearing the leaf prints, though at none of these other localities were the prints so numerous. It is possible that most of the so-called Dexter leaf collections come out of this general horizon, which is near the base of the Red Branch member of the Woodbine, or roughly about 100 feet above the Washita beds.

Roland W. Brown examined the collections from both localities and reports as follows:

Orig. No. C 344. Ferruginous sandstone (= Red Branch member) on flat top of a hill south of Sandy Creek Valley, 0.3 mile east of road, 2.3 miles east and 1.2 miles north of Callisburg, Cooke County.

Sassafras cretaceum Newberry
Cinnamomum sezannense Watelet
Quercus suspecta Lesquereux
 ?*Andromeda pfaftiana* Herr
 ?*Magnolia lacoeana* Lesquereux
Ficus proteoides Lesquereux

This assemblage looks as though it had been collected from the so-called Dakota sandstone of Kansas. I am surprised, however, at the absence of conifers.

Orig. No. G 337. Tuffaceous sandstone (= Red Branch member), east road ditch, base of hill, 0.22 mile south of Iron Ore Creek bridge and 2.6 miles south of Highway 69, near Denison, Grayson County.

Betulites westi Lesquereux
Sterculia lugubris Lesquereux

Age: Upper Cretaceous. The *Betulites westi* is a common species in the Dakota sandstone of Kansas.

FOSSIL COLLECTING LOCALITIES²

McLENNAN COUNTY³

LEWISVILLE MEMBER

1. 11835. Keyes Branch near old Bosqueville, 6 miles northwest of Waco; a 4-foot bed of calcareous sandstone overlying the Buda limestone. T. W. Stanton, 1923.
2. 14587. Ravine east of Waco road, 2.8 miles east of Gholson, 9.5 miles north by west of Waco; soft, fine sandstone interbedded with dark shaly clay, 15 or 20 feet below base of Eagle Ford shale. L. W. Stephenson, T. W. Stanton, J. B. Reeside, Jr., 1929.

HILL COUNTY

LEWISVILLE MEMBER

3. 11836, 14589, 19019. Hillsboro road, 2 miles east of Whitney; fine, more or less ferruginous sandstone. T. W. Stanton, 1923; L. W. Stephenson, Stanton, and J. B. Reeside, Jr., 1929; Roy T. Hazzard, 1941(?).
4. 13572. Aquilla Creek, right bank, 1.6 miles west of Peoria; in borings in light-gray calcareous concretions at base of Woodbine formation, resting on Grayson marl. L. W. Stephenson, 1926.

² The first number refers to the locality at which fossils were collected; it is also shown on maps and on the chart of distribution. It is followed by the U. S. Geological Survey collection number or by the number of another collection which is identified.

³ McLennan, Hill, and Johnson Counties are not shown on accompanying maps.

5. 13575. Horne Branch, 0.2 mile east of Woodbury; fine ferruginous sandstone interbedded with sand and clay. L. W. Stephenson, 1926.
6. 19018. Aquilla Creek, 1.2 miles east of Aquilla town; gray calcareous sandstone, weathering to yellowish-brown. Roy T. Hazzard, 1941(?).
7. 19020. Northeast-southwest road, 3 miles northeast of Whitney; reddish-brown ferruginous sandstone. Roy T. Hazzard, 1941(?).
8. 19021. Northwest-southeast road, 1.7 miles south of Woodbury; fine white sand in part weathered to ferruginous sandstone. Roy T. Hazzard, 1941(?).
See also 210, 211, 212, 213, and 214.

JOHNSON COUNTY

LEWISVILLE MEMBER

9. 13571. Hillsboro road, 2.5 miles northwest of Parker, 7.8 miles southeast of Cleburne; fine, more or less ferruginous sandstone. L. W. Stephenson, 1926.
10. 14141. Small branch north of a secondary road, 2.25 miles west of Grandview; oyster layer 30 feet below the top of a section composed of sandstone, sand, and subordinate clay. L. W. Stephenson, 1928.

TARRANT COUNTY

DEXTER MEMBER

11. 18979, 19508. Road ditches just north of crossroad, 1.4 miles northeast of Handley; weathered fine red ferruginous sandstone, a marine facies at base of member. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
12. 18982. Ditch of east-west road, west-facing slope of Village Creek Valley, 2.4 miles west by north of Retta; weathered red ferruginous sandstone, a marine facies, underlain by sand, which is estimated to be only a few feet above the contact with the Grayson marl. L. W. Stephenson and H. H. Gray, 1944.
13. 18985. Ditch of north-south road, northwest-facing slope of Village Creek Valley, 2.4 miles southeast of Everman; ferruginous, calcareous sandstone, a marine facies immediately above contact with the Grayson marl below. L. W. Stephenson and H. H. Gray, 1944.
14. 18988. Bed of a small branch of Rush Creek, 3 miles east by south of Handley, 1 mile south of U. S. Highway 80, just southwest of a small dairy plant; weathered orange, brown, and red ferruginous sandstone, a marine facies near base of member. L. W. Stephenson and H. H. Gray, 1944.
15. 18989. West-facing slope of Rush Creek Valley, field north of east-west road, 3.2 miles east-southeast of the center of Handley; the lower of two layers of weathered red ferruginous sandstone, marine facies. L. W. Stephenson and H. H. Gray, 1944.
16. 18991. West-facing slope of Rush Creek Valley in field north of east-west road, 3.2 miles east-southeast of the center of Handley; weathered brown and red ferruginous sandstone, a marine facies in part conglomeratic, forming the upper of two ferruginous layers that are separated from each other by 6.5 feet of shale. L. W. Stephenson and H. H. Gray, 1944. This and the preceding fossiliferous bed (loc. 15) are estimated to lie 40 to 50 feet above the base of the member.
17. 20280. North side of east-west road, 50 feet east of T-road to the north, 2.3 miles northeast of the railroad station at Keller, 0.5 mile north-northwest of a church; coarse ferruginous sandstone, a marine facies about 50 feet above base of the member. W. H. Monroe and L. W. Stephenson, 1946.

18. 20282. Roadside ditch, 2.3 miles northeast of the railroad station at Keller, 0.4 mile northwest of a church (0.2 mile southeast of loc. 17); coarse ferruginous sandstone, a marine facies about 40 feet above base of the member. W. H. Monroe and L. W. Stephenson, 1946.

EULESS MEMBER

19. 18980. East-west road, 2.6 miles north of Arlington, 0.15 mile west of the Arlington-Grapevine highway; weathered orange, brown, and red fine ferruginous sandstone with many external and internal molds of fossils. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
20. 18981. Slope of hill about 2.4 miles west by slightly north of Mansfield, about 1.2 miles north of the Johnson County line (= "twin hill" locality of Hazzard); a 3-foot bed of weathered, strongly ferruginous claystone full of shell imprints, 6 feet below a ferruginous conglomerate. L. W. Stephenson, Roy T. Hazzard, B. W. Blanpied, W. C. Spooner, and H. H. Gray, 1944.
21. 18981a. Slope of hill about 2.4 miles west by slightly north of Mansfield, about 1.2 miles north of the Johnson County line (= "twin hill" locality of Hazzard); weathered fine ferruginous sandstone with many shell imprints, 36 feet above a thin ferruginous conglomerate. L. W. Stephenson, Roy T. Hazzard, B. W. Blanpied, W. C. Spooner, and H. H. Gray, 1944.
22. 18983. Shallow cut of north-south road, 1 mile northeast of Kennedale; weathered orange and red fine ferruginous sandstone. L. W. Stephenson and H. H. Gray, 1944.
23. 18984. Top of hill on second class north-south road, 2 miles northwest of Euless, 1.7 miles south of Glade; weathered, friable ferruginous, tuffaceous sand. L. W. Stephenson and H. H. Gray, 1944.
24. 18994. North-facing slope of Big Bear Creek Valley at crossing of north-south road, 1.9 miles north of Euless; weathered orange, brown, and red fine ferruginous sandstone. L. W. Stephenson and H. H. Gray, 1944.
25. 18995. Cut on the Arlington-Grapevine highway, 0.2 mile north of its intersection with State Highway 183, 1 mile west by south of Euless; weathered reddish-brown medium to coarse hematitic and limonitic, tuffaceous? sandstone, 6 or 7 feet above base of member. L. W. Stephenson and H. H. Gray, 1944.
26. 18999. Ravine south of the Chicago, Rock Island and Pacific Railroad, at Dorothy Siding; dark shale 19 to 21 feet below the base of massive sandstone of the Lewisville member. L. W. Stephenson and H. H. Gray, 1944.
27. 19039. State Highway 183, within 1.2 miles west-southwest of Euless; weathered orange, brown, and red ferruginous sandstone. Roy T. Hazzard (field station B), 1941(?).
28. 19040. State Highway 183, within 1.2 miles west-southwest of Euless; weathered brown and red ferruginous sandstone. Roy T. Hazzard (field station W), 1941(?).
29. 19041. State Highway 183, within 1.2 miles west-southwest of Euless; weathered brown friable ferruginous sandstone. Roy T. Hazzard (field station RD), 1941(?).
30. 19041a. State Highway 193, 250 yards west of store at Euless; weathered, fine ferruginous sandstone. Roy T. Hazzard, 1941(?).
31. 20276. Northwest-facing slope of Dove Creek Valley, near a right angle turn of a county road, 3.5 miles northwest of Grapevine, 1.15 miles south of Denton County line; ferruginous concretions weathered out of shale. W. H. Monroe, H. B. Stenzel, and L. W. Stephenson, 1946.
32. 20789. Exact locality uncertain. Found loose on slope near State Highway 183, 1.4 miles west-southwest of Euless, probably from one of three highway excavations nearby; light-gray calcareous sandstone. James P. Conlin, 1947.

LEWISVILLE MEMBER

33. Texas Univ., collected by S. Leverett, 1892 (orig. no. 52a). From [Big] "Bear Creek near Dallas County line." (Not on map.)
34. 476, 478, 506. Johnson Creek (formerly Trading House Creek) "2 miles northeast of Arlington [probably about 1.5 miles]"; fine ferruginous sandstone in lower part of member. W. F. Cummins, 1886; C. A. White, 1887.
35. 477, 507. Johnson Creek (formerly Trading House Creek), 1 mile east of Arlington, Tarrant County; abundantly fossiliferous, impure limestone in lower part of member. W. F. Cummins, 1886; C. A. White, 1887. Recent attempts to find this locality have been unsuccessful.
36. 508. Nine miles north of Arlington; Tarrant unit of Moreman. Details are lacking, and the locality has not been identified by later investigators; it probably is in the valley of Big Bear Creek or one of its headwater tributaries, within 3 miles of Euless. C. A. White, 1887. (Not on map.)
37. 11735. Johnson Creek (formerly Trading House Creek), about 3 miles northeast of Arlington; calcareous sandstone. T. W. Stanton, 1923.
38. 11736. Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line; calcareous sandstone (Tarrant unit of Moreman). T. W. Stanton, 1923.
39. 11738, 13582, 13583, 14110, 14570, 18231. Cut of Chicago, Rock Island and Pacific Railroad, and stream branches nearby, 1.1 to 1.3 miles east of Tarrant Station, and within 0.3 mile west of Dorothy Siding; sandy shale and marl with interbedded thin platy sandstones; include Tarrant unit of Moreman and underlying heavy-bedded sandstone. T. W. Stanton, 1923; L. W. Stephenson, 1926, 1928, 1940; Stephenson, Stanton, and J. B. Reeside, Jr., 1929.
40. 13581. Public road (old road) just west of bridge over Big Bear Creek, about 2.7 miles northeast of Tarrant Station; shaly clay with concretions of calcareous sandstone (Tarrant unit of Moreman). L. W. Stephenson, 1926.
41. 14567, 14568. Small branch within 1,000 feet north of the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line; gray calcareous sandstone, about 10 feet above a thin conglomerate at base of Tarrant unit of Moreman. L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929.
42. 14569, 17160, 18073. Cut in public road, 0.4 mile north of the Chicago, Rock Island and Pacific Railroad, 1 mile northeast of Tarrant Station, 1.5 miles west of the Dallas County line; 8 feet of thin-bedded sandstone, clay, and sandy clay, with a conglomerate 1 to 8 inches thick at base (Tarrant unit of Moreman). L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929; Stephenson, 1935; Roy T. Hazzard, 1939.
43. 14579. Walnut Creek, 150 feet below the old pier of an abandoned bridge, about 4.8 miles east-northeast of Mansfield; calcareous, conglomeratic sandstone in bed of creek. L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929.
44. 18218, 18638, 18986, 18998, 19504. A small south-flowing branch intersecting the Chicago, Rock Island and Pacific Railroad just east of Dorothy Siding, about 1 mile west of the Dallas County line; about 18 feet of clay, sand, and platy calcareous sandstone, irregularly bedded and more or less cross-bedded, forming the upper part of the mem-

- ber (Tarrant unit of Moreman), exposed 750 to 1,200 feet upstream from the railroad. L. W. Stephenson, 1940, 1941; Stephenson and H. H. Gray, 1944; Stephenson and H. R. Bergquist, 1945.
45. 18219. Cut along spur of Chicago, Rock Island and Pacific Railroad leading to gravel pit at Dorothy Siding, 1.2 miles west of the Dallas County line; sand and sandstone. L. W. Stephenson, 1940.
46. 18221, 19507. Ditch just north of the Chicago, Rock Island and Pacific Railroad near west end of cut, 0.9 mile west of the Dallas County line; gray calcareous sandstone interbedded in sandy shale, about 7 feet above base of upper part (Tarrant unit of Moreman) of the member. L. W. Stephenson, 1940.
47. 18639, 19526. Johnson Creek (formerly Trading House Creek), 1.5 miles northeast of the Methodist Church at Arlington, 0.9 mile north-northeast of the Eastern Star Home; fine ferruginous sandstone in lower part of member. L. W. Stephenson, 1941; Stephenson, W. H. Monroe, and H. R. Bergquist, 1945.
48. 18640. Walnut Creek, left bank, 1,500 feet downstream from the crossing of a northwest-southeast road, which is about 5.7 miles northeast of Mansfield; fine gray calcareous concretionary sandstone. L. W. Stephenson, 1941.
49. 18987, 19512. Branch north of the old Keller road, south of the present State Highway 114, 1.3 miles west of Grapevine; calcareous sandstone just above a thin conglomerate. L. W. Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, and H. R. Bergquist, 1945.
50. 18992. Borrow pit south of Chicago, Rock Island and Pacific Railroad, 0.1 mile east of Dorothy Siding, about 0.9 mile west of the Dallas County line; cream-colored marl (Tarrant unit of Moreman). L. W. Stephenson and H. H. Gray, 1944.
51. 18993. North-facing slope of Big Bear Creek Valley at crossing of north-south road, 2.2 miles east by north of Eules; calcareous sandstone (Tarrant unit of Moreman). L. W. Stephenson and H. H. Gray, 1944.
52. 18996, 19502. Ditch of road to Grapevine adjacent to Mr. Straul's house, 2.4 miles north of Arlington; shale with calcareous concretions (Tarrant unit of Moreman). L. W. Stephenson, Roy T. Hazzard, and others, 1944.
53. 18997. Branch of Big Bear Creek at crossing of a north-south road, 1.2 miles northeast of Eules; calcareous sandstone (Tarrant unit of Moreman). L. W. Stephenson and H. H. Gray, 1944.
54. 19505. In bed of Johnson Creek (formerly Trading House Creek), about 1.3 miles northeast of the Methodist Church at Arlington; yellowish and brownish ferruginous sandstone in lower part of the member. L. W. Stephenson and H. R. Bergquist, 1945.
55. 20787, 20788. Banks and bed of a tributary to Big Bear Creek, on the estate of Herman A. Dearing (Woodland Hill Farm), 1.5 miles east of Eules, 0.2 mile north of State Highway 183; fine-grained calcareous sandstone (Tarrant unit of Moreman). James P. Conlin, 1947.
- See also 215 and 215a.
57. 19724. Roadside outcrop 5.5 miles east-northeast (airline) of Roanoke railroad station, 3.5 miles south by west of Bartonville, and 0.9 mile northeast of wire bridge over Denton Creek; 6-inch layer of ferruginous sandstone, a marine facies, resting on Buda limestone and overlain by carbonaceous clay of the Woodbine formation. H. R. Bergquist and W. H. Monroe, 1946.
58. 19727, 20040. Two-tenths of a mile north of a road corner, 2.4 miles southeast of Argyle, 2.4 miles northwest of Bartonville, 3.2 miles northeast of Smoots; limonitic concretions, a marine facies, in bed of plastic gray clay near its top; this bed is about 65 feet above the calculated Grayson-Dexter contact. W. H. Monroe, 1946; H. R. Bergquist and Monroe, 1946.
59. 20041. One and seven-tenths miles south by west of Bartonville, 4.1 miles east-southeast of Smoots; small hematitic and limonitic concretions with many imprints of fossils, a marine facies, in upper part of the member. H. R. Bergquist and W. H. Monroe, 1946.
- See also 216.

EULESS MEMBER

60. 479. Lignite bed, Denton Creek; borers in wood which is now in the form of brown calcareous lignite. W. F. Cummins, 1886. (Not on map.)

LEWISVILLE MEMBER

61. Texas Univ. (707?). Timber Creek, southwest of Lewisville. W. F. Cummins, about 1892. (Not on map.)
62. Bureau of Economic Geology. Timber Creek, southwest of Lewisville. W. F. Cummins, 1892. (Not on map.)
63. Bureau of Economic Geology No. 707. Timber Creek, west of south of Lewisville. (Not on map.)
64. Bureau of Economic Geology No. 708. "Timber Creek, 2 miles below [above?] the old Dallas-Lewisville road crossing"; this is probably near the second or middle bridge. W. F. Cummins and R. T. Hill. (Not on map.)
65. Bureau of Economic Geology No. R 17395. Locality not stated on label but probably Timber Creek, southwest of Lewisville; collection possibly from two localities. (Not on map.)
66. Bureau of Economic Geology No. R 17600. Timber Creek, southwest of Lewisville. W. F. Cummins, 1892. (Not on map.)
67. U.S.N.M. 20134. "Timber Creek, 4 miles south [probably about 2.5 miles southwest] of Lewisville." C. A. White, 1889. (Not on map.)
68. U.S.N.M. 21840. "Timber Creek, 4 miles [probably less than 3 miles] west or southwest of Lewisville." C. A. White and C. B. Boyle, about 1889. (Not on map.)
69. U.S.N.M. 21842. Timber Creek, "4 miles south and west of Lewisville [probably 3 miles or less]." C. A. White and C. B. Boyle, about 1889. (Not on map.)
70. U.S.N.M. 32694. Timber Creek. F. W. Cragin, about 1892. (Not on map.)
71. 447. Timber Creek near Lewisville. R. T. Hill. (Not on map.)
72. 475, 504. "Timber Creek, 4 miles [3 miles] west by south of Lewisville (first bridge, road to Shiloh Church)." W. F. Cummins, 1886; C. A. White, 1887. (Not on map.)
73. 505. "Timber Creek, 2 to 4 miles [exact meaning not clear] south or southwest of Lewisville." C. A. White, 1887. (Not on map.)
74. 1567. "Timber Creek, 4 miles [less than 4 miles] southwest of Lewisville." Frank Burns, 1895. (Not on map.)
75. 7552, 18647. Timber Creek, about 100 yards below the upper or first bridge (road to Shiloh Church), 3 miles

DENTON COUNTY

DEXTER MEMBER

56. 11750, 18223, 19525. Top of Grayson Bluff, overlooking Denton Creek Valley, 3.7 miles northeast of Roanoke, 1.7 miles east by south of Giffhill; dark reddish-brown ferruginous sandstone, a marine facies, near base of member. T. W. Stanton, 1922; Roy T. Hazzard, 1940; L. W. Stephenson, W. H. Monroe, and H. R. Bergquist, 1945.

- west by south of Lewisville; irregularly bedded calcareous sand and sandstone. L. W. Stephenson, 1911, 1941.
76. 7553. Timber Creek, about 0.25 mile below the first or upper bridge (road to Shiloh Church), about 3 miles west by south of Lewisville; ferruginous, calcareous sandstone. L. W. Stephenson, 1911.
77. 7554. Timber Creek, 3 miles west by south of Lewisville, about 0.5 mile below the upper bridge (road to Shiloh Church); gray calcareous sandstone. L. W. Stephenson, 1911.
78. 7555, 18648, 19503. Timber Creek, right bank, within 100 yards upstream from the second or middle bridge (Flower Mount crossing), 2.5 miles southwest of Lewisville; a bed of oysters and other fossils in a sand and sandstone matrix 1 foot thick, about 10 feet above the bed of the creek. L. W. Stephenson, 1911, 1941; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
79. 7556, 14565, 19510. Near mouth of small south-flowing branch of Timber Creek, 800 feet upstream from the second or middle bridge, 2.5 miles southwest of Lewisville; from an oyster reef. L. W. Stephenson, 1911; Stephenson, T. W. Stanton, J. B. Reeside, Jr., 1929; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
80. 7557. Timber Creek, 2.5 miles southwest of Lewisville, a few hundred yards below the second or middle bridge; an oyster reef a few inches thick interbedded with sandstone. L. W. Stephenson, 1911.
81. 7558, 19501. Timber Creek, about 0.25 mile upstream from the third or lower bridge, about 2.25 miles south-southwest of Lewisville; fossiliferous, calcareous, more or less conglomeratic sandstone. L. W. Stephenson, 1911; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
82. 7559. Timber Creek, right bank, about 400 feet below the lower or third bridge, 2.125 miles south-southwest of Lewisville; an oyster bed 7 feet thick at foot of bluff. L. W. Stephenson, 1911.
83. 11730. Timber Creek, Tom Brown's crossing (third or lower bridge), about 2.25 miles south by west of Lewisville; sandstone. T. W. Stanton, 1923.
84. 11731. Timber Creek, Flower Mount crossing of Timber Creek (second or middle bridge), 2.5 miles southwest of Lewisville; sandstone. Near collection 7555. T. W. Stanton, 1923.
85. 18233, 19003, 20278. Below the spillway at Lake Dallas dam (=Garza Dam), 4.8 miles north of Lewisville; about 18 feet of sand and sandstone with interbedded oyster reefs. L. W. Stephenson, 1940; Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, 1946. (This locality presents a spectacular display of reefs of *Ostrea soleniscus* Meek in an unusually broad exposure.)
86. 18649. Sandstone loose in bed of Timber Creek, 3 miles west-southwest of Lewisville. L. W. Stephenson, 1941. (Not on map.)
87. 19000. Ditch of east-west road, west-facing slope, 0.8 mile south-southwest of Texas and Pacific Railway station at Pilot Point, 0.4 mile west of the railroad track; weathered light brown sandy claystone. L. W. Stephenson and H. H. Gray, 1944.
88. 19001. South of east-west second-class road, 3.6 miles northwest of Lewisville, 0.8 mile west of U. S. Highway 77; gray slightly calcareous sand. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
89. 19002. Small branch south of east-west road, 4 miles west-northwest of Lewisville, 2 miles south-southwest of Lake Dallas; platy, calcareous sandstone. Roy T. Hazzard, 1939.
90. 19509. Bluff on right side of Timber Creek, about 1,000 feet downstream from mouth of Rocky Branch, about 0.4 mile upstream from the middle bridge, 2.7 miles southwest of Lewisville; calcareous sandstone. L. W. Stephenson and H. R. Bergquist, 1945.
91. 19511. Road ditch, 2 miles east of Aubrey; ferruginous sandstone interbedded with gray shaly clay. L. W. Stephenson, 1945.
92. 19524. Bed of Rocky Branch, about 500 feet upstream from junction with Timber Creek, about a mile downstream from the Shiloh road crossing (first bridge), about 2.9 miles southwest of Lewisville; calcareous sandstone. L. W. Stephenson, H. R. Bergquist, 1945.
93. 20277, 20279, 20281. Below the spillway at Lake Dallas dam (=Garza Dam), 4.8 miles north of the center of Lewisville; ferruginous sandstone at base of oyster reef-bearing sandstone. L. W. Stephenson and W. H. Monroe, 1946. (See note with coll. 18233.)
94. 20545. In creek, 0.15 mile west of road, 0.4 mile north of State Highway 24, 1.5 miles northwest of Little Elm; calcareous conglomerate at base of a reef sandstone of *Ostrea soleniscus* Meek. H. R. Bergquist, 1947.

COOKE COUNTY

RED BRANCH MEMBER

95. 20261. East slope of knoll, about 200 feet south of east-west road, about 400 feet southwest of road corner, 3.3 miles north of Pilot Point, 1.3 miles west of Grayson County line (approximate latitude 33°6'30''); ferruginous sandstone. H. R. Bergquist, 1946.
96. 20262, 20272. South edge of road on east-facing slope, about 0.1 mile east of road T at crest of hill, 2.8 miles S. 70° E. of Callisburg (latitude 30°41'9''), 1.35 miles west of Grayson County line; thinly bedded ferruginous sandstone. H. R. Bergquist, 1946.
97. 21016. Near crest of a hill, southwest of a road corner, 0.4 mile west of Isle du Bois Creek and 2 miles west of Texas and Pacific Railway crossing in Tioga; ferruginous sandstone in lower part of member. H. R. Bergquist, 1948. See also 217.

LEWISVILLE MEMBER

98. 20259. U. S. Highway 82, 700 feet east of a filling station at crossroads, 2 miles west of Whitesboro, 0.35 mile west of Grayson County line; reddish-brown ferruginous sandstone, near base of member. H. R. Bergquist, 1946.
99. 20269. West-sloping field east of road and north of school, 0.5 mile north of U. S. Highway 82, 0.5 mile west of Grayson County line; loose pieces of coarse ferruginous sandstone weathered out in soil, near base of member. H. R. Bergquist and L. W. Stephenson, 1946.
100. 20270. West-sloping field east of road and north of school, 0.5 mile north of U. S. Highway 82, 0.5 mile west of Grayson County line; loose pieces of fine ferruginous sandstone weathered out in soil, near base of member. H. R. Bergquist and L. W. Stephenson, 1946.

GRAYSON COUNTY

RED BRANCH MEMBER

101. 20266. West ditch of road near base of north slope, 0.8 mile south of junction with road to Denison, and 3.5 miles west by slightly north of Ambrose, in northeastern part of the County; sandy, carbonaceous shale, near base of member. H. R. Bergquist, 1946.
102. 20316. Hillside north of Iron Ore Creek, 0.1 mile west of U. S. Highway 69, 0.85 mile N. 14° W. of Star School, about

- 4 miles S. 30° E. of the Missouri-Kansas-Texas Railroad station at Denison; ferruginous concretions at base of carbonaceous shale overlying silty gray clay, near base of member. H. R. Bergquist, 1946.
103. 20317. Bank of south tributary of Iron Ore Creek, 0.5 mile N. 25° E. of Star School, 0.25 mile west of road, 4.55 miles airline S. 40° E. of Missouri-Kansas-Texas Railroad station in Denison; ferruginous concretions in tuffaceous clay at base of tuffaceous sandstone, upper part of member. H. R. Bergquist, 1946.
104. 20320. Road 0.65 mile south of crossroads which is 1 mile S. 68° W. of center of Ambrose; sideritic concretion in tan to gray mealy carbonaceous clay below tuffaceous sandstone, near base of member. H. R. Bergquist, 1946.
105. 20544. South of Ambrose 1.3 miles; siderite layer in stream bed, east of road, near base of member. H. R. Bergquist, 1946.
- See also 218.

LEWISVILLE MEMBER

106. 1460. Top of Iron Ore Knob, 4 miles south [probably southwest] of Denison. R. T. Hill, 1894. (Not shown on map.)
107. 7522. North-south public road, south-facing slope of headwater branch of Iron Ore Creek, 7.5 miles north of Sherman, 2.75 miles east by south of Pottsboro; ferruginous sandstone. T. W. Stanton and L. W. Stephenson, 1911.
108. 14093. Branch of Mustang Creek, 3.6 miles east-northeast of Whitesboro, 0.8 mile south of Sadler; concretionary masses of calcareous sandstone rising about 5 feet above bed of branch, near top of member. L. W. Stephenson, 1928.
109. 18224. Right bank of branch, 450 feet east of north-south road, 0.8 mile south of Sadler; calcareous sandstone, near top of member. L. W. Stephenson, 1940.
110. 18232. Shallow road cut just east of bridge over Spring Creek, 1.9 miles south-southeast of Collinsville, 1.3 miles east of branch of Texas and Pacific Railway; ferruginous sandstone, 6 feet above a thick oyster bed. L. W. Stephenson, 1940.
111. 18235. Mineral Creek, left bank, east of a north-south road crossing, 1.5 miles northeast of Sadler; ferruginous sandstone, 8 to 10 feet above bed of creek at east end of bluff, upper part of member. L. W. Stephenson, 1940.
112. 18243. Right bank of a branch, 500 feet south of the new U. S. Highway 82, 2.4 miles east by south of Whitesboro; soft gray sand on a concretionary mass of sandstone, 3 feet above water level, near top of member. L. W. Stephenson, 1940.
113. 18259. Martins Spring Branch, 200 feet north of road crossing, 3 miles west by north of Pottsboro; gray sandstone, near top of member. L. W. Stephenson, 1940.
114. 18963, 19024. Headwater branch of Walnut Creek, east of north-south road, about 0.7 mile north of Gordonville; gray calcareous sandstone. Roy T. Hazzard, 1941; L. W. Stephenson and H. H. Gray, 1944.
115. 18964. North-flowing branch of Brushy Creek intersecting east-west road, 0.9 mile east of Sandusky; weathered, red ferruginous sandstone. L. W. Stephenson and H. H. Gray, 1944.
116. 18965. Ditch of north-south road, 0.8 mile southwest of Gordonville; brown and red ferruginous sandstone. L. W. Stephenson and H. H. Gray, 1944.
117. 18966. Gully, east of Whitesboro road, about 1.75 miles south of Sandusky; weathered, reddish-brown ferruginous sandstone, near base of member. L. W. Stephenson and H. H. Gray, 1944.
118. 18967. Ravine in field, 0.1 mile west of north-south road, 0.3 mile north of the post office at Gordonville; weathered, friable brown ferruginous sand. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
119. 18968. Road ditch, 0.3 mile west of Gordonville; weathered, friable brown ferruginous sandstone. L. W. Stephenson and H. H. Gray, 1944.
120. 18969. Top of bluff on headwater branch of Walnut Creek, 0.2 mile east of north-south road, 1.3 miles north of Gordonville; weathered, brown, friable ferruginous sandstone, about 60 feet above the contact with the tuffaceous sandstone of the Red Branch member below. L. W. Stephenson, 1944.
121. 18970. North-south road, 3 miles north by east of Sherman Junction, 2.5 miles west of Star School, 0.4 mile south of Iron Ore Creek (in front of D. F. Jones' house); weathered, brown ferruginous sandstone, about 20 feet above base of member. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
122. 18972, 19015, 19500. Near a west-flowing small branch 1.05 miles east and 0.2 mile south of Penland (Terrace station), 0.3 mile southeast of Dugans Chapel (now a private dwelling), 8.2 miles southeast of the business center of Denison; greenish-gray tuffaceous, calcareous sandstone, near top of member. Roy T. Hazzard, 1941 (?); L. W. Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
123. 18973. Deadmans Curve on old U. S. Highway 75, about 3.3 miles southwest of the business center of Denison; weathered, orange and brown ferruginous sandstone, about 25 to 30 feet above base of member. Roy T. Hazzard, 1939.
124. 18974. Loose in the bed of a small branch tributary to a larger headwater branch of Walnut Creek, 0.8 mile north-east of Gordonville. Roy T. Hazzard, 1942 (?). (Not on map.)
125. 18975. Headwater ravine of Walnut Creek, 0.3 mile north of Gordonville, 0.2 mile east of north-south road; gray shaly clay, in part sandy. L. W. Stephenson, Roy T. Hazzard, and others, 1944.
126. 18976, 19022, 19495. Right bank, 4 feet above bed of a headwater branch of Walnut Creek, east of a north-south road, 0.5 mile north of Gordonville; weathered, reddish brown ferruginous sandstone, upper part of member. Roy T. Hazzard, 1941; L. W. Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
127. 19023. Headwater branch of Walnut Creek, east of north-south road, about 0.6 mile north of Gordonville; gray calcareous claystone. Roy T. Hazzard, 1941.
128. 19026. Old U. S. Highway 75, 0.6 mile south of Deadmans Curve, near Ellsworth School; cross-bedded sand below zone with *Exogyra columbella levis*, near top of member. Roy T. Hazzard, 1939.
129. 19027. Deadmans Curve on a hillside, old U. S. Highway 75, about 3.3 miles southwest of the business center of Denison; brown shaly clay, below fossiliferous sand (see coll. 18973), about 25 feet above base of member. Roy T. Hazzard, 1939.
130. 19491. Weathered out on hill just south of northwest-southeast stretch of road at Oak Grove, about 5 miles west of the business center of Denison; ferruginous sandstone. H. R. Bergquist, 1945.
131. 20263. Copper Creek (tributary to Sandy Creek), 4.8 miles (airline) south 25° west of Gordonville, 0.8 mile north 25° east of U. S. E. Dixie triangulation station; reddish-

- brown ferruginous sandstone, lower part of member. H. R. Bergquist, 1946.
132. 20271. Branch of Sandy Creek east of north-south road, 1.5 miles north of Mineral Creek, 2.5 miles north of Missouri-Kansas-Texas Railroad at Sadler; brown, medium grained, friable, ferruginous sandstone. H. R. Bergquist and L. W. Stephenson, 1946.
133. 20273. Along stream east of road, 1.2 miles north of Brushy Creek, 0.1 mile southeast of road corner, about 2 miles north-northwest of Sandusky, 9.5 miles north of Whitesboro; ferruginous sandstone, 10 feet above a bed of lignite and base of member. H. R. Bergquist, 1946.
134. 20274. East side of Mustang Creek bridge, 2 miles south-southwest of Sadler, 0.3 mile north of Texas and Pacific Railway, calcareous concretions in sand, in upper part of member. H. R. Bergquist, 1946.
135. 20309. A small stream gorge, 0.35 mile west of road, 1.9 miles S. 54° W. of center of Ambrose; sandy calcareous lens in silty gray shale, 6 feet below a thin tuffaceous sandstone, estimated to be same horizon as concretions at locality G-236b, 50 to 60 feet below topmost *Ostrea soleniscus* reef zone and top of member. H. R. Bergquist, 1946, 1948.
136. 20319. At a fall in a gully, 0.2 mile west of road, 1.8 mile S. 45° W. of center of Ambrose; sideritic concretions in a 6-foot bed of gray silty shale, 1 foot below an 8-foot bed of tuffaceous sandstone, and 5 feet above a 2-foot bed of lignite, estimated 50 to 60 feet below top of member. H. R. Bergquist, 1946.
137. 20538. Small stream cut, 0.1 mile northwest of a small house at roadside, about 0.2 mile south, 0.5 mile west of Star School, which is on U. S. Highway 69, about midway between bridges over Iron Ore and Choctaw Creeks, about 5 miles southeast of Denison; (a) boring mollusks in a piece of poorly preserved brownish fossil wood in upper part of the member; (b) mollusks in a calcareous concretion closely associated with the piece of wood, 21 feet below top of member. H. R. Bergquist, 1947.
138. 20540. Valley and hillside adjacent to a tributary to Iron Ore Creek, 0.55 mile west of Star School, which is on U. S. Highway 69, about 5 miles south-southeast of Denison; from basal sandstone and oyster zone of the member. H. R. Bergquist, 1947.
139. 20541. About 30 feet below top of a 50-foot bluff of the member, on a branch of Brushy Creek, 2.5 miles south and 1 mile east of Gordonville; calcareous concretionary lenses in sandy shale, in upper part of the member. H. R. Bergquist, 1947.
140. 20543. Two and three-tenths miles west, 0.6 mile north of Sandusky; basal fossiliferous horizon of the member. H. R. Bergquist, 1946.
141. 20546. Along stream tributary to Mustang Creek, 0.15 mile south, 0.4 mile east of road bend at south edge of Sadler; sandstone at top of the member, about 70 feet below base of Eagle Ford shale. H. R. Bergquist, 1947.
142. 20551. Branch of Iron Ore Creek, 0.35 mile south, 0.9 mile west of Star School, which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, about 5 miles south-southeast of the center of Denison; massive sandstone at top of the member. H. R. Bergquist, 1946.
143. 20552. Creek tributary to Iron Ore Creek, 0.15 mile south, 0.8 mile west of Star School, which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, about 5 miles south-southeast of the center of Denison; oyster-bearing sandstone 2 feet thick, at base of 42-foot sandstone section of the member, and about 65 feet below the top of the member. H. R. Bergquist, 1947.
144. 20874. Along a stream tributary to Mustang Creek, east of road bridge, 1 mile south of the Missouri-Kansas-Texas Railroad station at Sadler; calcareous sandstone, equivalent of uppermost oyster reef horizon or top of the member. H. R. Bergquist, 1947.
145. 20885. Loose block of rock at roadside, 1.2 miles (airline) northeast of the railroad station at Sadler; gray calcareous sandstone. H. R. Bergquist, 1947.
146. 20886. Stream tributary to Brushy Creek, about 0.5 mile east of road T, and 2.6 miles south and 0.7 mile east of Gordonville; fine ferruginous sandstone, in upper part of member. H. R. Bergquist, 1947.
147. 20887. East of stream tributary to Brushy Creek, about 0.25 mile above junction with creek, west of an embayment of Mineral Creek, arm of Lake Texoma, 0.05 mile west of road, approximately 1.9 miles south and 1.55 miles east of Gordonville; 5 feet of ferruginous sandstone (with *Inoceramus prefragilis*), overlain by fine limonitic sandstone (with *Breviarca (Sanoarca) grandis*) in 3 feet of sandy shale (with *Phelopteria dalli*). H. R. Bergquist, 1947.
- See also 219-227.

TEMPLETON MEMBER

148. Texas Univ., orig. nos. 153-156. "Four miles east of Whitesboro [less than 4 miles.]" J. A. Taff, 1892. (Not on map.)
149. Texas Univ., orig. no. 43 (type). "Four miles east of Whitesboro [less than 4 miles], and one mile south of Whitesboro-Sherman road." J. A. Taff, 1892. (Not on map.)
150. U.S.N.M. 29403. "Four miles [less than 4 miles] east of Whitesboro." J. A. Taff, about 1892. (Not on map.)
151. 439a. "Four miles south [southwest] of Denison." Details lacking; probably near Ellsworth School. R. T. Hill. (Not on map.)
152. 13800, 13866, 14557. Martins Spring Branch, 0.2 mile south of the Mineral Wells road, 2.9 west by north of Pottsboro; calcareous septarian concretions. L. W. Stephenson and W. P. Popenoe, 1927; Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929.
153. 13801, 18250. Martins Spring Branch, 2 $\frac{7}{8}$ miles west of Pottsboro, 0.7 mile (estimated) below the Mineral Wells road; a thin hard sandy limestone at top of member. L. W. Stephenson and W. P. Popenoe, 1927; Stephenson, 1940.
154. 14092, 14560, 17163, 18236, 18971. Gullies just south of the old Sherman highway, 2.8 miles east by south of the center of Whitesboro; about 20 feet of dark noncalcareous shaly clay with scattered fossiliferous septaria of earthy calcium carbonate, about 45 feet below base of Eagle Ford shale. L. W. Stephenson, 1928, 1935, 1940; Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929; Stephenson, Roy T. Hazzard and others, 1944.
155. 14556. Old Sherman highway at Ellsworth School, 4 miles southwest of Denison; strongly calcareous sandstone near base of member. L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929.
156. 14563. North-south road, 0.5 mile northwest of Ethel, about 4 miles east by south of Collinsville; fine calcareous, concretionary sandstone near top of member. L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929.
157. 16436. "The old Denison-Sherman road, 3.25 miles [probably near Ellsworth, about 4 miles] southwest of the geographic center of Denison." Roy T. Hazzard, 1933.

158. 18220. Near head of small branch just east of a branch of the Texas and Pacific Railway, 2.2 miles north of Sherman Junction; calcareous sandstone in upper part of member. L. W. Stephenson, 1940.
159. 18252. Near head of north-flowing branch of Iron Ore Creek, 3 miles northeast of Sherman Junction, 1.9 miles east of a branch of the Texas and Pacific Railway; calcareous septarian concretions below a thick sandstone and about 20 feet below the sandstone which yielded collection 18257; about 50 feet below top of member. L. W. Stephenson, 1940.
160. 18257, 18978, 19506. South bank of east-west road near the head of a northward-flowing branch of Iron Ore Creek, 3 miles northeast of Sherman Junction, 1.9 miles east of a branch of the Texas and Pacific Railway; fine calcareous sandstone about 30 feet below top of member. L. W. Stephenson, 1940; Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
161. 18977. Within 8 feet above the bed of a small branch, 0.2 mile south of Ellsworth School, 4 miles south-southwest of Denison; strongly calcareous sand. L. W. Stephenson and H. H. Gray, 1944.
162. 20275. Four-tenths mile south of 4-way road corner, 1.3 miles west of the southwest end of the dam of Loy State Park Lake; calcareous septarian concretions in a 22-foot bed of sandy shale, east bank of a stream, about 50 feet below base of Eagle Ford shale. H. R. Bergquist and L. W. Stephenson, 1946.
163. 20311. Bluff on tributary to Cornelius Creek, 3.35 miles north, 0.5 mile west of U. S. Highway 69 underpass of Texas and Pacific Railway at Bells; large fossiliferous septarian concretions at base of 6 feet of silty gray shale underlying a 5- to 10-foot bed of sand; 15 feet above base of member. H. R. Bergquist, 1946.
164. 20314. Bluffs along Templeton Branch of Cornelius Creek, 0.2 to 0.3 mile west of road corner, 0.5 to 0.6 mile west of Bells-Ambrose road, 2.7 miles N. 5° E. of junction of Missouri-Kansas-Texas and Texas and Pacific railroads in Bells; concretions in interlensed shale and sand 20 feet (estimated) above the *Ostrea soleniscus* reef zone and top of the Lewisville member. H. R. Bergquist, 1946, 1947.
165. 20315. Bluff on tributary to Cornelius Creek, 0.4 mile downstream from road corner, 0.9 mile east of underpass of Missouri-Kansas-Texas Railroad, 3.3 miles N. 16° W. of the junction of this railroad with the Texas and Pacific Railway in Bells; calcareous concretions in sand 20 to 22 feet above the *Ostrea soleniscus* reef zone and top of the Lewisville member. H. R. Bergquist, 1946.
166. 20539. North-flowing branch of Iron Ore Creek, 0.22 mile south, 0.6 mile west of Star School, which is on U. S. Highway 69, about midway between the crossings of Iron Ore and Choctaw Creeks, 5 miles south-southeast of Denison; thin bed of indurated sandstone in the member, 16 to 18 feet above top of Lewisville member. H. R. Bergquist, 1947.
167. 20542. Bluff south of Missouri-Kansas-Texas Railroad, 1 mile north and 1.85 miles east of Sadler; shale in the member within 30 feet of base of Eagle Ford shale. H. R. Bergquist 1947.
168. 20547. Road cut in slope, 0.4 mile south of Iron Ore Creek, 0.9 mile west, 0.9 mile south of Iron Ore Creek bridge on U. S. Highway 69, about 4.8 miles southeast of the center of Denison; calcareous septarian concretion in lower part of the member. H. R. Bergquist, 1946.
169. 20548. Gully 0.15 mile southeast of school at Ellsworth; calcareous septarian concretion in lower part of the member. H. R. Bergquist, 1946.
170. 20550. Gully, 250 feet north of road, 0.65 mile south, 1 mile west of Star School, which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, 5 miles south-southeast of the center of Denison; ledge-forming sandstone in the member, 6 to 8 inches thick, estimated to be 40 feet below base of Eagle Ford shale and about 42 feet above top of Lewisville member. H. R. Bergquist, 1946.
171. 20553, 20592. Gully, south of a barn (or stable), 0.5 mile south, 0.75 mile west of Star School which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, 5 miles south-southeast of the center of Denison; ledge-forming sandstone about 45 feet below top of the member. H. R. Bergquist, 1947.
172. 20593. Branch of Iron Ore Creek, 0.4 mile south, 0.8 mile west of Star School which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, about 5 miles south-southeast of the center of Denison; calcareous septarian concretion in the member, about 12 feet above the base. H. R. Bergquist, 1947.
173. 20594. Gully, 300 feet north of road at point 120 feet east of road T to the south, 0.65 mile south, 1 mile west of Star School which is on U. S. Highway 69 about midway between the crossings of Iron Ore and Choctaw Creeks, about 5 miles south-southeast of the center of Denison; flaggy sandstone about 35 feet above oyster reef sandstone at top of Lewisville member. H. R. Bergquist, 1946.
174. 20875. Ditch west side of road 100 yards north of Mustang Creek bridge, 1.7 miles south and 0.6 mile west of Missouri-Kansas-Texas Railroad station at Sadler; ferruginous, argillaceous sand, near base of member. H. R. Bergquist, 1947.
175. 20879. Along a tributary of Cornelius Creek, Joe Henry Whiting property, 0.2 mile north and 0.3 mile east of secondary road underpass of Missouri-Kansas-Texas Railroad, approximately 3.5 miles north-northwest of Bells; concretions in lower part of member (*Metengonoceras-Metoicoceras* zone). H. R. Bergquist, 1947.
176. 20880. Drainage bed about 100 feet south of old Pottsboro-Gordonville road, 0.2 mile east of road corner, 2.1 miles west and 0.6 mile north of center of Pottsboro; boulder-like indurated mass of fine buff calcareous sandstone in upper part of member. H. R. Bergquist, 1947.
177. 20882. North side of road, west-facing slope of Mustang Creek Valley, 0.15 mile east of the bridge, about 1 mile (airline) east of Sadler; ferruginous, silty to sandy shale 12 to 15 feet below basal flaggy sandstone of Eagle Ford shale. H. R. Bergquist, 1947.
178. 20884. West-facing bank of a stream about 100 yards west of a country road, 0.5 mile southwest of Willow Springs School, 0.45 mile south of old Pottsboro-Gordonville road, 4.9 miles west and 0.8 mile north of the railroad station at Pottsboro; thin shells in lower 7 feet of 12-foot exposure of dark-gray shale; top of exposure is 40 feet below base of Eagle Ford shale. H. R. Bergquist, 1947.

FANNIN COUNTY

LEWISVILLE MEMBER

179. 10555, 10556, 18618, 19006. Lower end of Hyatts Bluff, Red River, right side, 4.5 miles N. 62° W. of center of Ravenna; dark gray shaly clay and gray calcareous sand below tuffaceous sandstone. L. W. Stephenson and O. B. Hopkins, 1917; Roy T. Hazzard, 1939; Stephenson, 1941.
180. 13798. Sheep Creek, Carson Survey, on line between farms owned by M. L. Taylor and R. Williams, about 4 miles N. 37° E. of center of Savoy; argillaceous, tuffaceous

- sand, 8 feet above base of section. L. W. Stephenson and W. P. Popenoe, 1927.
181. 13857. Sheep Creek, Carson Survey, on line between farms owned by M. L. Taylor and R. Williams, about 4 miles N. 37° E. of center of Savoy; massive agrillaceous sand at base of section. L. W. Stephenson and W. P. Popenoe, 1927.
182. 18248, 19492. Sheep Creek, about 1,600 feet north of an east-west road; 4 miles N. 37° E. of center of Savoy, about 3.125 miles east of the Grayson County line; sandstone about 25 feet stratigraphically higher than the zone from which collection 18256, and others were obtained, and near top of member. L. W. Stephenson, 1940; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.
183. 18253. Branch of Sheep Creek, 4.2 miles N. 37° E. of center of Savoy, 3.2 miles east of the Grayson County line; zone of small calcareous concretions 6 to 10 feet below a zone of large concretions. L. W. Stephenson, 1940.
184. 18256, 18627, 19494, 19715. Sheep Creek, 4.2 miles N. 35° E. of center of Savoy, 3 miles east of the Grayson County line, 0.5 mile downstream from an east-west road; abundantly fossiliferous calcium carbonate concretions at base of the exposed section, and about 30 feet below top of member. L. W. Stephenson, 1940, 1941; Stephenson, W. H. Monroe, H. R. Bergquist, 1945; Bergquist, 1945.
185. 18258. Branch of Sheep Creek, 4.3 miles N. 36° E. of center of Savoy, 3.15 miles east of the Grayson County line; concretions in an oyster shell marl 20 feet below a bed of large concretions. L. W. Stephenson, 1940.
186. 18617. From the crest of the northward-facing slope of Brushy Creek Valley, 3.4 miles N. 15° E. of center of Savoy, 0.2 mile east of the road to Anthony; calcareous, glauconitic sand, within 6 feet below sandstone in lower part of the member. L. W. Stephenson, 1941.
187. 18624, 19025. Road to Anthony, 3 miles N. 12° E. of center of Savoy; weathered gray to brownish calcareous, argillaceous sand in upper part of the member. L. W. Stephenson, 1941; Roy T. Hazzard, 1941 (?).
188. 18626. Sheep Creek, 4.2 miles N. 35° E. of center of Savoy; loose in bed of creek, washed from beds overlying the bed from which collection 18256, and others, were obtained. L. W. Stephenson, 1941. (Not on map.)
189. 18650. Loose in the bed of Sheep Cheek, about 4.1 miles N. 36° E. of center of Savoy; the exact position of the bed from which this piece of rock came was not ascertained, but it was not far out of place. L. W. Stephenson, 1941. (Not on map.)
190. 19513. Ditch of State Highway 100, 2.8 miles S. 15° E. of Monkstown; oyster reef in matrix of calcareous sandstone. L. W. Stephenson, W. H. Honroe, and H. R. Bergquist, 1945; Bergquist, 1947. (This appears to be an abnormal geographic position for this species and may indicate the presence of a fault structure. Evidence of faulting was observed in close association with the reef in the ditch, the fault plane apparently intersecting the road at this place. Shale in ditch down slope—north—from the fault has the aspect of Eagle Ford shale, the shale being on the downthrow side of the fault.)
191. 19714. Gully near fence, 1,250 feet north of east-west road, approximately 3.5 miles N. 28° E. of center of Savoy; claystone in lower part of the member. H. R. Bergquist, 1945.
192. 20307. East tributary of Sheep Creek about 150 yards downstream from waterfall over tuffaceous sandstone, 0.35 mile south of east-west country road and 0.4 mile west of north-south road, 2.6 miles east and 3.4 miles north of railroad station in Savoy; lens of calcareous sandstone in sandy shale 3 or 4 feet below top of member. H. R. Bergquist, 1946.
193. 20308. Tributary of Sheep Creek, about 170 yards southwest and downstream from locality 192 and 6 feet lower, at east-facing bend, 2.5 miles east and 3.35 miles north of the railroad station in Savoy; top of fine-grained calcareous, glauconitic sandstone of the Lewisville member, 6 feet below basal tuffaceous clay of the overlying Templeton member. H. R. Bergquist, 1946.
194. 20310. Above waterfall on a small branch 0.25 mile northwest of R. E. Sturdivant's farmhouse, 3.35 miles N. 36° E. of railroad station at Savoy; calcareous sandstone at top of member. H. R. Bergquist, 1946.
195. 20312. Sheep Creek, 4 miles N. 34° E. of railroad station at Savoy, 3 miles east of Grayson County line, 0.55 mile downstream from road corner east of R. E. Sturdivant's farm, near locality 184; float concretionary material in bed of creek, but probably only a short distance from the outcrop of the source bed, estimated about 30 feet below top of member. H. R. Bergquist, 1946.
196. 20321. East bank of Sheep Creek, 0.27 mile N. 10° E. of road corner east of R. E. Sturdivant's farm at Savoy, and 3.8 miles N. 36° E. of railroad station at Savoy; large fossil log perforated by boring mollusks in shale near top of member. H. R. Bergquist, R. E. Sturdivant, 1946.

TEMPLETON MEMBER

197. 13533. Public road, 3.8 miles west of Ravenna, 0.5 mile east of Spies' store; ferruginous sandstone. L. W. Stephenson, H. D. Miser, and C. H. Dane, 1926.
198. 18254. Branch below the crossing of the Anthony road, 2 miles N. 20° E. of center of Savoy; calcareous sandstone. L. W. Stephenson, 1940.
199. 20313. Low east-facing bluff along branch of Brushy Creek, 0.3 mile west of Savoy-Anthony road, 2 miles N. 9° E. of center of Savoy; dark gray shale estimated 25 feet below base of Eagle Ford shale. H. R. Bergquist, 1946.

LAMAR COUNTY

TEMPLETON MEMBER

200. 7503. A 14-foot dug well near a cotton gin in valley at the south edge of Chicota; dark, essentially noncalcareous clay. T. W. Stanton and L. W. Stephenson, 1911.
201. 12872, 12873, 13569, 13797, 14546. Bed of Red River near old Slate Shoals, 2.8 miles east of Slate Shoals (also known as old Tinnin and Womack's Gin), 8 miles east of Arthur City; interbedded sandy shale and gray fine calcareous cross-bedded sandstone, in bed of river near right bank. W. B. Sprague and H. S. Cave, 1924; L. W. Stephenson, 1924, 1927; Stephenson and C. H. Dane, 1926; Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929. (The beds exposed at low water at this locality as late as 1929 were subsequently covered by the shifting sands of the river, and in 1941 the site had become a willow-grown flat.)
202. 13070, 14551. Right side of Red River bottom, about 1.5 miles north of Ragtown; dark noncalcareous clay near base of member. L. W. Stephenson, 1925; Stephenson T. W. Stanton, J. B. Reeside, Jr., 1929.
203. 13570, 13799, 18266, 19498. Golden Bluff, Red River, 3 miles east of Arthur City; fine glauconitic sandstone 30 feet above coarse, tuffaceous sandstone of the Lewisville member. L. W. Stephenson, C. H. Dane, 1926; Stephenson, W. P. Popenoe, 1927; Stephenson, 1940; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.

204. 14549. Small branch, on land of Charles Price, about 3 miles east-southeast of Arthur City, about a mile north of J. W. Doughtry's house; dark shale below a layer of platy sandstone (basal layer of Eagle Ford shale); L. W. Stephenson, T. W. Stanton, J. B. Reeside, Jr., 1929.
205. 18267. Loose in branch, about 3 miles east by south of Arthur City, 0.4 mile south of Golden Bluff; probably from dark shale of the member. L. W. Stephenson, 1940.
206. 18271, 18877, 21013. Road cut (State Farm Road 197), 2.2 miles west of Arthur City, 1.75 miles east of Chicota, 0.1 mile east of Sanders Creek bridge; oyster-bearing sandstone 22-25 feet above road level. Roy T. Hazzard, 1939; L. W. Stephenson, 1940.
207. 18274, 18619, 19012, 20881. Borrow pit just north of State Farm Road 197, at a cut 2.2 miles west of Arthur City, 0.1 mile east of Sanders Creek bridge, 1.75 miles east of Chicota; dark-gray sandy shale with calcareous fossiliferous septarian concretions, probably 20 to 25 feet above base of the member. L. W. Stephenson, 1940, 1951; Stephenson and H. H. Gray, 1944; H. R. Bergquist, 1948. See also 228-231.

RED RIVER COUNTY
LEWISVILLE MEMBER

208. 13565, 14544, 18276, 21015. Branch, 2 miles east by slightly north of Kanawha, 1.2 miles south-southeast of West Scrap, on land owned by A. F. Eggers; oyster bed 40 feet lower than upland level at the farm house. L. W. Stephenson and C. H. Dane, 1926; Stephenson, T. W. Stanton, and J. B. Reeside, Jr., 1929; Stephenson, 1940; Bergquist, 1948.
209. 18620, 19004, 19005, 19527. Pine Bluff, Red River, near the northwestern corner of Red River County; dark tuffaceous shale 3 to 5 feet below the base of massive tuffaceous sandstone. Roy T. Hazzard, 1939; L. W. Stephenson, 1941; Stephenson and H. H. Gray, 1944; Stephenson, W. H. Monroe, H. R. Bergquist, 1945.

SUPPLEMENTAL LIST OF FOSSIL COLLECTING LOCALITIES

The following localities are shown on the maps (except those in Hill and Tarrant Counties) but are not shown on the chart of distribution.

HILL COUNTY
LEWISVILLE MEMBER

210. 21079. Hill near school, "about 5 miles northwest of Woodbury quarry [4 miles northwest of Woodbury]"; fine ferruginous sandstone. W. S. Adkins, 1948.
211. 21080. North of State Highway 22, 1.2 miles west by north of Peoria; fine hematitic and limonitic sandstone 30 feet below local top of Woodbine formation (Lewisville member). W. S. Adkins, 1948.
212. 21081. Northeast-southwest road about 5 miles southeast of the center of Blum; 1 foot above local base of Woodbine formation (Lewisville member). W. S. Adkins, 1948.
213. 21082. Northeast-southwest road 2.4 miles north-northwest of Peoria, 1.1 miles east of a cemetery; fine ferruginous sandstone 30 to 35 feet below the local top of the Woodbine formation (Lewisville member). W. S. Adkins, 1948.
214. 21083. Near northeast-southwest road about 5 miles east-southeast of Whitney, about 3.2 miles southwest of Peoria; fine ferruginous sandstone 30 to 35 feet above local base of Woodbine formation (Lewisville member). W. S. Adkins, 1948.

TARRANT COUNTY
LEWISVILLE MEMBER

215. U.S.N.M. 76214. About 3 miles southeast of Pleasant Glade (Tarrant unit of Moreman). *Acanthoceras wintoni* Adkins, received from James P. Conlin, 1939.
- 215a. U.S.N.M. 76215 and 76221. Three miles east of Pleasant Glade (Tarrant unit of Moreman). *Acanthoceras tarantense* (Adkins), received from James P. Conlin, 1939.

DENTON COUNTY
DEXTER MEMBER

216. 20042. One mile southwest of Bartonville; porous ferruginous sandstone, a marine facies, near top of the member. W. H. Monroe and H. R. Bergquist, 1946.

COOKE COUNTY
RED BRANCH MEMBER

217. 20260. Side of road 4.3 miles N. 73° E. of the Burns community, about 1.3 miles west of Grayson County line (approximate latitude 33°32'), at top of west-facing slope, 0.1 mile west of road junction; ferruginous sandstone with clay pebbles. H. R. Bergquist, 1946.

GRAYSON COUNTY
RED BRANCH MEMBER

218. 20876. Bed of tributary to Choctaw Creek, about 100 yards east of a road, 3.4 miles west of Ambrose, 0.65 mile north of road into Mill Creek Valley; layer of partly weathered siderite over sandy shale, and overlain by 2 feet of lignite and lignitic shale, near base of member. H. R. Bergquist, 1947.

LEWISVILLE MEMBER

219. 21001. Road ditch, 8 feet above base of exposure, 0.05 mile south of road T to west, 0.4 mile east of Missouri-Kansas-Texas Railroad at a point 0.5 mile north of Penland (Terrace station); indurated gray sandstone a few inches thick, in upper part of member. H. R. Bergquist, 1948.
220. 21002. A few feet above backwaters of Walnut Creek embayment of Lake Texoma, nearly 0.7 mile north of road corner which is 1 mile east of Gordonville cemetery; from upper part of 18-foot exposure of sandstone, the top of which lies about 70 feet below the uppermost oyster reef sandstone at the top of the member. H. R. Bergquist, 1948.
221. 21003. Hillside about 25 feet above bed of stream flowing north, emptying into Walnut Creek embayment of Lake Texoma, approximately 0.3 mile north of a road corner which is about 1 mile east of Gordonville cemetery; from limestone concretions in shale, about 35 feet below base of uppermost oyster reef sandstone at the top of the member. H. R. Bergquist, 1948.
222. 21004. A few feet above bed of stream flowing north into Walnut Creek embayment of Lake Texoma, approximately 0.4 mile north of road corner which is about 1 mile east of Gordonville cemetery; from basal part of zone of sandstone, about 52 to 54 feet below base of the uppermost oyster reef sandstone at the top of the member. H. R. Bergquist, 1948.
223. 21005. Hillside 0.17 mile east of north-south improved road, at a point 2 miles south of U. S. Highway 69, the junction being 0.45 mile by road southeast of overpass of Missouri-Kansas-Texas Railroad in southeastern Denison, about 3.4 miles south by east of center of that town; ferruginous concretions in sandy shale of the lower part of the member. H. R. Bergquist, 1948.

224. 21006. Along a stream a few yards east of a farmyard, 0.1 mile east of road, at a point 0.22 mile north of road T to west, approximately 1.25 miles west and 1.85 miles south of the center of Ambrose; from indurated sandy shale beneath fine tan sandstone, 30 feet below tan to brown sandstone in road, which is considered to be the equivalent of the uppermost oyster reef sandstone and top of the member. H. R. Bergquist, 1948.
225. 21007. Near crest of slope, a few yards north of road culvert, about 2.55 miles N. 10° W. of center of Gordonville; brown siltstone in sandy gray shale of lower part of the member, about 30 feet above base. H. R. Bergquist, 1948.
226. 21008. Near road about 50 yards north of a road culvert, at a point about 2.55 miles N. 10° W. of the center of Gordonville; ledge of fine brown sandstone about 10 feet above base of the member, and about 25 feet below road level. H. R. Bergquist, 1948.
227. 21009. Road in front of C. P. Jones' residence at road curve near crest of slope south of Iron Ore Creek valley and 2.7 miles south of U. S. Highway 69, junction of roads being 0.45 mile by road southeast of highway overpass of Missouri-Kansas-Texas Railroad in southeastern Denison; ferruginous concretions in shale 10 to 12 feet above base of the member. H. R. Bergquist, 1948.

LAMAR COUNTY
TEMPLETON MEMBER

228. 21010. Along a stream flowing northwesterly to Golden Bluff, about 0.25 mile south of the bluff in a wooded area and within latitude N. 32°52'3"-10" and longitude W. 95°28'46"-54" (see Medill No. 4 sheet of Camp Maxey, U. S. Army Photo Maps); from limestone concretion in shale of the lower part of the member, 6 to 8 feet above top of Lewisville member. H. R. Bergquist, 1948.
229. 21011. Road cut in north-facing slope of valley tributary to Sanders Creek, 0.15 mile by road southeast of a cotton gin in southeastern Chicota, about 0.5 mile by road south of junction with State Farm Road 197; from basal part of 9½-foot exposure of friable sandstone estimated 30± feet below top of the member. (See Grant no. 6 sheet of Camp Maxey, U. S. Army Photo Maps.) H. R. Bergquist, 1948.
230. 21012. In stream bed beneath Texas Power & Light power line, 0.2 mile south of State Farm Road 197, near south edge of a small artificial lake which is 0.9 mile by road west of U. S. Highway 271 in Arthur City; from 9-foot exposure of fossiliferous glauconitic grayish-tan to brown sandstone, top estimated 30 to 35 feet below top of the member. H. R. Bergquist, 1948.
231. 21014. Cut of State Farm Road 197, 2.2 miles west of Arthur City, 0.1 mile east of Sanders Creek bridge; dark gray shale 18 to 20 feet below oyster-bearing sandstone at top of cut, estimated 30 to 35 feet above base of the member. H. R. Bergquist, 1948.

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SYSTEMATIC PALEONTOLOGY⁴

Phylum PORIFERA

Class SPONGIAE

Subclass SILICISPONGIAE

Order MONACTINELLIDA

Family CLIONIDAE

Genus CLIONA Grant, 1826

Type species: *Clinona celata* Grant, (1826, p. 78). Recent, in the waters of the Firth of Forth, Scotland.

Casts of borings in the thick shells of fossil mollusks found in the upper part of the Navarro group of Texas and referred to the genus *Clinona* Grant are described in my monograph on the fossils of that group (1941, pp. 54-56). Casts of similar borings in the shells of mollusks in the Woodbine formation are described on following pages.

In the Navarro group the material forming the casts is of phosphatic nature; often the shell substance of the host in which the borings were made is dissolved away, leaving the network of phosphatic material as the only representative of the shell, the form of which is often faithfully preserved by the dense development of the casts. In the Woodbine formation the borings in the shells have usually been filled with iron oxide, either limonite or hematite, and the casts thus formed are found lining the internal and external molds left in ferruginous sandstone when the shell substance was removed in solution in circulating ground waters. In the case of a few specimens the shell substance is still preserved and the borings are filled with crystalline calcite.

Clinona retiformis Stephenson, n. sp.

Plate 8, figures 1-3

The species is based mainly on the casts of borings, which appear as irregular intercommunicating networks, chains, and clusters on the surface of the molds of mollusks left in ferruginous sandstone when the shell substance of the host was dissolved away. The young sponges entered the shell through numerous circular openings of their own making, which range in diameter from 0.1 mm or less to about 0.5 mm. Once inside the shell the young sponges bored laterally, the individuals often meeting and fusing to form colonial assemblages. The borings are extremely irregular, ranging from small to relatively large tubes, swelling at intervals to still larger irregular ovate- or jug-shaped cavities. The pattern may be that of an open lacework of laby-

⁴Throughout this section entitled "Systematic paleontology" collections of fossils are referred to by locality numbers which follow the side heading Occurrence. Localities, designated by these numbers, are described in detail on pages 35-44 and are referred to on the maps wherever possible. Most of them are also on the chart of distribution.

United States National Museum catalog numbers are given to types and figured specimens.

rinthine passages or a dense mesh of tubes and turnip-shaped intercommunicating cavities. The surface of the cast is finely stippled, a feature which appears to be characteristic of the genus. In general the patterns formed by the casts are small and fine, the diameters of the largest tubes and swellings rarely exceeding 1 mm except at the meeting places of two or more of the larger cavities.

The growth habit of this species is similar to that of *Cliona microtuberum* Stephenson (1941, pp. 54-56), but the pattern formed by the borings is consistently very much smaller and finer, this fact, together with its lower stratigraphic position, indicating with reasonable certainty that it is specifically distinct.

Types.—Holotype, ferruginous casts of borings on an external mold of a young shell of *Ostrea soleniscus* Meek, U.S.N.M. 105068; 1 figured paratype, U.S.N.M. 105069; unfigured casts of about 15 paratypes on molds of the same oyster, U.S.N.M. 105070; all from Eules member on State Highway 183, within 1.2 miles west-southwest of Eules, Tarrant County. One figured paratype, U.S.N.M. 105071; 1 unfigured paratype, U.S.N.M. 105072.

Occurrence.—Tarrant County: Locs. 12, 23, 29 (includes holotype, 1 figured paratype and 15 unfigured paratypes), 47; Denton County: locs. 72 (2 paratypes, 1 figured), 75, 91; Cooke County: locs. 98, 99; Grayson County: locs. 116, 117, 123, 132.

Range.—Dexter member to Lewisville member.

Genus SPECUS Stephenson, n. gen.

Type species: *Specus fimbriatus* Stephenson.

Etymology: Latin *specus*, a cave or cavern.

The name *Specus* is here proposed for an organism, probably of commensal rather than parasitic habit, which bored in thick molluscan shells. The available material consists of the ferruginous casts of the borings on the internal molds of mollusks, the shell material of which has been dissolved and removed in solution, leaving the casts uncovered. The casts are small, circular in cross section, club-shaped, straight, curved or irregular in trend, increasing gradually in size from the point where the young animal entered the shell to the sub-hemispherical internal end of the boring. Additional details are given in the description of the genotype, *S. fimbriatus*.

The organism which made these borings is not known. It is provisionally regarded as a sponge, and is questionably referred to the *Clionidae*. The regular increase in the size of the boring and the lack of stippling on the surface of the casts seem to exclude it from the genus *Cliona*. Several kinds of bivalve mollusks, notably *Pholadidea* and *Botula*, are common as commensal borers in the thick shells of mollusks, but the borings made by them are usually larger than the ones here described.

Specus should perhaps be regarded as a convenient form genus to which fossil borings of this kind may be referred until more is known about the organisms that produced them.

Specus fimbriatus Stephenson, n. sp.

Plate 8, figures 4-6

The casts of borings here described are small club-shaped forms having an observed maximum length of about 8 mm and ranging in diameter from about 0.2 mm at the small end to 0.75 mm at the large end. The larger end is rounded to a subhemispheric profile. The casts have been observed on the internal molds of two bivalve species, *Breviarca (Sanoarca) grandis* and *Ursirivus fanninensis*, and on the external mold of one gastropod. At each of the two localities at which the species was found on the internal molds of bivalve shells one specimen of *B. (S.) grandis* exhibits the casts of the borings; on each of these shells a colony of young sponges was distributed along the margin of the shell and bored inward in the fringing manner shown in the illustrations. That the organism did not always enter the shell at the margin is shown by the internal mold of a right valve of *Ursirivus fanninensis*, on which a cluster of the casts is present on the most inflated part of the mold. The casts are circular in cross section and more or less crooked and irregular in trend; the surface of each cast is smooth. In the holotype most of the casts are covered with a thin film of secondary crystalline calcite except in a few small areas from which the calcite has been accidentally broken away, exposing the smooth surface beneath.

Types.—Holotype, numerous casts of borings in the shell of *Breviarca (Sanoarca) grandis*, U.S.N.M. 105073, from a locality near base of Dexter member, in a field north of an east-west road 3.2 miles east-southeast, of Handley, Tarrant County. One figured paratype, U.S.N.M. 105074; 1 figured paratype, U.S.N.M. 105075.

Occurrence.—Tarrant County: Locs. 15 (holotype), 19 (2 paratypes, figured), 47; Denton County: loc. 56; Cooke County: loc. 100.

Range.—Dexter member to Lewisville member.

Phylum COELENTERATA

Subphylum CNIDARIA

Class ANTHOZOA

Subclass HEXACORALLA

Order MADREPORARIA

Suborder APOROSA

Family "ASTRAEIDAE"

Genus ASTRANGIA Edwards (Milne) and Haime, 1848

Type species: *Astrangia michelini* Edwards (Milne) and Haime. Recent, North America. (Edwards (Milne) and Haime, 1848, p. 496).

Astrangia (Coenangia) lamarensis Wells

Plate 57, figure 1

1947. *Astrangia (Coenangia) lamarensis* Wells, Bull. Am. Paleontology, vol. 31, no. 123, pt. 3, pp. 165-166, pl. 10 (1), figs. 15-16.

Dr. John W. Wells has, at my request, described this, the only known species of coral in the Woodbine forma-

tion, as quoted below. The Slate Shoals locality is now referred to the Templeton member of the formation.

Corallum encrusting or adherent, small, measuring 8 x 11 mm, but incomplete, up to 3 mm. thick. Corallites averaging 2 mm. in diameter, cerioid, with nearly completely fused walls. Calices moderately deep (ca. 1 mm.). Septa 24, in three complete cycles, thin, nonexsert, laterally strongly and acutely granulate, margins irregularly dentate, those of the first two cycles equal and extending to the axis where they mingle with a weak trabecular columella. Third cycle septa slightly thinner than the principals, short, apparently fused by inner ends to secondary septa.

Holotype.—U.S.N.M. 104171 (U.S.G.S. 14546 [loc. 201] collected in 1929 by L. W. Stephenson, T. W. Stanton, and J. B. Reeside, Jr.).

Occurrence.—Woodbine formation (U. Cretaceous-Cenomanian), near old Slate Shoals, Red River, Lamar County, Texas. [Templeton member.]

Remarks.—This is the first record of this subgenus in rocks older than Miocene, although astrangiids are known to occur as early as the Lower Cretaceous (*Arctangia*). It differs from all the Tertiary and Recent species in the very small size of the corallites. The single specimen is only moderately well preserved and is fixed to a fragment of an oyster shell."

Phylum ANNELIDA

Class CHAETOPODA

Order TUBICOLA

Family SERPULIDAE

Genus SERPULA Linné, 1758

Type species: *Serpula seminulum* Linné (1758, p. 786). Recent, in the Adriatic Sea.

Serpula implicata Stephenson, n. sp.

Plate 8, figures 7-9

Tubes small, long, slender, exceedingly irregular in trend, often intricately entangled, very gradually increasing in diameter from a minimum observed diameter of 0.2 mm to a maximum of 2 mm. The tubes lie recumbent, attached longitudinally on one side to an oyster shell or other hard object; along the under side the tube wall is thickened to form a flattish base of attachment; opposite the base a sharp, narrow, low ridge forms a longitudinal crest along the top of the tube. The tubes attain a length of 50 mm or more. The growth lines are distinct and encircle the tube approximately transverse to its length, but as they approach the crestal ridge on either side they bend forward a little. As preserved many of the tubes are badly crushed, but some of them are in good condition.

The tubes of this species are more often found attached to shells of *Ostrea soleniscus* than to other shells or objects; they are particularly common on oyster shells of this species from Timber Creek southwest and south of Lewisville, Denton County.

Types.—Holotype, attached to the type of *Anomia ponticulana* Stephenson, U.S.N.M. 105076, from a locality near mouth of a

small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton County. Colony of paratypes on shell of *Ostrea soleniscus* Meek, U.S.N.M. 105077a; colony of paratypes on another part of same shell, U.S.N.M. 105077b; unfigured paratypes on other shells of the same species 105078 and 105079.

Occurrence.—Tarrant County: Loc. ?44; Denton County: locs. 71, 72, 73 (part of paratypes), 74, 78 (holotype on holotype of *Anomia ponticulana*), 79 (part of paratypes), 80-82; Fannin County: locs. 179, 184.

Range.—Lewisville member.

Unidentified specimens of *Serpula*

A tangle of tubes nestled on the interior of a left valve of *Aguileria cumminsii* White, from the Lewisville member on Timber Creek, Denton County (loc. 73), appears to belong to an undescribed species of *Serpula* (pl. 9, fig. 1). The tube is long and slender and comparable in diameter to the tube of *S. implicata*. The distinguishing character of the tube is the coarse, somewhat irregular, annular ridges, which are in contrast to the fine growth markings of *S. implicata*. The maximum diameter of the tubes is about 1.6 mm. U.S.N.M. 105080.

A tangle of small tubes from the Lewisville member on Timber Creek, 3 miles west by south of Lewisville, Denton County (loc. 75), represents an indeterminate species of *Serpula*. The tubes are thin-walled, subcircular in cross section, and are irregularly intertwined among themselves. The growth lines are fine, sharp, and closely spaced. The largest measured diameter is a little less than 1 mm. U.S.N.M. 105081.

Phylum MOLLUSCOIDEA

Class BRYOZOA

Family VINELLIDAE

Genus GRAYSONIA Stephenson, n. gen.

Type species: *Graysonia bergquisti* Stephenson.

Etymology: Derived from the name of the Grayson family, for whom Grayson County was named.

The casts of an organism which infested the thick shells of Cretaceous mollusks are interpreted to have been made by a species of boring Bryozoa. These casts are in part remarkably similar in size, form, and habit of growth to *Bascomella gigantea* Morningstar (1922, p. 157), considered to be a bryozoan, from Morningstar's McArthur member of the Pottsville formation (Pennsylvanian) of southeastern Ohio. My attention was called to this similarity by R. S. Bassler. However, the species here described manifests a habit of growth additional to that of the Pottsville species, because of which, and also because of the great difference in age between it and *Bascomella*, the new name *Graysonia bergquisti* is proposed for it.

The characteristics of *Bascomella gigantea* Morningstar, the genotype of *Bascomella*, are described by Morningstar, and more fully by Condra and Elias (1944, pp. 538-542, illustrated). In most respects the descriptions given by these authors apply equally well

to the organism here named *Graysonia bergquisti*. But there are differences, and the latter species lived much later in geologic time.

In *Graysonia* the zoarium is represented by a compound system of tubular stolons and vesicles (internodes) embedded in the shells of mollusks. The available material consists of ferruginous (limonitic and hematitic) fillings of the cavities once occupied by the organism in the shells. Subsequent to the filling of the cavities the enclosing shell material was dissolved away, leaving the fillings as faithful casts of the cavities.

The casts of the stolons are present as slender ferruginous tubes more or less irregularly distributed through the cavity but typically forming connected series of little arches, the various series often intermingling to form a complicated meshwork of arches, as shown in one of the illustrations. In cross section the stolons are not circular, but are rather strongly compressed to flattish on the upper and lower surfaces of the arches. The bases of the arches appear to be attached to the surface of either the external or internal mold of the mollusk. Here and there among the meshwork branching stolons may be seen, and rarely several stolons diverge irregularly from a common center. The ferruginous casts of the stolons are hollow. The vesicles or internodes are irregularly subovate in form and range in size from microscopic to a measured maximum length of 4.5 mm. They may be present in great numbers and may or may not be irregularly intermingled with the stolons. Here and there a stolon may be seen attached to the side of a vesicle, or apparently coming off from its base. The casts of the vesicles are attached to either the external or internal molds, the flattish bases covering areas of relatively small or large size. The casts may be crowded together in great numbers or may be more or less widely scattered. Some of them appear to merge one with the other. Many of the casts exhibit concentric parallel, more or less oblique linings which probably reflect the contact of the vesicle with the growth layers of the enclosing shell wall; the casts are composed of sand grains cemented with iron oxide enclosed within a thin, smooth coating of iron oxide.

Most of the features just described are very similar to those of *Bascomella gigantea*, but in addition some of the examples include casts of a part of the organism which excavated an elongated, club-shaped cavity, circular in cross section and attaining much greater size than the casts of the stolons; these may be attached to the casts of the vesicles with which they are obviously closely associated, or they may stand apart attached to the external or internal mold; they increase in diameter away from their points of origin and have rounded termini; rarely one of them is seen to send off one or two branches; like the vesicles they are composed of cemented sand grains. These peculiar casts

appear to be modified forms of vesicles rather than of the stolons.

Graysonia bergquisti Stephenson, n. sp.

Plate 9, figures 2-6; plate 10, figures 27, 28

The material includes casts of vesicles (internodes), stolons, and peculiar club-shaped parts which appear to represent a modified form of vesicle of a species of Bryozoa. These features have been rather fully described under the generic heading. All three features are present on the specimen selected as holotype. The organism lived and thrived among mollusks inhabiting a sandy sea bottom. Doubtless both the stolons and the vesicles of the organism communicated freely with the enclosing sea water through openings in the outer surface of the shell of the host. It was probably commensal rather than parasitic, deriving its nourishment from the surrounding sea water and excavating cavities in the shell of the host for protection only. The host was either a bivalve or a gastropod, the thicker-shelled species being preferred. In some of the larger gastropods (example, *Gymnentome valida*) there is a definite tendency for the vesicles to aline themselves along the sutures between the whorls, as if that were a favorable place of entrance to the host.

Types.—Holotype, U.S.N.M. 105082; 2 figured paratypes, U.S.N.M. 105083 and 105084; 22 unfigured paratypes, U.S.N.M. 105085; all from the Lewisville member in a branch east of a north-south road, 2.5 miles north of Sadler, Grayson County. Three figured paratypes, U.S.N.M. 105086, 105087, 105088; 3 paratypes, unfigured, U.S.N.M. 105089; 1 figured paratype, U.S.N.M. 105090; 23 paratypes, unfigured, U.S.N.M. 105091. Named in honor of Harlan R. Bergquist, one of my coworkers in the area of the Woodbine formation.

Occurrence.—Hill County: Loc. 7; Tarrant County: locs. 11, 12; Denton County: loc. 91; Cooke County: loc. 99 (21+paratypes, 1 figured); Grayson County: locs. 116, 117 (6 paratypes, 3 figured), 123, 131, 132 (holotype, 24 paratypes, 2 figured).

Range.—Dexter member to Lewisville member.

Family MEMBRANIPORIDAE

Genus MEMBRANIPORA Blainville, 1830, sensu lato

Type species: *Flustra membranacea* Linné, 1767. Recent, in the eastern Atlantic Ocean and adjacent seas.

Membranipora sp.

Plate 10, figure 26

A few examples have been observed of Bryozoa which, according to R. S. Bassler, belong to the group *Membranipora* Blainville (sensu lato), encrusting the shells of *Ostrea soleniscus* Meek, and in one instance the shell of *Protarca tramitensis* (Cragin). The zoaria consist of encrusting sheets of calcareous zooecia arranged in rows radiating more or less irregularly from an ill-defined central area, as shown in the illustration. The zooecia appear as small elongated perforations walled by calcite, about 4 to a millimeter in each row. None of the detailed features, such as the

ovicells, which are necessary for a refined classification of this group, appears to be present in the meager available material. Examples are present from localities 73, 79, 80, and 82, all from Timber Creek, Denton County, and from locality 196, Fannin County. All are from the Lewisville member. At each of the Timber Creek localities the colonies of *Membranipora* are closely associated with the tubes of *Serpula implicata*. Figured specimen, U.S.N.M. 105092.

Class BRACHIOPODA

Order ATREMATA

Superfamily LINGULACEA

Family LINGULIDAE

Genus LINGULA Bruguière, 1797, sensu lato

Types species: *Lingula unguis* Linné (= *L. anatina* Lamarck). Recent, in Western Pacific seas.

Twelve localities have yielded specimens, in part poorly preserved, that obviously belong to the exceedingly long-ranging group commonly referred to the genus *Lingula* Bruguière. In the absence of the soft parts, and the views of the interior, the simplicity and similarity of the shells of many of the members of the group are such as to render difficult their separation into clearly defined species. The use of the name *Lingula subspatulata* Hall and Meek (1855) for specimens subsequently found in American sediments of Upper Cretaceous age must therefore be regarded as provisional and subject to correction as more and better material becomes available and more exact knowledge of the features of the shells is acquired.

Lingula subspatulata Hall and Meek?

Plate 10, figures 1-3

1855. *Lingula subspatulata* Hall and Meek, Am. Acad. Arts, Sci. Mem., new ser., vol. 5, pt. 2, p. 380, pl. 1, figs. 2a, 2b.
1877. *Lingula subspatulata* Hall and Meek. White, U. S. Geol. and Geol. Survey W. 100th Mer. Rept., vol. 4, pt. 1, p. 169, pl. 15, fig. 4a.
- ?1889. *Lingula subspatulata* Hall and Meek. Whiteaves, Canada Geol. and Nat. History Survey, Contr. Canadian Paleontology, vol. 1, pt. 2, pp. 185, 186.
1899. *Lingula subspatulata* Hall and Meek. Stanton, U. S. Geol. Survey Mon. 32, pt. 2, p. 636.
1903. *Lingula subspatulata* Hall and Meek. Johnson, School Mines Quart. [Columbia Univ.], vol. 24, p. 113, pl. 1, figs. 11a, 11b.
1907. *Lingula subspatulata* Hall and Meek. Weller, New Jersey Geol. Survey, Cretaceous Paleontology, vol. 4, p. 356, pl. 27, figs. 20, 21.
1917. *Lingula subspatulata* Hall and Meek. Dowling, Canada Dept. Mines, Geol. Survey, Mem. 93, p. 45. (Listed only.)
1933. *Lingula subspatulata* Hall and Meek. Warren, Royal Soc. Canada Trans., 3rd ser., vol. 27, sec. 4, p. 111.
1941. *Lingula* aff. *L. subspatulata* Hall and Meek. Stephenson, Texas Univ. Pub. 4101, p. 70, pl. 3, figs. 7-9.
- ?1944. *Lingula subspatulata* Hall and Meek?. Bergquist, Jour. of Paleontology, vol. 18, no. 1, p. 10.

The shells are dark-brown, elongate, compressed, polished, with a more or less pointed posterior end and terminal beak. Although they exhibit a general similarity in form, they vary individually in outline, ranging from twice as long as wide to about one and a half times as long as wide. The greatest width is near or a little in advance of the midlength. It is not possible to determine accurately the differences in thickness because nearly all specimens have suffered more or less mechanical compression. Nearly all are subtruncated at their anterior ends. The growth lines are fine and somewhat irregular, and very fine, obscure radial lines may be seen on the better-preserved shells. One of the narrower shells (loc. 179, coll. 10555) measures: Length 13.8 mm, width 6.4 mm, thickness 2.4 mm. One of the broader shells (loc. 165, coll. 20315) measures: Length about 15 mm, width 10.5 mm. Some of the larger incomplete shells probably attained a length of 20 mm or more.

Types.—Holotype, from the Pierre shale near Red Cedar Island, Missouri River, 35 miles below Fort Pierre, S. Dak., American Museum of Natural History, New York, 9341/1. One figured example, U.S.N.M. 105093; 4 unfigured examples, U.S.N.M. 105094; 1 figured example, U.S.N.M. 105095; 1 figured example, U.S.N.M. 105096.

Occurrence.—Tarrant County: Locs. 35, 36; Grayson County: locs. 122, 129, 142, 165 (1 example figured); Fannin County: locs. 179 (figured example), 183, 184 (figured example), 186, 192; Red River County: loc. 209.

Range in Texas.—Lewisville and Templeton members of Woodbine formation. Specimens compared with this species are recorded from the Nacatoch sand and Kemp clay of the Navarro group.

Range in Western Interior.—Pierre shale, South Dakota.

Phylum MOLLUSCA

Class PELECYPODA

Order PRIONODESMACEA

Superfamily NUCULACEA

Family NUCULIDAE

Genus NUCULA Lamarck, 1799

Type species: *Arca nucleus* Linné. Recent, in European waters.

Nucula rivulana Stephenson, n. sp.

Plate 10, figures 4-6

Shell small, subtrigonal in outline, strongly inequilateral, equivalve, moderately inflated, with greatest inflation well above the midheight and a little in advance of the beaks; shell wall thick. Beaks narrow, prominent, sharply incurved, slightly separated, opisthogyrate, situated a little in advance of the posterior extremity. Anterodorsal margin long, inclined, very broadly arched; anterior margin sharply rounded below the midheight; ventral margin broadly and regularly rounded; posterior margin truncated vertically, rounding broadly above into the slightly arched pos-

terodorsal margin. Lunule elongated, of moderate width, limited outwardly by a faint line; escutcheon broad, with moderately distinct outline, radially excavated on either side of a dividing rostrum formed by the upturned margins of the shell. Outer surface polished and marked only by fine growth lines; beneath the clear polish can be seen the fine internal radial structure characteristic of the genus.

Dimensions of the holotype, a complete individual: Length 9.8 mm, height 7.7 mm, thickness 5.3 mm.

Hinge long, narrow, asymmetrically arched; in the figured paratype the dental apparatus consists of a series of 15 closely spaced teeth in front of the chondrophore and a series of 9 back of it; those in front increase in size from the chondrophore nearly to the anterior terminus; in the posterior series the tooth just below the beak is proportionately large and is followed first by a small tooth and this in turn by successively larger teeth to about the seventh from the chondrophore. The chondrophore is small, deep-set, and strongly oblique toward the front. Inner margin finely crenulated. Adductor scars small, subovate, the anterior one slightly larger than the posterior one.

Types.—Holotype, U.S.N.M. 105097; one smaller paratype, a right valve, figured, U.S.N.M. 105098; 7 unfigured paratypes, U.S.N.M. 105099; all from Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Grayson County: Locs. 114, 132, 135, 223; Fannin County: locs. 179, 184 (type lot), 191.

Range in Texas.—Lewisville member.

Nucula sholsa Stephenson, n. sp.

Plate 10, figures 7-9

Shell small, subtrigonal in outline, strongly inequilateral, equivalve, moderately inflated, with maximum inflation well above the midheight and a little back of the midlength. Beaks narrow, prominent, strongly incurved, closely approximate, strongly opisthogyrate, situated slightly in advance of the posterior extremity. Anterodorsal margin very broadly arched, rounding into the anterior margin, which is sharply rounded well below the midheight; ventral margin broadly and regularly rounded; posterior extremity obtusely subangular; posterodorsal margin excavated at the extremity, sharply arched above. Lunule obscure, the margins, however, becoming intrenched as they approach the beaks. Escutcheon broad, proportionately short, with a pronounced, rather broad radial sulcus on each valve, extending in a curve from the beak to the lower posterodorsal margin, thus surrounding a pronounced central rostrum formed by the upraised margins of the valves. Surface ornamented with somewhat irregular, distinct concentric ridges, which radially number 6 or more to the millimeter. The internal radial structure characteristic of the genus is discernible in this species. The concentric markings are in strong contrast to the polished surface of *Nucula rivulana*.

Dimensions of the holotype, a complete shell of medium size: Length, 6.3 mm; height, 4.9 mm; thickness, 3.4 mm. The largest paratype, a left valve, is 8.7 mm long.

The anterior part of the hinge on the illustrated specimen presents a series of 18 sharp teeth, increasing in prominence from the chondrophore nearly to the anterior extremity; the posterior part is short, with only 6 or 7 somewhat irregular teeth of medium size. Chondrophore long, narrow, moderately deep, extending forward and obliquely downward. Adductor scars sharply impressed, the anterior one small, subcircular, the posterior one larger, broadly subovate. Inner margin finely crenulated.

Types.—Holotype, a nearly complete shell of medium size, U.S.N.M. 105100; 1 figured paratype, U.S.N.M. 105101; 1 unfigured paratype, U.S.N.M. 105102; all from bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar County. The name of the species is formed by anagram from the word "shoals."

Occurrence.—Lamar County: Loc. 201.

Range.—Templeton member.

Unidentified specimens of *Nucula*

One small, nearly complete shell with both valves intact, from the Lewisville member at a branch intersecting the Chicago, Rock Island and Pacific Railroad just east of Dorothy Siding, Tarrant County (loc. 44), is very much like *Nucula rivulana* but is proportionately shorter, higher, and thicker, and reveals the internal radiating structure lines less distinctly. Although well preserved, it is probably juvenile, for which reason it is not made the type of a new species. U.S.N.M. 105103.

Four very imperfect specimens from the Lewisville member at Hyatts Bluff on Red River, Fannin County (loc. 179), are too imperfect for specific identification. They consist of internal molds with fragments of poorly preserved shell attached. The largest specimen is 13 mm long and 10.5 mm high. U.S.N.M. 105104, 105105.

A piece of fine, ferruginous sandstone from the Lewisville member on a branch of Walnut Creek, 0.5 mile north of Gordonville, Grayson County (loc. 126), contains great numbers of incompletely preserved shells of a small species of *Nucula*. In form and size the shell is much like *N. rivulana*, except that it is slightly shorter and higher and perhaps a little plumper. As preserved, the outer layer of shell material is corroded away, except in a few small fragmentary areas, thus revealing conspicuously the inner radiating structure characteristic of the Nuculidae. One of the larger shells, a right valve, measures: Length 10.5 mm, height 8.5 mm, convexity 3 mm. U.S.N.M. 105106.

Numerous poorly preserved specimens, probably belonging to the same species as the preceding, were found in the Lewisville member about 1.2 miles north-

east of Gordonville cemetery, Grayson County (loc. 221). U.S.N.M. 105107.

Genus *ACILA* H. and A. Adams, 1858

Type species: *Nucula divaricata* Hinds, by subsequent designation (Stoliczka, 1871, p. 325). Recent, in the China Sea.

Subgenus *TRUNCACILA* Schenck, in Grant and Gale, 1931

Type species: *Nucula castrensis* Hinds. Recent, off Sitka, Alaska.

Acila (*Truncacila*)? *chicotana* Stephenson, n. sp.

Plate 10; figures 23-25

Shell of medium size, thick, elongate-subovate in outline, strongly inequilateral, equivalve, moderately inflated, most inflated well above the midheight and a little in advance of the beaks. The beaks are corroded in the holotype but appear to be opisthogyrate; they are situated about 0.3 the length of the shell from the posterior extremity. The shell lacks a posterior rostral sinus such as characterizes the typical *Acila*. Anterodorsal margin long, very broadly arched; anterior margin sharply rounded below the midheight; ventral margin broadly rounded, rising a little more steeply toward the rear; posterior margin a little less sharply rounded than the anterior; posterodorsal margin steeply descending, slightly arched. Lunule obscure; an obscure shallow radial excavation extends from the beak along the outer side of the anterodorsal slope to the margin. Escutcheon short, wide, weakly outlined. On the outer surface the growth lines and undulations are moderately coarse. Much of the inflated part of the surface is badly corroded and does not preserve the ornamentation. Radiating ribs are numerous, low, broadly round-crested, and separated by incised lines. Well-preserved parts of the surface exhibit a system of fine, irregularly zigzag ridges that is developed independently of both the regular radial and the concentric ornamentation. These markings are similar to the zigzag ridges on *Acila banquereauensis* Stephenson (1936, p. 387, pl. 3, figs. 12-14), but are finer and much less conspicuous both in strength and in the magnitude of the angulations. Schenck (1936, pp. 104-105) objects to the application of the name *Acila* to nuculid shells having the irregular type of zigzag sculpture exhibited by *A. banquereauensis* on the ground that this is not true divaricate sculpture. It seems to me probable that the zigzag sculpture on these species is the result of the same kind of biologic process as that which produced the sculpture on the typical *Acila*.

This type of sculpture is developed independently of both concentric and true radial ribbing, as is indicated by the presence of regular radial ribbing in addition to the zigzag markings on the species *chicotana* here described. In any event, the species *banquereauensis* and *chicotana* are more closely related to *Acila* than they are to the typical *Nucula*.

Dimensions of the holotype, a shell with the two valves together: Length 21.2 mm, height 16 mm, thickness 12 mm.

Parts of the hinge are preserved on two specimens. The two series of teeth are separated by a chondrophore that is narrow, deep, and oblique downward and forward. The posterior adductor scar, as seen on an internal mold, is small and deeply impressed. The inner margin is finely crenulated. The characteristic internal radiating structure of the Nuculidae is brought out clearly on corroded surfaces.

A further comparison with *Acila banquereauensis* shows that this species is not so steep on the posterodorsal surface and has the beaks a little farther forward, but the two species are closely and probably generically related.

Types.—Holotype, U.S.N.M. 105108; 3 unfigured paratypes, U.S.N.M. 105109; 3 unfigured paratypes, U.S.N.M. 105110. From a borrow pit at a road cut, 2.2 miles west of Arthur City, Lamar County.

Occurrence.—Grayson County: Locs. 154, 165, 167, 170; Lamar County: locs. 200, 201, 203, 207 (types).

Range.—Templeton member.

Acila (*Truncacila*)? sp. a

Plate 10, figure 21

A fragment of a small nuculoid shell showing the outer surface, from the Lewisville member, 0.9 mile west of Dallas County line in Tarrant County (loc. 41), presents a series of closely spaced, sharply developed, asymmetric ridges trending obliquely forward and downward across the anterior slope to the margin; in cross section these ridges have their short steep slope above and their longer, more gentle slope below, and resemble the zigzag ridges on *Acila chicotana*, except that they are rougher and more irregular in their development; the ridges end rather abruptly toward the rear, leaving the main lateral surface smooth with the exception of very fine growth lines and fine, obscure radial lines such as characterize the nuculoid family. The fragment, about the forward half of a right valve, measures: Length 4.1+ mm, height 4.7 mm. U.S.N.M. 105111.

The imprint in ferruginous sandstone of a fragment of shell that appears to belong to the same species as that represented by *Acila* (*Truncacila*)? sp. a was found in the Dexter member at a roadside exposure, 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville, Denton County (loc. 57). U.S.N.M. 105112.

Acila (*Truncacila*)? sp. b

Plate 10, figure 22

A fragment of the anterior portion of the left valve of a young shell, not including the beak, from the Templeton member at a roadside exposure, 3 miles northeast of Sherman Junction, Grayson County (loc.

160), possesses form, outline, and ornamentation that relate it closely to *Acila banquereauensis* Stephenson (1936, pp. 387-388, pl. 3, figs. 12-14), from a piece of fossiliferous rock dredged from a depth of 200 fathoms on Banquereau, off the coast of Nova Scotia. The shell is moderately inflated, the anterodorsal margin is broadly arched, the anterior margin is rather sharply rounded, and the ventral margin is broadly and regularly rounded. The surface is ornamented with sharply developed, closely spaced, irregularly zigzag ridges which trend independently of the growth lines; in cross section these ridges are steep on the upper side and slope gently down below. The whole surface is covered with very fine, closely spaced, radiating lines. The fragment, about half the anterior part of a left valve, measures: Length 5.5+mm, height 4.7 mm. U.S.N.M. 105113.

An incomplete shell from the Templeton member in a gully 250 feet north of a road, 0.65 mile south and 1 mile west of Star School in northeastern Grayson County (loc. 170), is about the same size and exhibits closely similar sculpture, and is considered to be specifically identical to the preceding (sp. b). U.S.N.M. 105114.

Family NUCULANIDAE

Genus NUCULANA Link, 1807, sensu lato

Type species: *Arca pernula* Müller. Recent, in Danish waters.

The validity of *Nuculana* Link versus *Leda* Schumacher is discussed by Stewart (1930, pp. 48-50). See also Iredale (1915b, p. 483).

The small species here described under the name *Nuculana? mutuata* has little if any anterior gape and apparently a very slight posterior gape. The presence or absence of a pallial sinus in the material examined was not determined.

Nuculana? mutuata Stephenson, n. sp.

Plate 10, figures 10-12

Shell small, elongate-subovate in outline, rather plump in the umbonal region, slightly inequilateral, equivalve. A broad, very shallow depression extends backward from the beak, reaching the posteroventral margin just below the extremity. Beaks moderately prominent, nearly direct, strongly incurved, approximate, situated about 0.45 the length of the shell from the anterior extremity. The dorsal margins diverge from the beaks at an angle of about 135°. Anteroventral margin descending, very gently arched; anterior margin sharply rounded; ventral margin broadly rounded centrally, rising steeply toward the front and less steeply toward the rear; posterior margin very sharply rounded; posterodorsal margin descending, nearly straight. Surface marked only by very fine growth lines.

Dimensions of the holotype, a shell with the two valves slightly separated ventrally: Length 8 mm, height 5 mm, thickness about 4 mm.

Hinge teeth small, short, numerous, and arranged in two narrow, widely diverging series of nearly equal length; the teeth nearest the beak in each series are very small and closely spaced but increase regularly in size distally to points a little past the middle, beyond which they again become somewhat smaller. Inner margin smooth.

This species is similar in form to *Yoldia? subacuta* but is smaller, shorter in proportion to the height, plumper, less pointed at the rear, and has the beaks situated near the midlength.

Types.—Holotype, U.S.N.M. 105115; paratype, figured, U.S.N.M. 105116; 29 unfigured paratypes, U.S.N.M. 105117; all from a borrow pit south of the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. 41, 46, 50 (type loc.).

Range.—Lewisville member.

Nuculana? sp.

Plate 10, figure 13

One internal mold of a taxodont shell in ferruginous sandstone of the Lewisville member from a branch east of a north-south road, 1.5 miles north of Mineral Creek, 2.5 miles north of Sadler, Grayson County (loc. 132), appears to pertain to the genus *Nuculana* Link. The shell is subequilateral with a rather prominent beak, and is more strongly convex than most of the species of this generic group. It measures: Length 11.5 mm, height 8 mm, convexity about 3 mm. U.S.N.M. 105118.

Genus YOLDIA Møller, 1842

Type species: *Yoldia hyperborea* Loven. Recent, in Arctic Ocean off Nova Zembla and Spitzbergen.

For critical discussions of the use of this name, see Dall (1898, pt. 4, p. 595) and Stewart (1930, pp. 59-60).

Each of the two species here questionably referred to this genus possesses a deep pallial sinus and apparently a slight siphonal gape at the rear, but they do not have the wide anterior pedal gape which Dall considered one of the characteristics of the genus.

Yoldia? septariana Cragin

Plate 10, figures 14-16

1893. *Yoldia septariana* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 218.

1928. *Yoldia septarina* Cragin [sic]. Adkins, Texas Univ. Bull. 2838, p. 88.

1951. *Yoldia septariana* Cragin. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 10 (following p. 163).

Shell relatively thick, of medium size for the genus, elongate, moderately inflated, maximum inflation below the beak, well above the midheight, from which place the surface slopes gently toward the anterior and ven-

tral margins and more gently toward the posterior margin, becoming constricted and slightly excavated as it approaches the extremity. There appears to be a slight posterior siphonal gape, but no anterior pedal gape can be detected. Beaks incurved, moderately prominent, nearly direct, situated about 0.4 the length of the shell from the anterior extremity. Antero- and posterodorsal margins diverge from the beak at an angle of about 145°. Anterodorsal margin very broadly arched; anterior margin rather sharply rounded above the midheight; ventral margin broadly and regularly rounded, except toward the posterior extremity, where it bends up more strongly and becomes subtruncated; posterior extremity very sharply rounded to subpointed, well above the midheight; posterodorsal margin long and nearly straight or very broadly concave. A shallow groove 0.5 mm or less in width closely borders the posterodorsal margin. Surface marked only by growth ridges of fine to medium strength.

Dimensions of a cotype, a large left valve shown in plate 10, figure 15. Length 18 mm, height 10.2 mm, convexity 3 mm.

The hinge presents numerous closely spaced angulated teeth in two sets, the anterior set numbering 17 to 20 and the posterior set 22 to 25, the two rows meeting under the beak at an angle of about 145°. Ligamental pit not clearly preserved in the material examined.

The adductor scars cannot be seen clearly, but the anterior scar appears to be of moderate size, subcircular, and situated about midheight, and the posterior scar small, somewhat elongated, and situated just beneath the hinge. The pallial sinus, as seen on several internal molds, is 3 to 4 mm deep and 2 to 2.5 mm wide in adults; it is rounded at the inner end and is situated high just beneath the adductor scar.

The individuals of this species are present at the type locality of *Metengonoceras dumbli* (Cragin) "4 miles [sic] east of Whitesboro, Grayson County." Cragin did not figure the species. Calcareous concretions more recently collected from dark clay at a locality just south of the old Whitesboro-Sherman road, 2.8 miles east of Whitesboro, contain many shells of this species. The concretions are lithologically identical with those from which cotypes of this species and of *Metengonoceras dumbli* were obtained, and the geologic position is certainly the same.

Types.—Cotypes, 7 left and 6 right valves, all internal molds with more or less shell material adhering, in the collection of the University of Texas. According to the label with the cotypes, this species came from the Eagle Ford shale at a locality 4 miles east of Whitesboro, 0.25 mile south of the Sherman road, Grayson County. The matrix and the associated fauna, however, show that it came from dark shale of the Templeton member of the Woodbine formation about 45 feet below the base of the Eagle Ford shale. One of the cotypes, a large left valve, is figured. Ten or more specimens are contained in the matrix

attached to the types of *Metengonoceras dumbli* Cragin, from the same locality. Twenty-five or more selected topotypes, U.S.N.M. 105122, from locality 154. One plesiotype, U.S.N.M. 105121; 1 plesiotype, U.S.N.M. 105119.

Occurrence.—Hill County: Locs. 3, 7; Johnson County: loc. 9; Tarrant County: locs. 34, 44, 46; Denton County: loc. 90; Grayson County: the cotypes from "4 miles [sic] east-southeast of Whitesboro, 0.25 mile south of the old Whitesboro-Sherman road" (type area). (See plastotype of a cotype, U.S.N.M. 105120.) Also locs. 49 (plesiotype), 107, 114, 131, 154 (includes 1 plesiotype and 25 or more selected topotypes), 164, 165, 167, 172; Lamar County: locs. 200, 202, 207.

Range.—Lewisville member to Templeton member.

Yoldia? *subacuta* Stephenson, n. sp.

Plate 10, figures 17, 18

Shell of medium size, elongate-subovate in outline, narrow posteriorly, moderately inflated centrally, compressed posteriorly. A broad, shallow, radial constriction extends from just back of the beak to the posteroventral margin below the terminus. Beaks rather low, nearly direct, incurved, situated about 0.4 the length of the shell from the anterior end. Anterodorsal margin relatively short, broadly arched; anterior margin sharply rounded slightly above the midheight; ventral margin broadly rounded centrally, curving up sharply toward the front and less sharply, becoming subtruncated, toward the rear; posterior extremity subpointed slightly above the midheight; posterodorsal margin long, gently descending, nearly straight, bordered on each valve by a narrow, shallow groove. Surface marked only by fine growth lines and narrow, weak undulations.

Dimensions of the holotype: Length 13.9 mm, height 7.5 mm, thickness 5 mm.

Hinge teeth small, numerous, arranged in two widely diverging, nearly straight series, the posterior one being about two-fifths longer than the anterior one.

This species differs from *Yoldia? septariana* Cragin in its lesser height in proportion to its length, in its greater compression posteriorly, and in its markedly more pointed extremity. It may be a smaller shell, but the available material is too meager for the determination of its average and maximum dimensions.

Types.—Holotype, U.S.N.M. 105123; 4 unfigured paratypes, U.S.N.M. 105124; from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Hill County: Loc. 5; Tarrant County: loc. 41; Denton County: loc. 89; Fannin County: loc. 184 (type loc.).

Range.—Lewisville member to Templeton member.

Superfamily ARCACEA

Family ARCIDAE

Genus PROTARCA Stephenson, 1923

Type species: *Protarca obliqua* Stephenson, from the Snow Hill marl member of the Black Creek formation (Upper Cretaceous), Snow Hill, N. C. (1923, pp. 103-105).

Protarca? tramitensis (Cragin)

Plate 11, figures 17-22

1893. *Arca galliennei* D'Orbigny, var. *tramitensis* Cragin, Texas Geol. Survey, 4th Ann. Rept. for 1892, pp. 168-170.
1894. *Barbatia micronema* (Meek). Stanton, U. S. Geol. Survey Bull. 106, pp. 89-91, pl. 21, figs. 3, 4. (In part; not figs. 1, 2.)
1928. *Arca tramitensis* Cragin. Adkins, Texas Univ. Bull. 2838, p. 89.
1951. *Protarca? tramitensis* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, figs. 11, 12 (following p. 163).

Shell large, thick, elongate, subtrapezoidal in outline, moderately inflated, maximum inflation about midway of the length and well above the midheight, equivalve, inequilateral. Umbonal ridge moderately prominent, subangular in the young stage near the beak, becoming rounded and progressively broader to very broadly rounded near the terminus of large individuals; the umbonal ridge is markedly the most inflated part of the shell. The beaks are prosogyrate, are 1 mm or more apart in adults, and are situated about 0.22 the length of the shell from the anterior extremity; they are broad, nonprominent, and each is divided radially by a broad shallow depression that extends downward and backward with increasing width to the ventral margin. Anteriorly the surface rounds down gently to the margin; the posterodorsal slope is broadly excavated in the radial direction. Hinge line straight, variable in proportionate length, averaging about 0.6 the length of the shell. Dorsal margin very broadly arched; anterior margin evenly and rather sharply rounded; ventral margin very broadly concave or nearly straight in some individuals; posterior margin sharply rounded below, broadly arched and inclined forward above, meeting the hinge line at an angle of about 150°. The species exhibits considerable individual variation in outline and in the proportion of length to height.

The outer surface on well-preserved shells is covered from the front to the umbonal ridge with closely crowded fine radiating ribs of irregular strength. On and beyond the umbonal ribs, the ribs fade out to a smooth surface. The strength of the ribbing appears to be a little greater on left than on right valves.

The one available cotype(?) is incomplete, but its approximate dimensions are: Length 72 mm, height 41 mm, thickness 36 mm. An average-sized shell from Timber Creek measures: Length 70 mm, height 38 mm, thickness 32.8 mm. A smaller and proportionately more elongated specimen from the same locality measures: Length 57 mm, height 30 mm, thickness 24.5 mm. Shells having a length as great as 90 mm are present in the collections from Timber Creek.

The ligamental area is greatly elongated, broadly rounded on its upper margin, and ranges in width to 5 or 6 mm in large individuals. It is covered with 4 or more chevron-shaped grooves, the posterior limbs of

which are greatly elongated and gently descending and the anterior limbs of which are short, gently descending, and more or less obscure. The elongated hinge is narrow and presents a long, narrow row of fine, closely set median transverse teeth, 9 or 10 larger oblique teeth on the wider anterior part of the hinge plate and 7 or 8 similar large teeth on the posterior part of the plate; the obliquity of the teeth increases both to the front and the rear and the end teeth are nearly parallel to the hinge; some of the larger teeth are angulated in trend. The anterior adductor scar is small and subovate; the posterior adductor is subtriangular and is much larger than the anterior scar. On well-preserved material the simple pallial line is marked by numerous short closely spaced, radially directed striae. The inner surface presents several weak to obscure grooves and ridges radiating outward from beneath the beak.

The species resembles the genotype, *Protarca obliqua* Stephenson (1923, p. 104, pl. 19), in its ornamentation, ligamental apparatus, dental apparatus, and adductor scars. As in *P. obliqua*, the adductors lie on a smooth surface, with no suggestion of bounding and partly supporting carinae, such as characterize *Idonearca*, *Trigonarca*, *Glycymeris*, and some other taxodonts. The species differs from the typical *Protarca* mainly in its much greater elongation and in the greater thickness of its shell. Cragin did not figure this species. One medium-sized incomplete shell, with the two valves together, from Timber Creek is believed to be a cotype because it was collected by Taff, who was one of the collectors mentioned by Cragin. Although this shell is imperfect, its form and surface ornamentation are well enough preserved to permit other fossils to be satisfactorily identified with it.

T. W. Stanton placed this species in the synonymy under *Barbatia micronema* (Meek). The type of Meek's species, *Trapezium micronema*, is an imperfect internal mold (U.S.N.M. 7846) with some shell material adhering to it and with the radial ribbing obscurely showing on parts of the surface. It came from the Bear River formation at Bear River City, Wyo. Although closely related to Cragin's species, Meek's type specimen is proportionately more elongated, the dorsal and ventral margins are more nearly parallel, and the beaks are closer to the anterior extremity. Some of the specimens from the lower part of the Upper Cretaceous in the Western Interior agree more closely with Cragin's species than does Meek's type.

Types.—Cragin had considerable material available from the Lewisville member, but he did not illustrate the species. He gave measurements of four specimens. One specimen now at the University of Texas, collected by J. A. Taff (here figured) was doubtless before Cragin when he described the species, and may perhaps be considered a cotype, but it is apparently not one of the measured specimens. (See plastotype, U.S.N.M. 105125.) Two specimens figured by Stanton (see synonymy) may be considered typical (U.S.N.M. 22870). Topotypes are figured in the present paper (U.S.N.M. 21842).

Occurrence.—Tarrant County: Locs. ?16, ?20, 23, ?25, ?28, 29, 30, 36, 39, 43-45; Denton County: locs. 71, 72 (includes two specimens figured by Stanton, U.S.N.M. 22870), 73-76, 79, 81, 83-85, 89; also Cragin's types from Timber Creek, southwest of Lewisville; also collection bearing U.S.N.M. 21842 but no Survey collection number, from "4 miles south [sic] of Lewisville," probably Timber Creek (loc. 69); Cooke County: loc. 99; Grayson County: locs. 106, 115-117, ?122, 123, 128, 132, 135, 137, 142, 219, 224; Fannin County: locs. 179, 180, 184, 185, 191, 193-195; Red River County: loc. 209.

Range.—Dexter member(?); Eules member to Lewisville member.

Protarca? sp.

A poorly preserved imprint of a taxodont shell in ferruginous sandstone of the Dexter member, from a roadside exposure 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville, Denton County (loc. 57), is questionably referred to *Protarca* Stephenson. It has the form of *Protarca? tramitensis* (Cragin), but has much stronger radiating ribs, which tend to alternate in size and are more or less distinctly noded. The shell is 26+ mm long and about 19 mm high. U.S.N.M. 105126.

Genus *BREVIARCA* Conrad, 1872

Type species: *Trigonarca saffordi* (Gabb) Conrad (= *Breviarca haddonfieldensis* Stephenson, 1935, pp. 362-363). Not *Arca saffordi* Gabb, 1860. *Breviarca haddonfieldensis* is from the Woodbury clay (Upper Cretaceous), Haddonfield, N. J.

Breviarca minor Stephenson, n. sp.

Plate 11, figures 7-9

Shell small, short, subtrapezoidal, inequilateral, subequivalve, strongly inflated, greatest inflation below the beaks at about two thirds the height. The left valve slightly overlaps the right valve all around the margin. Umbonal ridge distinct but rounded. The surface slopes steeply to the anterodorsal margin, less steeply to the anterior and ventral margins; posterodorsal slope steep, broadly excavated. There is a moderately pronounced keel caused by the upturned margins at either end of the ligamental area. Beaks prominent, broad, strongly incurved, nearly direct but apparently slightly opisthogyrate, slightly less than 0.5 mm apart in the holotype, situated about 0.45 the length of the shell from the anterior extremity. Anterior margin regularly rounded; ventral margin broadly rounded; posterior margin sharply rounded below at the end of the umbonal ridge, broadly rounded and inclined forward above. Surface ornamented with rather pronounced concentric lines and with numerous small, weak, radial ribs that tend to alternate in size on the dorsal slopes.

Dimensions of the holotype, a complete shell: Length 4.5 mm, height 3.4 mm, thickness 3.2 mm.

The cardinal area is subtrigonal in outline and is slightly broader behind than in front of the beaks. The straight basal edge of the area is 2.8 mm long, and the other two sides are slightly arched. The ligamental

area is small, trigonal, subequilateral, and is directly below the beak. It is amphidetic, is slightly sunken, and is striated at right angles to the hinge line. The hinge as seen in poorly preserved material is straight medially and aches down slightly at the ends; it is set with 12 or more small teeth which are at right angles to the hinge line centrally but become oblique toward the extremities. Inner surface of shell not clearly uncovered.

Types.—Holotype, U.S.N.M. 105127, from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County; 6 unfigured paratypes, U.S.N.M. 105128; 1 figured paratype, U.S.N.M. 105129; 3 unfigured paratypes, U.S.N.M. 105130.

Occurrence.—Lamar County: Locs. 201 (holotype and 6 unfigured paratypes), 207 (4 paratypes, 1 figured).

Range.—Templeton member.

Breviarca habita Stephenson, n. sp.

Plate 10, figures 19, 20

Shell small, longer than high, subtrapezoidal, inequilateral, nearly equivalve, inflated, greatest inflation above the midheight and a little in advance of the midlength. The left valve slightly overlaps the right around the margins. Umbonal ridge rather sharply subangular, extending in a broad curve to the lower end of the posterior margin. The surface slopes steeply to the anterodorsal margin, and less steeply to the anterior and ventral margins; posterodorsal slope long, very steep, broadly excavated. Anterior margin a little more narrowly rounded than a semicircle; ventral margin broadly rounded; posterior margin subangular below at the extremity, becoming nearly straight and inclining strongly forward above, rounding broadly into the straight dorsal margin. The surface presents very fine growth lines and numerous small, weak to obscure radiating lines that are somewhat irregular in strength on the posterodorsal slope; the crossing of the two sets of lines produces a very fine obscure cancellation.

Dimensions of the holotype, a nearly complete shell: Length 6.4 mm, height 4.7 mm, thickness 3.5 mm. Dimensions of a small complete paratype: Length 3.1 mm, height 2 mm, thickness 1.6 mm.

The cardinal area is broader behind than in front of the beaks and is slightly excavated on either side of the marginal anterior and posterior keels. Ligamental area small, triangular, amphidetic, slightly sunken, and about one-third or one-fourth as long as the cardinal area; on the available material transverse ligamental striations are obscure but appear to be present. The hinge is too imperfectly preserved for description. The features of the inner surface are not uncovered.

Compared with *Breviarca minor* this species is larger, has a more sharply angular and more elongated umbonal ridge.

Types.—Holotype, U.S.N.M. 105131; 35 unfigured paratypes, U.S.N.M. 105132; from the Templeton member at a bluff on branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County; 4 unfigured paratypes U.S.N.M. 105133.

Occurrence.—Tarrant County: Loc. 41; Grayson County: locs. 164, 165 (holotype and 35+unfigured paratypes); Lamar County: locs. 201 (4 unfigured paratypes), 207, 207.

Range.—Lewisville member to Templeton member.

Unidentified specimens of *Breviarca*

The internal mold of a small taxodont shell in ferruginous sandstone of the Dexter member, from a roadside exposure 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville, Denton County (loc. 57), is questionably referred to *Breviarca* Conrad. It is strongly convex, has a pronounced subangular, elongated umbonal ridge, and a steep posterodorsal slope. Dimensions: Length 9 mm, height 6 mm, convexity about 2.5 mm. U.S.N.M. 105134.

Several internal and external molds of a small bivalve belonging to *Breviarca* Conrad were found in ferruginous concretions in the Dexter member, 0.2 mile north of a road corner, 2.4 miles southeast of Argyle, 2.4 miles northwest of Bartonville, Denton County (loc. 58). The shell is rather low-convex, subcircular in outline, with a nonprominent, rounded umbonal ridge; cross striations are present on the ligamental area. The dimensions of one internal mold are: Length 10.5 mm, height 9.2 mm, thickness 5.5 mm. U.S.N.M. 105135.

The internal mold of a small taxodont shell in ferruginous sandstone of the Lewisville member from Copper Creek, 4.6 miles south 25° west of Gordonville, Grayson County (loc. 131), is similar in size and form to the preceding and may be the same species. U.S.N.M. 105136.

Subgenus *SANOARCA* Stephenson, n. subgen.

Type species: *Breviarca* (*Sanoarca*) *grandis* Stephenson.

Etymology: Latin *sanus*, sound, healthy; *Arca*.

The subgenus *Sanoarca* is like the typical *Breviarca* in form, in surface features, and in the orientation of the fibers of the ligament transverse to the hinge line. The subgenus differs from the typical *Breviarca* in the faintness of the impressions which the transverse fibers leave on the area, and in that there are no radiating carinae or buttresses bounding and partly supporting the adductor scars; the low, relatively coarse ridges that cross the area from its outer margin to the hinge line mark the successive stages of growth of the hinge teeth and are not to be confused with true ligamental striations. The type species is much larger than most species of *Breviarca* s.s.

Breviarca (*Sanoarca*) *grandis* Stephenson, n. sp.

Plate 11, figures 11-16

1893. *Arca* (*Trigonarca*) *siouxensis* (Hall and Meek). Cragin (in part), Texas Geol. Survey, 4th Ann. Rept. for 1892, p. 170. Not *Pectunculus siouxensis* Hall and Meek.

1928. *Arca* (*Trigonarca*) *siouxensis* (Hall and Meek) Cragin. Adkins, Texas Univ. Bull. 2838, p. 89.

Shell large for the genus, thick, subtrapezoidal in outline, strongly inflated in the adult, greatest inflation well above the midheight and slightly back of the beaks, inequilateral, equivalve. Umbonal ridge pronounced, broadly rounded. Beaks prominent, strongly incurved, slightly prosogyrate, about 2.5 mm apart in the holotype, situated 0.45 the length of the shell from the anterior extremity. From the greatest inflation the shell rounds down rather steeply to the anterior and ventral margins, and, back of the umbonal ridge it descends in a steep straight slope to the posterior margin. In the holotype the right valve exhibits a broad radial depression extending from the beak to the ventral margin a short distance in front of the umbonal ridge, but this appears to be either a mechanical distortion or an individual variation. Anterior margin regularly rounded, slightly subtruncate in some individuals; ventral margin broadly rounded, becoming nearly straight in some large adults; posterior margin sharply rounded below, broadly rounded to subtruncate above, inclined forward toward the end of the ligamental area. There is a noticeable individual variation in outline and form, some shells being more inflated than others.

Fine concentric lining is present over the outer surface. Fine, more or less obscure, radiating lines may be seen on some specimens and appear to be absent, perhaps due to corrosion, on others; these ridges tend to alternate in strength and are generally best developed on the umbonal ridge and on the dorsal slopes. One large individual (pl. 11 fig. 16) shows an increase in the strength of the radiating ridges and a distinct alternation in their size, toward the anterior and ventral margins.

Dimensions of the holotype: Length 42 mm, height 36 mm, thickness 28.5 mm. A young, nearly perfect shell measures: Length 26.3 mm, height 22.5 mm, thickness 15.4 mm. The large shell shown in plate 11, figure 16, is 51 mm long.

In the holotype the straight base of the ligamental area is 21 mm long, half the total length of the shell. This area forms a subisosceles triangle with a very long straight base and slightly arched sides. The ligament covers the whole area and the fibers composing it are oriented at right angles to the hinge line and on most shells are only faintly impressed on the area. Portions of the ligament are present on some specimens, but the material is very soft and easily rubbed off. The traces of the teeth, which may be seen extending down across the areas of many specimens, should not be mistaken for the fine ligamental striations. There is a marked variation in the size of the ligamental area on different individuals from the same locality. The hinge is set with many teeth, numbering 40 or more

in medium and large shells. The median teeth are small, are transverse to the hinge line, and are alined in a straight row bordering the area. The row of median teeth is continuous at each end with a downward arching series of larger teeth, the two series being about equal in length. These larger teeth may be angulated, or more or less irregular, and become successively more nearly horizontal toward the termini. The teeth are finely striated on the sides in the direction of movement of the valves. As the shell increases in size the ligamental area encroaches more and more downward on the median row of teeth, which becomes successively narrower and finally disappears in large adults, leaving only the arched series of teeth at the ends. Adductor scars large, subtrigonal, the posterior one noticeably the larger. No carinae are present bounding the adductors and the inner surface is otherwise smooth. Pallial line simple and inner margin of shell smooth.

The holotype of *Pectunculus siouxensis* Hall and Meek (1855, p. 384) from the "Dakota group of the Upper Missouri Cretaceous series," mouth of Big Sioux River, on Missouri River, is an internal mold of a rather small left valve. Although having the form of *Breviarca* (*S.*) *grandis*, neither the essential generic nor the specific characters are preserved, and the reference of the Texas species to it by Cragin and others does not seem justified.

Types.—Holotype U.S.N.M. 105137; 2 figured paratypes, U.S.N.M. 105138, 105139; 13 unfigured paratypes, U.S.N.M. 105140; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. One paratype figured, U.S.N.M. 105141; 1 paratype unfigured, U.S.N.M. 105142.

Occurrence.—Johnson County: Loc. 9 (juvenile); Tarrant County: locs. 11, 14-16, 19-22, 24, 25, 27, 28, 34, 35, 39, 47, 54; Denton County: locs. 73 (paratype), 75, 78, 79, and Texas Univ. Coll., identified as *Trigonarca siouxensis* Hayden and Meek; Cooke County: locs. 98, 99; Grayson County: locs. 107, 114, 116, 117, 122, 123, 125-127, 129, 130, 132, 135, 139, 164, 223, 224; Fannin County: locs. 179, 180, 183 (includes 1 paratype), 184 (holotype and 15 paratypes, 2 figured), 186, 187, 191-193, 195, 220; Lamar County: loc. 201; Red River County: loc. 209.

Range.—Dexter member to Templeton member.

Breviarca (*Sanoarca*) *faucana* Stephenson, n. sp.

Plate 11, figures 5, 6

Shell small, subtrapezoidal in outline, inflated, inequilateral, equivalve. Umbonal ridge well rounded. Beaks prominent, rather broad, strongly incurved, nearly direct, situated about 0.4 the length of the shell from the anterior extremity. The surface rounds down broadly to the anterior and ventral margins and steeply to the anterodorsal margin; back of the umbonal ridge the posterodorsal slope is steep and straight. Anterior margin evenly rounded; ventral margin very broadly rounded, nearly straight centrally; posterior margin sharply rounded below, becoming nearly straight and strongly inclined forward above. Surface with fine to

medium coarse incremental lines and with obscure fine radial lines showing on some well-preserved specimens.

Dimensions of the holotype: Length 9.5 mm, height 8.2 mm, convexity 3.2 mm.

The ligamental area is amphidetic and the characteristic transverse lines of the genus are obscure on most shells. The base of this area in adults is at least 3 mm long. The teeth are numerous and form a continuous series, which is straight centrally and arches down gracefully toward the extremities; centrally the teeth are vertical but become progressively more oblique, until at each end of the series they are nearly horizontal. The inner shell surface appears to be essentially smooth, with proportionately large adductor scars that lack bounding radiating carinae such as characterize the more typical species of *Breviarca*. Inner margin smooth.

The species differs from *Breviarca* (*Sanoarca*) *grandis* in its consistently small size and in the lack or obscurity of radiating lines on the outer surface.

Types.—Holotype, U.S.N.M. 105143; 21 unfigured paratypes, U.S.N.M. 105144; all from the Lewisville member in a small stream gorge, 0.45 mile west of road, 1.9 miles S. 54° W. of center of Ambrose, Grayson County.

Occurrence.—Tarrant County: Locs. 21, 28; Grayson County: locs. 107, 132, 135 (type loc.).

Range.—Eules member to Lewisville member.

Family NOETIDAE

Genus *LINTER* Stephenson, 1937

Type species: *Linter acutata* Stephenson, from the Nacatoch sand of the Navarro group (Upper Cretaceous), Navarro County, Tex. (1937, pp. 449-451; 1941, pp. 85-86).

Linter? sp.

Plate 11, figure 10

The genus *Linter* is questionably represented by one incomplete internal mold of a left valve from the Lewisville member on the Hillsboro road, 2 miles east of Whitney, Hill County (loc. 3). The specimen is characterized by a high, sharply angular, strongly oblique umbonal ridge, above which the wide posterodorsal slope is broadly excavated and below which the main surface slopes steeply to the ventral margin. The outline at the posterior extremity is acutely angular. The descending posterodorsal margin is broadly arched centrally. Fine concentric growth lines are impressed on the surface of the mold. The anterior part of the mold is broken away and the hinge and area are not exposed. U.S.N.M. 105145.

Family CUCULLAEIDAE

Genus *IDONEARCA* Conrad, 1862

Type species: *Cucullaea capax* Conrad (1858, p. 328), from the Owl Creek formation (Upper Cretaceous), Tippah County, Miss. (Conrad, 1862, p. 289; 1872, p. 54). (See Stephenson, 1941, pp. 89-91.)

Idonearca blanpiedi Stephenson, n. sp.

Plate 11, figures 1-4

Shell of medium size and thickness, subtrapezoidal, strongly convex, with greatest inflation well above the midheight at about the midlength, inequilateral, equi-valve. Umbonal ridge rather sharply subangular. Beaks moderately prominent, broad, incurved, nearly direct, situated about 0.45 the length of the shell from the anterior extremity. From its greatest inflation just in front of the umbonal ridge the surface curves broadly and gently downward toward the anterior and ventral margins; the posterodorsal slope is steep and straight. The anterior margin is subtruncated beneath the end of the cardinal area, rounding below into the very broadly rounded ventral margin; terminus sharply rounded, almost subangular, passing above into a long, nearly straight posterior margin that inclines strongly forward to the dorsal margin. Surface of holotype corroded and showing practically no radial ornamentation; small obscure radial ridges that tend to alternate in size can be seen toward the ventral margin of the figured paratype.

Dimensions of the holotype, a right valve: Length 53 mm, height 46 mm, convexity 21.5 mm. Dimensions of the figured paratype: Length 39 mm, height 30 mm, convexity 14.5 mm.

The cardinal area forms an elongated, isosceles triangle whose straight base is, in the holotype, about two-thirds the total length of the shell (35 mm), and whose greatest width under the beak is 7.5 mm; the area is covered with sharply incised, roughly chevron-shaped ligamental grooves numbering 6 in the holotype; in the holotype the grooves are markedly zigzag in trend, but in the figured paratype they are regular in their arrangement. Hinge narrow, nearly straight medially, curving down slightly at the front end, more strongly at the rear. The medial teeth are small and irregular; the end teeth are coarser and fewer in number than on the typical *Idonearca*; they are slightly oblique downward toward the interior, becoming nearly horizontal at the ends; they show a slight tendency to angularity in trend at their inner ends. Fine, irregular, transverse striations are present on the teeth but they are obscurely preserved on the available material. The anterior adductor scar is subtrigonal, lacks a bounding carina, and is smaller than the posterior scar; the latter is elongated and is bounded within by a long, broadly curved, strong, sharp carina, essentially like that on *Idonearca* and on *Trigonarca*. Pallial line simple, bordered within by short, rather coarse radial striations. Inner margin smooth.

The species exhibits considerable individual variation in outline and form. It differs from *Idonearca capax* Conrad in its thinner shell and its fewer and coarser teeth, which slope gently inward and downward

instead of outward and downward. There is also a tendency for the chevron-shaped ligamental grooves to develop minor irregularities in trend; in some shells this tendency manifests itself in a zigzag pattern which may obscure the chevron-shaped pattern of the grooves, an extreme example being the holotype.

Cucullaea terminalis Cragin (1894, p. 3) from his section near Belvidere, Kan., of Kiamichi (Comanche) age, resembles this species, but it has a shorter hinge line and a more deeply excavated posterodorsal slope, and is not specifically identical.

Types.—Holotype, U.S.N.M. 105146; 1 unfigured paratype, U.S.N.M. 105147; from 4 miles southwest of Denison, Grayson County. One figured paratype, U.S.N.M. 105148; 1 unfigured paratype, U.S.N.M. 105149. Named in honor of B. W. Blanpied of Shreveport, La.

Occurrence.—Grayson County: Locs. 151 (holotype and 1 unfigured paratype), 157 (1 figured and 1 unfigured paratype), 162.

Range.—Templeton member.

Superfamily PTERIACEA

Family PINNIDAE

Genus PINNA Linné, 1758

Type species: *Pinna rudis* Linné. Recent, in the waters of the West Indies.

Pinna sp.

Plate 15, figures 1, 2

One incomplete internal mold, with an irregular band of prismatic shell material adhering on, the left side toward the rear and a film of lamellate shell material along the upper edge of the right valve. The specimen does not show enough of the surface features to justify using it as the type of a new species. It is from the Templeton member near old Slate Shoals, Red River, Lamar County (loc. 201). The shell is of medium size for the genus, and is elongate-subtrigonal in outline, with a considerable part of the pointed anterior end broken away. The impression of a radiating sulcus or carina is present on either side of the mold about midway of the height. A few obscure radiating ribs may be seen on the lower and middle parts of the outer surface. Dorsal margin nearly straight; ventral margin nearly straight anteriorly, curving broadly and gently upward toward the rear; posterior margin strongly subtruncated, inclining slightly forward to the hinge line above. Rather strong growth lines and undulations extend from the hinge line downward and a little rearward to well below the sulcus, thence curve sharply around toward the front on the lower part of the shell. A faint impression that appears to be a large adductor scar may be seen on the left valve well back of the midlength and above the sulcus. Dimensions of the incomplete figured specimen: Length 147+ mm, height 70 mm, thickness 26 mm. U.S.N.M. 105150.

Family PEDALEONIDAE

Genus *INOCERAMUS* J. Sowerby, 1819

Type species: *Inoceramus cuvieri* Sowerby.

For discussions and references relating to the history of the name *Inoceramus*, see Stephenson (1923, pp. 127-130; 1941, pp. 98-99) and Stewart (1930, p. 104). I do not agree with Stewart that "there is no indication in Parkinson's paper that he wished to ascribe to Sowerby the genus he was describing." Parkinson clearly wished to ascribe the name *Inoceramus* to Sowerby, and that was his reason for mentioning Sowerby.

Inoceramus prefragilis Stephenson, n. sp.

Plate 12, figures 10-12; plate 13, figures 1, 2

Adult shell large, moderately inflated, higher than long, strongly inequilateral, slightly inequivalve. Beaks terminal, prominent, strongly incurved, prosogyrate, the left beak a little more strongly curved forward than the right. The shell is most prominently inflated in the umbonal region, the inflation extending downward, spreading out, and becoming lower toward the ventral margin; centrally the slope in front of the inflation descends abruptly to the anterior margin approximately at right angles to the plane of contact of the valve and becomes slightly overhanging toward the beak; the slope to the posterodorsal and posterior margins is only moderately steep; and the slope to the ventral margin is still less steep and is broadly curved in profile. The posterior slope may or may not bear one or two broad, shallow radial depressions. The anterior margin is nearly straight and extends nearly directly downward; ventral margin more narrowly rounded than a semicircle. Surface of medium-sized specimens ornamented all over, or nearly so, with closely spaced low, narrow, concentric ribs and may or may not exhibit irregular, broad growth undulations. The narrow concentric markings are most sharply and regularly developed in the umbonal region, with a tendency to become less regular ventrally; on large individuals the surface away from the umbonal region is almost without the narrow concentric markings, presenting instead coarse, irregular undulations such as appear on the large paratype shown in plate 13, figure 1.

Dimensions of the holotype, a medium-sized left valve: Length about 71 mm, height about 95 mm, convexity about 30 mm. The large paratype just cited, a right valve, measures approximately: Length 160 mm, height 184 mm, convexity 50 mm. There is considerable individual variation in outline, form, and sculpture.

The numerous specimens collected at the type locality consist of internal molds of right and left valves to which greater or less amounts of shell material are attached. The shells range in height from a minimum of

10 mm to a maximum of 184 mm. The shell as preserved is composed of two layers, an inner thin lamellar layer and an outer prismatic layer. The latter is proportionately thin over the main surface of the mold but thickens markedly along the dorsal margin; the thick edge of this layer forms the area on which the multi-vincular ligament is attached. The numerous transverse ligamental pits are narrow, shallow, and closely spaced, the interspaces being narrower than the pits.

A comparison of the smaller shells of this species with the holotype of *Inoceramus fragilis* Hall and Meek (1856, p. 388, pl. 2, figs. 6 a, b) shows that they are closely related to that species. (See plastotype of holotype of *I. fragilis*, U.S.N.M. 105163.) *I. fragilis* is a small right valve (incorrectly oriented in the original figure, where it is represented as a left valve) in a matrix of gray shale, from Missouri River, 5 miles below the mouth of Vermillion River (South Dakota or Nebraska). Closely associated with the mold are several well-preserved external molds of juvenile examples of *Collignonicerias* ("*Prionotropis*") *woolgari* (Mantell), which, according to J. B. Reeside, Jr., indicates a zone in the lower part of the Carlile shale of the Colorado group. In terms of the Texas section this would be of late Eagle Ford age. The holotype is preserved in the James Hall collection in the American Museum of Natural History, New York City, and bears the number 9358/1. Photographs of the type are reproduced in plate 12, figures 3, 4, of this paper, for comparison with the species here described. Meek later supplemented the original description with the descriptions of more mature specimens, concerning which he says: "The specimen represented by our figure 5, plate 5, came from near the same locality [type locality]; while the larger ones, from which our woodcuts were prepared, came from the same horizon near Fort Benton, Montana" (1876b, p. 43). The specimen illustrated by his plate 5, figure 5, is preserved in the National Museum under catalog number 228. An old label in Meek's handwriting indicates that the specimen came from the south base of the Black Hills and not from the type locality, and this agrees with the record in the catalog book. Two later labels in the tray indicate the southwest base of the Black Hills as the source of the specimen. Meek was evidently in error in ascribing the source to the type locality. Stanton (1894, p. 76) and others have placed *Inoceramus howelli* White (1879, p. 284) and *I. perplexus* Whitfield (1880, p. 392) in the synonymy with *I. fragilis*, but each appears to be a separate valid species; the types are preserved in the National Museum, the former under catalog number 8052 and the latter under catalog numbers 12263 and 12274.

In northeastern Texas *Collignonicerias woolgari* (Mantell) is the guide fossil of a well-developed zone in the Eagle Ford shale somewhat above its middle part (See Haas, 1948, p. 106). This zone is therefore strati-

graphically considerably above the Lewisville member of the Woodbine formation.

The holotype of *Inoceramus fragilis* (pl. 12, figs. 3, 4) is the poorly preserved internal mold of an immature individual, and because of the lack of distinguishing features is inadequate for specific description. Compared with *Inoceramus prefragilis* it is longer in proportion to the height and it does not show the characteristic concentric ribbing of that species. It measures: Length 13 mm, height 13 mm.

W. A. Cobban has shown me one specimen of an undescribed species of *Inoceramus* similar to, if not specifically identical with, *I. prefragilis*, from the Belle Fourche shale, Black Hills, S. D. According to J. B. Reeside, Jr., this member carries an ammonite fauna indicating its upper Cenomanian age and it therefore is of about the same age as the upper part of the Woodbine formation.

The species is similar in outline, form, and surface sculpture to *Inoceramus pictus* Sowerby, from the Lower Chalk (zone of *Holaster subglobosus*, upper Cenomanian) of England (Woods, 1911, vol. 2, pt. 7, p. 279, pl. 49, figs. 5, 6; text fig. 36).

Types.—Holotype, U.S.N.M. 105151; 2 figured paratypes, U.S.N.M. 105152a-b; 1 figured paratype, U.S.N.M. 105154; 20 unfigured paratypes, U.S.N.M. 105153; 18 unfigured paratypes, U.S.N.M. 105156; 15 unfigured paratypes, U.S.N.M. 105155; all from the Lewisville member near a small branch 1.05 miles east and 0.2 mile south, of Penland (Terrace station), 0.3 mile southeast of Dugans Chapel, Grayson County.

Occurrence.—Grayson County: Locs. 122 (holotype and 56 paratypes, 3 figured), 154.

Range.—Lewisville member to Templeton member.

Inoceramus arvanus Stephenson, n. sp.

Plate 12, figures 6-9

Shell of medium size, moderately inflated, roughly subquadrate to irregular in outline, strongly inequilateral. The two valves were not seen together but the left valve appears to be more strongly inflated and narrower in the umbonal region than the right. The anterodorsal slope is nearly vertical in trend and is very steep and may even overhang in the forward direction; in the right valve this slope may be subangular at its crest and may overhang more strongly than that of the left valve, the crest of which is rounded. The posterodorsal and posterior slopes descend more gently and may or may not be modified by one or two broad radiating shallow depressions. Beaks strongly incurved, prosogyrate, situated at the anterior terminus of the hinge and at or a little in advance of the anterior margin. The anterior margin is nearly straight and descends approximately at right angles to the hinge line; ventral and posterior margins broadly to irregularly rounded; dorsal margin straight. Surface marked only with fine growth lines and irregularly developed concentric undulations.

Dimensions of the holotype, a right valve: Length 47 mm, height 55 mm, convexity about 17 mm. The largest available specimen is about 65 mm long. Individually the shells are variable in outline, some being about equal in length and height and others higher than long.

The ligamental area is long and 3 or 4 mm wide in adults. It is crossed transversely by numerous shallow ligamental pits that are nearly twice as wide as the spaces separating them.

The available material is all in the form of internal and external molds. Compared with *Inoceramus prefragilis*, this species averages much smaller, is more inflated, is more irregular in outline and form, and lacks the regular concentric ribbing of the earlier stages of that species.

In a collection from the Belle Fourche shale, Black Hills, S. D., made by W. A. Cobban, are specimens of *Inoceramus* which are very similar to if not specifically identical with *I. arvanus*.

Types.—Holotype, the external and internal molds of a right valve, U.S.N.M. 105157; 3 figured paratypes, U.S.N.M. 105158a-c; 12 unfigured paratypes, U.S.N.M. 105159; all from a field 0.5 mile north of U. S. Highway 82, 0.5 mile west of the Grayson County line in Cooke County.

Occurrence.—Cooke County: Loc. 99 (type lot); Grayson County: locs. 114, 132.

Range.—Lewisville member.

Inoceramus eulesanus Stephenson, n. sp.

Plate 44, figure 2

The species is based on one imprint of a left valve in fine sandstone. The specimen is a gift to the U. S. National Museum from James P. Conlin, of Fort Worth, Tex. Shell of medium size, depressed convex, elongate-subovate downward and backward at an angle of about 80° to the hinge line. Beak narrow, slightly prominent, gently prosogyrate, situated well forward. The most inflated part of the shell is narrow and well up toward the umbo, from which place the surface slopes steeply in the anterodorsal direction, less steeply toward the posterodorsal margin, and gently toward the ventral margin. Anterior margin broadly rounded, ventral margin rather sharply rounded, posterior margin subtruncated, inclined forward, rounding above into the short nearly straight hinge line. The surface in the umbonal region is nearly smooth but passes into a surrounding belt that presents a series of pronounced concentric undulations or folds.

Approximate dimensions of the holotype: Length 54 mm, height 76 mm, convexity 10 mm.

This species is more compressed and more narrowly elongated than either of the two other described species in the Woodbine fauna. It is similar to, though not certainly specifically identical with, a specimen collected by W. A. Cobban from the Belle Fourche shale (upper Cenomanian), Black Hills, South Dakota.

Holotype.—U.S.N.M. 105160; from a loose piece of sandstone near State Highway 183, 1.4 miles southwest of Euless, Tarrant County; probably from one of three excavations along the highway.

Occurrence.—Tarrant County: Loc. 32.

Range.—Euless member (?).

Inoceramus sp. a

Plate 12, figure 1

An incomplete right valve from the Templeton member in a low bluff on the edge of the flood plain of Red River, 1.5 miles north of Ragtown, Lamar County (loc. 202, coll. 14551), is similar in form to *Inoceramus prefragilis*, but it has a narrower and more prominent umbonal inflation and is nontypical in the relative coarseness of its concentric ridges. U.S.N.M. 105161.

Inoceramus sp. b

Plate 12, figure 2

One incomplete internal mold of a right valve from the Templeton member, 2.8 miles east of Whitesboro, Grayson County (loc. 154), probably is an undescribed species. The shell is compressed, the beak is nonprominent and situated well back from the anterior extremity, the umbonal inflation is strongly oblique downward and a little backward, and the concentric ribs are distinctly developed, of moderate coarseness, and end abruptly against the straight dorsal margin back of the beak without bending forward. The mold as preserved measures: Length 48+ mm, height 45+ mm. U.S.N.M. 105162.

Genus **AGUILERIA** White, 1887

Type species: *Aguileria cumminsi* White, from the Woodbine formation, Lewisville member (=so-called Timber Creek beds), 4 miles [less than 4 miles] south of Lewisville, Denton County, Tex.

This genus is well described by White (1887a, pp. 35–37), who was justified in considering it distinct from the *Pteria*-like forms usually referred to *Gervillia*, and also from *Pedalion* Solander (= *Perna* Bruguière). *Gervillia renauxiana* Matheron, from the middle Turonian of France (D'Orbigny, 1845–1847, p. 490, pl. 398), which White regarded as probably congeneric with *Aguileria*, is similar in form and possesses similar ligamental features but appears from the illustrations to lack teeth and striations on the hinge. The genus *Panis* Stephenson is a related form, but it lacks hinge striations, has a small but well-differentiated forward-pointing anterior ear, a much broader posterior ear, and has its umbonal inflation much more strongly oblique downward. *Gervillia alaeformis* (Sowerby) (= *Modiola? alaeformis* Sowerby; see Woods, 1905, vol. 2, pt. 2, p. 79, text figs. 9–14; pl. 11, figs. 9–11), from the Lower Greensand (upper Aptian) of England, is also a related form, though perhaps not congeneric with *Aguileria*. *G. alaeformis* possesses hinge striations and

is characterized by its large size and the strong convexity of its left valve.

Aguileria cumminsi White

Plate 16, figures 5–8

1887. *Aguileria cumminsi* White, Acad. Nat. Sci. Philadelphia Proc., vol. 39, p. 39, pl. 2, figs. 1–3.

1893. *Aguileria cumminsi* White. Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, pt. 2, p. 167.

1951. *Aguileria cumminsi* White. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, figs. 5, 6 (following p. 163).

The description here given is based on the four original cotypes. Shell of medium size, thick, elongated obliquely backward and downward, strongly inequilateral, essentially equivalve, although the left valve of some individuals appears to be slightly more inflated. Umbonal inflation narrow near the beak, broadening toward the posterior extremity. Beaks small, nonprominent, strongly prosogyrate, situated slightly back of the anterior extremity. Anterior part of shell constricted in an area that is subtriangular, elongated backward and downward, and separated from the main shell by a pronounced, though not sharply defined, sulcus; where this sulcus on the left valve meets that of the right valve, the margin of the shell is deflected noticeably to the right, making a slightly sinuous line of junction between the two valves. The anterior constriction can scarcely be classed as an ear. Posterodorsal slope large, subtriangular, elongated obliquely backward and downward, sloping regularly up to the main shell surface. The margin of the anterior constriction is broadly rounded and the bulging front thus produced is separated from the ventral margin below by a broad indentation; ventral margin very broadly rounded; posterior margin sharply rounded below, becoming nearly straight and strongly inclined forward above, and on different individuals may or may not curve upward a little as it approaches the hinge line. The outer surface is marked only by incremental lines, which are fine on the younger stages and become coarser toward the margins in the older stages.

Dimensions of the cotype having the two valves together (pl. 16, figs. 6, 7): Length 58 mm, height 58 mm, thickness 32 mm. Some shells attain a length as great as 80 mm.

Ligamental area triangular, long, and straight on the inner margin; short, steep, and slightly arched on the anterodorsal margin; long and straight or broadly arched on the posterodorsal margin. On adults the area is crossed by four transverse ligamental channels of fairly uniform width (2.5 to 4 mm), and of somewhat irregular spacing. These vary considerably among different individuals. Hinge long, narrow, and broken into sections by the inner ends of the ligamental channels; the hinge area is completely covered with fine, irregular striations that trend downward and obliquely

backward, the striations becoming longer and less oblique to the hinge line near the posterior end; on the hinge of the left valve there is a small toothlike hump 4 or 5 mm from the anterior extremity and a more elongated, oblique tooth or crural ridge in a similar position near the posterior extremity; depressions are present at corresponding positions on the hinge of the right valve, and a short, oblique crural ridge lies just below the posterior depression. A byssal channel is present on the upper, anterior end of the inner surface, but there is little or no gape in the margin. Several small, irregular muscle scars appear high on the inner surface below and a little back of the beak, and the pallial line is marked by a row of tiny pallial muscle scars. The one adductor muscle scar is long, narrow, broadest below, and is close to and parallel to the posterior margin.

Types.—Four cotypes, U.S.N.M. 20134 and 20134a-c. The type locality is given as "Timber Creek beds" 4 miles [?] south of Lewisville; if this means that the material came from Timber Creek, and it probably does, the distance is overstated, for this creek is only about 2 miles south of Lewisville.

Occurrence.—Tarrant County: Loc. 39; Denton County: locs. 71-73, 75, 79, 83.

Range.—Lewisville member.

Genus PANIS Stephenson, n. gen.

Type species: *Panis cuneiformis* Stephenson.

Etymology: Latin *panis*, a loaf; gender masculine.

The genus *Panis* is characterized by its course multi-vinular ligament, the great breadth of the cardinal area, the great thickness of the part of the shell on which the area is developed, the excess of the height of the shell over the length, the strong downward obliquity of the umbonal inflation, the position of the inner byssal channel completely below the cardinal area, and the near absence of a byssal gape.

It has been customary to refer shells having a multi-vinular ligament of the sort possessed by *Panis* to the Maestrichtian genus *Gervillia* DeFrance, but the typical *Gervillia* (*G. solenoides* DeFrance, 1820, p. 502, 1824, pl. 12, figs. 2a-d, pl. 86, fig. 4) is in strong contrast to *Panis* in that it is a greatly elongated, relatively thin soleniform shell having a series of rather fine, irregularly oblique corrugations partly on the hinge, and partly on the cardinal area, and the byssal channel curves upward in front of the end of the cardinal area, thus forming a distinct byssal gape. The American Upper Cretaceous shells heretofore referred to *Gervilliopsis* Whitfield properly belong to *Gervillia*.

Panis simulates *Phelopteria* in form but in the features of its hinge is very unlike that genus.

In form and in ligamental characters *Panis* is related to *Aguilera cummansi* White, which, however, is much longer in proportion to the height, has an umbonal inflation that is much less strongly oblique downward, and, like the true *Gervillia*, possesses fine corrugations on

the narrow, edentulus hinge area below the cardinal area.

Gervillia dissita White (1888, p. 54, pl. 5, fig. 1) and *G. regoi* Maury (1936, pp. 98, 99, pl. 11, figs. 6, 7), from the Lower Cretaceous (middle Albian) of Brazil, appear to be members of the genus *Panis*.

The species *Avicula aguilerae* Böse (1918 [1920], p. 227, pl. 20, figs. 1, 2, 11, 12), reported to be from the lower Turonian, State of Coahuila, Mexico, may belong to this new genus, but the hinges are not shown, and the generic relations cannot be determined from the illustrations.

In its ligamental and hinge features this genus is similar to *Gervillia renauxiana* Matheron from the middle Turonian of France (D'Orbigny, 1845-1847, p. 490, pl. 398), but the umbonal inflation on *Panis* is much more strongly oblique downward away from the hinge line.

Panis cuneiformis Stephenson, n. sp.

Plate 14; figures 15-17

Shell of medium size, thick, roughly wedge-shaped as a whole, strongly inequilateral, slightly inequivalve. Umbonal inflation of right valve narrow above near the hinge, becoming progressively wider and more broadly rounded toward the posteroventral margin. Maximum inflation well above the midheight and well forward of the midlength. Beaks small, nonprominent, prosogyrate, situated well forward. Anterior ear small, triangular, dull-pointed, its surface rounding up rather steeply into the main surface of the shell, with line of separation obscure or wanting. Posterior ear large, broad, triangular, sloping gradually up to the umbonal inflation. Dorsal margin slightly and broadly arched; anterior margin excavated above just below the ear, becoming rounded below and curving regularly into the somewhat sharply rounded ventral margin; posterior margin broadly rounded. The left valve is similar in form to the right but is a little more strongly inflated. Surface nearly smooth, with growth lines obscure except toward the margins of the larger shells, where they may become somewhat coarse.

Dimensions of the incomplete holotype, a right valve: Length 62+ mm, height 72 mm, convexity 20 mm.

Cardinal area long, broad, crossed by three or more irregular ligamental grooves of varying width. On the holotype, the groove nearest the beak is oblique backward and downward, wide above, narrowing toward the inner margin and is bordered in front by a low crural ridge; a second groove is wide above and becomes still wider inward; a third groove is narrow above and widens inward. Hinge narrow, edentulous, and rendered wavy by indentations between the inner ends of the ligamental pits. The features of the interior are not well preserved, but several small irregular muscle scars lie high in the shell a little back of the beak and

from these a line of small, irregular pallial muscle scars extends downward, curving to the rear below. Inner margin smooth.

This species appears to be more closely related to *Aguileria cumminsii* White than it is to the typical *Gervillia*.

Types.—Holotype, U.S.N.M. 105164; 1 figured paratype, U.S.N.M. 105166; 7 unfigured paratypes, U.S.N.M. 105165; all from the base of the Lewisville member, a cut along a spur of the Chicago, Rock Island and Pacific Railroad, about 1.2 miles west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. ?11, 39, 45 (types); Grayson County: loc. ?137; Lamar County: loc. ?206.

Range.—Dexter member (?); Lewisville member; Templeton member (?).

Genus *GERVILLELLA* L. Waagen, 1907

Type species: *Perna aviculoides* Sowerby, from the Lower Cretaceous of England.

Gervillella? sp.

Plate 58, figure 3

One poorly preserved internal mold of a greatly elongated, compressed shell, possibly a *Gervillella* Waagen, from the Templeton member near old Slate Shoals, Lamar County (loc. 201, coll. 14546), bears some resemblance to *Perna aviculoides* Sowerby, the genotype of *Gervillella* Waagen, from the Lower Cretaceous of England (Sowerby, 1812, vol. 1, p. 147, pl. 66). However, it appears to lack the narrow, elongated posterior ear of that species, and its generic relationships are uncertain. A fragment of shell adhering to the mold near the anterior end shows a relatively thick prismatic layer overlain by a lamellar layer. The specimen, apparently a right valve, measures: Length 132+ mm., height about 30 mm. U.S.N.M. 105167.

Family *PTERIIDAE?*

Genus *PHELOPTERIA* Stephenson, n. gen.

Type species: *Pteria?* *dalli* Stephenson, dredged from Banquereau Bank off Nova Scotia (1936, pp. 389-390).

Etymology: Greek *πῆλος*, false, deceitful. *Pteria*, a bivalve genus.

In the original description of *Pteria?* *dalli* the curious fact was noted that in the young stage, as seen in one young shell, the ligament is multivincular, with four separate and distinct pits; in later stages these pits expand laterally and in the adult stage are merged into one long, shallow pit. It was also noted that in similar material from the Woodbine formation (Lewisville member) of Texas, the ligament of young shells is also multivincular. Several stages of union of the pits may be seen in the Texas shells, different individuals having from one to four pits at different stages of growth. The outer shell layer is prismatic. In form, *Phelopteria* is similar to *Pteria* Scopoli, but compared with the genotype of the latter, *Pteria hirundo* (Linné), a Recent

species of the Mediterranean and Indian seas, *Phelopteria* lacks the excessively long posterior wing extension of that species, has a proportionately shorter and less pointed anterior wing, and lacks a sharply defined umbonal ridge.

Phelopteria is provisionally placed in the family Pteriidae, but if an alivincular ligament is to be accepted as an essential character of that family this genus must be placed elsewhere. The *Pteria*-like form of *Phelopteria* and its relatively thin shell and narrow ligamental area would seem to bar it from the Pedalionidae. Perhaps a new family should be erected to contain it and other species having similar ligamental features.

Pteria (*Oxytoma*) *gastrodes* Meek, from the "second ridge" at Coalville, Utah (1873, p. 491), may be a *Phelopteria*. Meek's type specimen appears to be somewhat distorted by mechanical pressure. The shells from the "Pugnellus sandstone" on Williams Creek and in Huerfano Park, Colorado, which Stanton identified as representatives of Meek's species (1894, p. 74, pl. 9, figs. 7-10) appear to be referable to *Phelopteria*. The small shell shown in Stanton's figures 9 and 10 possesses a narrow cardinal area and multiple ligamental pits essentially like those of *P. dalli*.

Phelopteria dalli (Stephenson)

Plate 14; figures 4-14

1936. *Pteria?* *dalli* Stephenson, Geol. Soc. America Bull., vol. 47, p. 389, pl. 3, figs. 19, 20.

Adult shell large, comparatively thin-walled, sub-trigonal in outline, moderately inflated centrally above the midheight, inequilateral, inequivalve, the left valve slightly more inflated than the right. Beaks slightly prominent, strongly incurved, 2 to 2.5 mm apart in the adult, situated about one-third the length of the shell from the anterior extremity. The inflation of the shell is narrow in the umbonal region, but expands and becomes broadly rounded in the ventral and posteroventral directions. The wings are both strongly compressed and terminally subpointed; the anterior wing is trigonal in outline and is separated from the main part of the shell by a shallow radial sulcus, which on the right valve is marked by a more or less obscure slightly impressed line; the posterior wing is sub-trigonal, is much larger and more strongly compressed than the anterior wing, and its surface rounds broadly upward into the main body inflation. The dorsal margin is long and straight; the lower margin of the anterior wing is nearly straight as it passes backward and downward from the anterior end of the wing and becomes moderately excavated as it passes into the broadly rounded anteroventral margin; the posterior margin is subtruncated nearly vertically below and curves sharply rearward above, where it passes into the lower margin of the posterior wing. Surface smooth, with the excep-

tion of a rather strong development of concentric lines and overlapping thin growth lamellae.

Dimensions of a less than half-grown, somewhat incomplete shell with both valves in place: Length 45 + mm, height 34 mm, thickness 17.6 mm. The large shell shown natural size in plate 14, figures 11-13, is too incomplete for accurate measurement.

The cardinal area is long and narrow and in the more mature stages is occupied by one shallow ligamental groove from about 1 mm in front of the beak backward for a distance of 15 mm or more. In shells interpreted to be the young of this species the ligament is multivincular. Several stages in the union of these several ligaments to form the one long ligament of adults are shown in the interior view of the compound shells illustrated in plate 14, figures 8-10. On the inner margin of the hinge of each of the young left valves shown in figure 10 and from 1.5 to 2 mm in front of the beak is a small short tooth that protrudes slightly downward and inward and is separated from the hinge above by a surrounding narrow channel. At a corresponding position on each of a similar group of right valves are two similarly protruding small knobs or teeth, between which the tooth of the left valve fits. On the inner margin of the hinge of each of these young left valves, at positions ranging from 5 to 9 mm back of the beak, is a long, cruralike ridge, apparently functioning as a lateral tooth. This ridge extends backward and downward with a very gentle inclination and is separated from the margin above by a parallel channel. In a corresponding position on the right valve is a similar, but somewhat obscure, ridge that fits into the channel just described. The presence or absence of the crural ridges in the adult stage is not ascertainable from the present available material, the hinges of which are all incomplete in their posterior parts. High up on the interior of the right valve below the beak are two small, deeply impressed muscle scars close together, the posterior one being a little the higher of the two; corresponding impressed scars are present on the left valves. Extending downward and backward in a gentle curve from the anterior scar on each valve is a row of small pallial muscle pits. The adductor scar is obscure in the available material.

Pteria (Oxytoma) salinensis White (1879, p. 295) from the Mentor beds of Kiamichi (Comanche) age, in Saline County, Kan., appears to be a closely related species of this genus, but it is narrower in the umbonal region and is less strongly inflated. The shell from 5 miles west of Smolan, Saline County, figured by Twenhofel (1924, p. 82) as belonging to White's species, is broad and plump in the umbonal region and appears to be even more closely related to *P. dalli*.

Some of the shells of this species exhibit a phenomenon, no exact parallel to which has heretofore been recorded, so far as I am aware. It appears that for some

reason certain individuals developed from 2 to an observed maximum of 7 separate and distinct shells. Examples (illustrated in pl. 14, figs. 8-10) include not only young shells, but shells of medium and adult size. The phenomenon manifests itself in the form of groups of shells of the same kind and approximately the same size preserved in a manner such that their spacial relation to each other cannot be explained as an accidental, mechanical drifting together and nesting of the shells of different dead individuals. As many as a dozen such groups are present in a collection from southern Tarrant County (loc. 34), and similar groups have been obtained from the same, or approximately the same, zone at two other localities (39 and 73), the one farthest north being in southern Denton County, 20 miles from the first locality.

The groups may consist of two or more valves of one kind, either right or left, neatly nested together, the individual shells, however, separated from each other by thin films of matrix (pl. 14, fig. 10); or both valves may be present in their proper relation to each other, each pair after the initial one being enclosed between the partly open valves of the preceding pair, the several pairs being separated from each other by films of matrix (pl. 14, figs. 8, 9). In the case of the groups of single valves the nearly uniform size and arrangement of the shells in a given group render highly improbable their having been brought together accidentally by currents. In the case of the pairs of valves enclosed within each other the narrowness of the gape, the uniformity in the size of the pairs, and the neatness with which the surfaces of the successive shells parallel each other would seem to preclude any possibility of accidental grouping. Each group of single valves probably was originally paired with a corresponding group of opposite valves, the two groups having become separated from each other either before fossilization or by recent weathering of the matrix. In confirmation of this pairing the connecting matrix was removed from the center of a group of paired shells, thus producing two groups, one of right and one of left valves.

The only plausible explanation of this unusual grouping of shells that occurs to me is that it is due to an unfavorable pathologic condition of some kind, a condition that might be the result of disease or the changing salinity or mineralization of the sea water. It seems conceivable that, because of some such condition, the mantle of the living animal might separate from the inner shell surface, thus permitting a thin layer of bottom mud to seep in between the shell and mantle. A return of favorable living conditions might stimulate the animal to secrete a new shell separated from the original shell by the layer of mud. A succession of unfavorable and favorable conditions of the same kind,

perhaps seasonal, would result in the formation of a series of shells such as compose these groups.

The possibility that duplicate or multiple shells might be formed by one individual under the stress of special unfavorable environmental living conditions is indicated by several authors, whose observations are cited and discussed by Lamy (1932, pp. 253-255). It is not clear in the cases cited that there was complete separation of the mantle from the original shell before a partial duplication of the shell was begun. I have examined several examples of the bivalve *Saxicava arctica* Linné, from Auke Bay, Alaska, which show partial duplication of the shell.

Types.—Holotype, an adult left valve, Peabody Museum, Yale University, Y. P. M. 14811; 8 paratypes, 2 left valves, 4 right valves and 2 hinge fragments, Y. P. M. 14812. Three of the paratypes, 2 left valves and 1 right valve, are, by agreement, retained at the U. S. National Museum. From a loose boulder brought up from a depth of 200 fathoms by a fisherman's trawl, from the eastern part of Banquereau, off Nova Scotia.

Plesiotypes, U.S.N.M. 105168, 105169, 105170, 105171, 105172, 105173. *Examples*, U.S.N.M. 105174, 105175, 105176.

Occurrence.—Hill County: Loc. 3; Tarrant County: locs. 11, 28, 34 (includes 2 plesiotypes and 14 examples), 37, 38, 39 (includes examples mentioned), 41, 44, 53; Denton County: locs. 73 (includes 6 examples), 79; Cooke County: loc. 99; Grayson County: locs. 110, 113, 114, 121, 123, 126, 130-132, 137, 139, 167, 224, 226; Fannin County: locs. 180, 184 (2 plesiotypes), 185, 191, 193, 195; Lamar County: loc. ?206.

Range.—Dexter member to Templeton member.

Phelopteria timberensis Stephenson, n. sp.

Plate 14, figures 1-3

Shell small, compressed, inequilateral, inequivalve, right valve nearly flat, left valve slightly inflated. Beaks nonprominent, slightly incurved, prosogyrate, situated about one-fifth the length of the shell from the anterior extremity; umbonal region narrow near the beak, broadening out toward the posteroventral margin. Anterior wings small, subtrigonal, compressed; right anterior wing sharply separated from the main shell by a narrow, sharply impressed groove; left anterior wing bounded behind by a shallow sulcus, which lacks a sharply impressed groove. Posterior wings broad, compressed, not sharply delimited, but curving gently up to the main shell. Dorsal margin long, nearly straight except for a gentle arching near the beak; lower margin of anterior wing inclined backward and downward, deeply concave at the lower angle of the wings; anteroventral margin broadly rounded; posterior margin broadly rounded, gently inclined forward above, meeting the hinge line at an angle of about 110°. Surface showing only fine, distinct, overlapping growth lamellae, most strongly developed on the wings.

Dimensions of the holotype, the only available specimen: Length 17.2 mm, height 15.5 mm, thickness 4.8 mm.

The cardinal area is long and narrow, widest beneath the beak. Beneath the beak, there is a deeply im-

pressed, nonequilateral triangular ligamental pit which extends rearward about 2 mm; another less deeply impressed pit is 5.5 to 7.5 mm back of the beak.

The one available shell of this species may be juvenile. It is much more compressed than the young shells of *Phelopteria dalli* at the same stage of growth, but is similar to them in outline.

Holotype.—U.S.N.M. 105177, from near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton County.

Occurrence.—Denton County, Loc. 79.

Range.—Lewisville member.

Unidentified specimens of *Phelopteria*

Two left valves of a small *Phelopteria*-like shell that do not show the ligamental features were found in the Lewisville member on Aquilla Creek, 1.5 miles east of Aquilla town, Hill County (loc. 6). They were associated with a small unidentified species of *Exogyra*. U.S.N.M. 105178.

Several poorly preserved imprints of left valves resembling *Phelopteria*, in ferruginous sandstone of the Dexter member, from a roadside exposure 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville, Denton County (loc. 57), have the umbonal inflation narrower and more oblique than that of *P. dalli* and probably represent a different species. The largest imprint is 25+ mm long. U.S.N.M. 105179.

Large imperfectly preserved specimens, resembling *Phelopteria* in form, but lacking the necessary ligamental features for certain identification, were found in the Lewisville member at the top of Iron Ore Hill, 4 miles south of Denison, Grayson County (loc. 106). Compared with *P. dalli*, the umbonal inflation of this form appears to be broader and its angle with the hinge line greater. U.S.N.M. 105180.

Genus *PSEUDOPTERA* Meek, 1873

Type species: *Avicula anomala* Sowerby. Meek cites this species "as illustrated by D'Orbigny, in *Paléont. Française*, Ter. Crét. Tome III, pl. 392." According to Woods (1905, vol. 2, pt. 2, p. 64, pl. 9, fig. 2), the type of Sowerby's species, which came from the Upper Greensand at Blackdown, Devonshire, England, is in the Bristol Museum. It is obvious from his figure of this type that it is not the same species as the one figured by D'Orbigny, which is recorded as having come from the lower Turonian at Mans in the Department of Sarthe. However, the two species appear to belong to the same genus, as judged by the external features. *Pseudoptera* was proposed as a subgenus of *Pteria* Scopoli.

The Texas shells here referred to *Pseudoptera* Meek (1873, p. 489; 1876b, p. 29), though much smaller than the type species of that genus, resemble it in outline, form, and the character of the radial sculpture. The sculpture is well developed on part of the surface of

Pseudoptera serrata, but is comparatively weak on the other two species. *P. hornensis* shows the ligamental area to be long and narrow, bearing 4 or 5 widely spaced ligamental pits that are elongated in the linear direction of the hinge; it does not show the character of the dentition.

The shells referred to *Pseudoptera? rushana* show a similar type of ligamental area and in addition a strong oblique cardinal tooth and a long, narrow, slightly oblique lateral tooth in the left valve. The ligamental area and the hinge of the genotype are apparently unknown.

The genus *Pseudoptera* as here used is also placed only provisionally in the *Pteriidae*. The outline of the shell and the wing characters are very different from those of the typical *Pteria*, and the small widely separated ligamental pits probably do not coalesce at any stage of growth to form a single long pit.

The species *Avicula leveretti* Cragin (1893, p. 171, pl. 41, fig. 3), from the Kiamichi formation of the Comanche series, appears to be a *Pseudoptera*. It is larger than the Woodbine species, but is essentially identical in form.

***Pseudoptera serrata* Stephenson, n. sp.**

Plate 13, figure 6

Shell of medium size, thin, subtrigonal in outline, moderately inflated, strongly inequilateral, bent to the left and apparently gaping at the rear. Rostrum high and sharp, forming a broad, conspicuous posterior wing, which is limited below by a low, rounded, radial ridge. Between this ridge and the umbonal ridge below is a rather wide flattened radial band. Umbonal ridge forming a broad swell with a low subangular ridge marking its crest. Main surface below the umbonal ridge, steep, broadly convex. Anterior part of shell compressed to a small, trigonal, winglike extension. Beak small, nonprominent, situated about 6 mm back of the subpointed anterior extremity. Anterodorsal margin short, slightly inclined; anteroventral margin long, obliquely descending, broadly rounded, passing into the broadly rounded ventral margin; posterior margin narrowly rounded below, subtruncated at the terminus of the flattened surface band, strongly inclined forward at the posterior end of the rostrum; posterodorsal margin long, straight, horizontal. Surface of rostrum bearing 5 very narrow, low, widely separated, but irregularly spaced, radial ribs, each with an irregularly serrated crest. The flattened band below the rostrum appears to be smooth with the exception of a radial band along the lower side which bears 3 narrow serrated ribs, and the surface between the crest of the umbonal ridge and the ventral margin bears about 10 narrow, low radial ribs with uneven serrations along the crests.

Dimensions of the incomplete holotype: Length 40+ mm, height 31+ mm, convexity at least 8 mm.

The internal features of the shell are not observable in the four available specimens.

The serrated ribs of this species serve to distinguish it from the other species of *Pseudoptera* in the Woodbine fauna. Of the three species identified from the formation this one is nearest like the genotype, *Avicula anomala* Sowerby.

The small shell from Coalville, Utah, figured by White (1879, p. 281, pl. 10, fig. 2b) as *Pteria (Pseudoptera) propleura* (Meek), appears to be correctly referred to *Pseudoptera*. The large shell (fig. 2c) referred to the same species by White, which is the type of *Avicula (Pseudoptera) rhytophora* Meek (1873, p. 490), probably belongs to a genus more nearly related to *Aguileria* White.

Type.—Holotype, U.S.N.M. 105181; 1 unfigured paratype, U.S.N.M. 105182; 1 unfigured paratype, U.S.N.M. 105183; 1 unfigured paratype, U.S.N.M. 105184; all from the Lewisville member near a small branch 1.05 miles east and 0.2 mile south of Penland (Terace station), 0.3 mile southeast of Dugans Chapel, Grayson County.

Occurrence.—Grayson County: Locs. 122 (holotype and 3 unfigured paratypes), 164, 165.

Range.—Lewisville member to Templeton member.

***Pseudoptera hornensis* Stephenson, n. sp.**

Plate 16, figures 12-14

Shell of medium size, thin, elongate-subtrigonal, strongly oblique in outline, moderately inflated, flexed to the left and apparently gaping at the rear. Posterodorsal part of shell forming a prominent, elongated, compressed wing or rostrum. Beak very small, nonprominent, prosogyrate, situated within 2 or 3 mm of the sharp, acute anterior extremity. Anteroventral slope steep. The median part of the shell between the wing above and the steep slope below is compressed, forming a flattened, radiating band which extends to the subtruncated posterior extremity. The upper edge of this band is marked by an obscure radiating swell, which occupies the position of the more pronounced ridge on the genotype, *Pseudoptera anomala* (Sowerby); a similar obscure swell borders the lower edge of the band. In front of the beak is a very small, short, compressed anterior wing, below which, and for 10 or 12 mm back of which, the anteroventral margin is slightly flexed outward, probably indicating the presence of a narrow anterior gape. The right valve of the holotype is incomplete. Dorsal margin long and straight; anteroventral and ventral margins merging, long and broadly rounded; posterior margin subtruncated, inclined forward above, curving broadly upward to meet the dorsal margin at the extremity of the hinge. The incomplete external mold of one left valve shows the presence on the anteroventral slope of a series of

fine, tuberculated, radiating ribs with interspaces wider than the ribs; these fade out as they pass upward onto the inflated part of the shell. The rest of the surface is smooth with exception of fine concentric growth lines and gentle undulations.

Dimensions of the incomplete holotype: Length 40+ mm, height 28 mm, thickness about 12 mm.

Area long, narrow, and bearing 4 or 5 small, widely spaced ligamental pits elongated in the linear direction of the hinge. Hinge not clearly uncovered, but apparently very narrow.

Types.—Holotype, U.S.N.M. 105185; 1 figured paratype, U.S.N.M. 105186; both from Horne Branch, 0.2 mile east of Woodbury, Hill County. One unfigured paratype, U.S.N.M. 105187; 1 figured paratype, U.S.N.M. 105188; 3 unfigured paratypes, U.S.N.M. 105189.

Occurrence.—McLennan County: Loc. 2 (4 paratypes, 1 figured); Hill County: locs. 3, 5 (holotype and 2 paratypes, 1 figured); Tarrant County: loc. 750.

Range.—Lewisville member.

Pseudoptera viana Stephenson, n. sp.

Plate 15, figures 3-7

The holotype and part of the paratypes of this species are in the form of external and internal molds. Shell elongate, subtrigonal in outline, moderately inflated, flexed strongly to the left, gaping at the rear, inequivalve, the right valve more compressed than the left. Beaks small, nonprominent, situated 2 or 3 mm back of the anterior extremity. Posterior wing elongate-trigonal, moderately broad at the rear, broadly excavated radially. Anterior wing short, trigonal, compressed. Posterodorsal slope long, rather narrow, bounded above and below by low, sharp radial ribs, the lower one being the umbonal ridge. Main surface rounding down broadly to the ventral margin. A broad, shallow radial depression extends from the beak to the anteroventral margin. Anterior extremity pointed. The anterior and ventral margins merge in a broad, nearly regular convex curve; posterior margin subangular at the end of the umbonal ridge, truncated and inclined forward above; posterodorsal margin broadly concave; dorsal margin straight. On the left valve the posterior wing and the posterodorsal slope are faintly marked with fine radial lines. Anterior to the umbonal ridge the surface is ornamented with fine radial ribs that are strongest and most widely spaced adjacent to the ridge, become weaker and closely spaced centrally, are more widely spaced and weak below the beak, and become obscure adjacent to the anterior extremity. The surface of the right valve appears to be smooth with the exception of incremental lines.

Dimensions of the incomplete holotype, a left valve: Length 32+ mm, height about 20 mm, convexity about 4 mm. A nearly complete internal mold measures: Length 36 mm, height 17 mm, thickness 8.5 mm.

The ligamental area is long, narrow, and bears three or more widely spaced pits. The hinge is like that of *Pseudoptera hornensis*. Compared with the latter the shell is not so high in proportion to the length, is more strongly flexed to the left, and is more strongly ornamented with radial ribs. The species is intermediate between *P. hornensis* and *P. rushana*.

Type.—Holotype, U.S.N.M. 105190; 8 unfigured paratypes, U.S.N.M. 105192; all from Lewisville member on U. S. Highway 82, 2 miles west of Whitesboro, 0.35 mile west of Grayson County line, in Cooke County. One figured paratype, U.S.N.M. 105191; one unfigured paratype, U.S.N.M. 105194; 1 figured paratype, U.S.N.M. 105193; 1 figured paratype, U.S.N.M. 105195; 2 unfigured paratypes, U.S.N.M. 105196.

Occurrence.—Tarrant County: Locs. 11, 47 (2 paratypes, 1 figured); Cooke County: loc. 98 (holotype and 8 paratypes); Grayson County: loc. 133; Fannin County: locs. 184 (3 paratypes, 1 figured), 191.

Range.—Dexter member to Lewisville member.

Pseudoptera rushana Stephenson, n. sp.

Plate 16, figures 10, 11

Shell rather small, thin, elongate, compressed, strongly inequilateral, flexed to the left at the rear. Posterior wing narrow, nonprominent, elongate, being more than half as long as the shell. There probably is a slight byssal gape on the anterior extremity. Posterodorsal slope of left valve forms a flattish to slightly excavated radial band, separated from the main surface of the shell below by a low umbonal ridge that presents a wide subobtuse angle in cross section and is separated from the broadly excavated wing above by a similar ridge. The anterodorsal margin is very short and straight; the anterior extremity is subpointed; the anteroventral and ventral margins merge in one long, very broad curve; posterior margin nearly squarely truncated; posterodorsal margin nearly straight back of the wing. The main surface below the umbonal ridge rounds down rather steeply to the ventral margin toward the front and less steeply and less convexly toward the rear. Beak of left valve small, nonprominent, compressed, prosogyrate, situated within 1.5 or 2 mm of the anterior extremity; a shallow radial depression extends from the beak obliquely backward and downward to the ventral margin. A small triangular area in front of the beak is strongly compressed. Surface of right valve much compressed, with umbonal ridge obscure and the flattish wing separated from the main surface below by a narrow, shallow radial sulcus. Beak of right valve smaller and less prominent than that of the left valve. Surface of left valve has fine incremental lines. Obscure fine radial ridges are present on the main surface just below the umbonal ridge and on the posterodorsal surface of some specimens. Some shells appear to have no radial markings nor were any seen on any right valves. There is some individual

variation in form and outline. The holotype is a thin film of shell of a left valve covering the surface of an external mold.

Dimensions of the holotype: Length 30 mm, height 11 mm, convexity about 4 mm.

Ligamental area long, narrow, and bearing two or more short widely separated pits. The hinge of the left valve bears one strong cardinal tooth, extending obliquely downward and backward below the beak; it is bordered behind by a narrow, well-defined socket. Well back of the cardinal tooth is a long, narrow, lateral tooth, which is slightly oblique in trend downward and backward; it is bordered above by a narrow channel. The complete right hinge was not seen well-preserved, but the cardinal tooth of the left valve appears to fit into a corresponding socket between two oblique cardinals in the right valve, and the lateral tooth of the left valve is received between well-developed claspers in the right valve. Adductor scar subovate-elongate, situated just back of and below the lateral dentition; the long axis of the scar extends backward and downward.

Compared with *Pseudoptera hornensis*, this species is smaller, more narrowly elongate, and has the postero-dorsal area more distinctly set off by an umbonal ridge below and by a channel separating it from the wing above.

Types.—Holotype, U.S.N.M. 105197; 1 figured paratype, U.S.N.M. 105198; 9 unfigured paratypes, U.S.N.M. 105199; all from the Dexter member, west facing slope of Rush Creek Valley, 3.2 miles east-southeast of Handley, Tarrant County.

Occurrence.—Tarrant County: Locs. 15 (holotype and 10 paratypes, 1 figured), 34; Grayson County: loc. 132.

Range.—Dexter member to Lewisville member.

Pseudoptera gregaria (Shumard)

Plate 44, figure 1

1860. *Gervillia gregaria* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 606.
 1883. *Gervillia gregaria* Shumard. White, U. S. Geol. and Geog. Survey Terr. 12th Ann. Rept. for 1878, pt. 1, p. 38, pl. 18, fig. 3a.
 1928. *Gervillia gregaria* Shumard. Adkins, Texas Univ. Bull. 2838, p. 91.

This species was described by B. F. Shumard (as quoted below) without illustrations. However, C. A. White later prepared and published a figure of a left valve based on photographic copies of drawings that were furnished to F. B. Meek of the Hayden Survey by Shumard. The illustration given in the present paper is a reproduction of White's figure. No examples of the species are present in the collections now at my disposal. The following is Shumard's description:

Shell inequivalve, oblique, subovate, approaching subquadrate, moderately gibbous; wider than long; right valve more gibbous than the left, its anterior third strongly rounded; umbonal region convex for a short distance from the beak and thence flattened

to the anal extremity, which is subtruncate on the pallial side and furnished on the cardinal side with a long, narrow, triangular expansion; anterior margin forming a long, sweeping curve from beak to base; cardinal line straight, forming with the posterior margin an obtuse angle; beaks nearly terminal, scarcely passing the cardinal line; ligament facet rather narrow, marked with three or four pits which are rather shallow, and about equal to the spaces between; surface with numerous fine, concentric lines of growth, which, towards the base, assume a subimbricated character.

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

Form. and Locality.—Bluffs of Red River, Lamar County, in septaria embedded in the blue indurated marl near the base of the Lower Cretaceous Series. Collected by Dr. G. G. Shumard.

The so-called Lower Cretaceous series of Shumard is included in the Woodbine formation as now defined.

Type.—The whereabouts of the type material is not known, and presumably it is lost.

Unidentified specimens of *Pseudoptera*

One poor incomplete internal mold from the Dexter member at a locality 4.1 miles east-southeast of Smoots, 1.7 miles south by west of Bartonville, Denton County (loc. 59), is questionably referred to *Pseudoptera* Meek. It is an elongated, compressed shell showing none of the surface features. Dimensions: Length 16+ mm, height 9.5 mm, convexity about 3 mm. U.S.N.M. 105200.

An internal mold of *Pseudoptera?* sp. (pl. 15, fig. 8) from the Lewisville member in a gully east of the Whitesboro road, 1.75 miles south of Sandusky, Grayson County (loc. 117), pertains to the left valve of a species larger than *P. rushana*, and having the oblique cardinal tooth supported by a strong internal buttress. The surface features are not preserved. A considerable part of the mold back of the midlength is broken away. The incomplete mold measures: Length 33+ mm, height about 28 mm, convexity about 7 mm. U.S.N.M. 105201.

A fragment including the posterior portion of a medium-sized right valve (pl. 15, fig. 9) of a shell believed referable to *Pseudoptera* was found in the Lewisville member in a gully 1,250 feet north of an east-west road, about 3.5 miles N. 28° E. of Savoy, Fannin County (loc. 191). The form appears to be essentially like that of *Pseudoptera*. From the rounded umbonal ridge the surface slopes gently toward the dorsal margin, flattening in that direction; and it slopes steeply toward the anteroventral margin. The surface is ornamented with low, rather sharp-crested ribs of irregular spacing; in cross section the ribs slope gently toward the margins and steeply toward the beak. Fine obscure radiating lines cover most of the surface and are strongest on the anteroventral slope. In its longest dimension the fragment measures 30 mm and in the greatest transverse dimension, 20 mm. U.S.N.M. 105202.

Superfamily OSTRACEA

Family OSTREIDAE

Genus OSTREA Linné, 1758

Type species: *Ostrea edulis* Linné. Recent, off European shores.

Ostrea soleniscus Meek

Plate 16, figures 1-4; plate 17, figures 7-10

1871. *Ostrea soleniscus* Meek, Am. Philos. Soc. Proc., vol. 11, p. 430.
1873. *Ostrea soleniscus* Meek, U. S. Geol. Survey Terr. 6th Ann. Rept. for 1872, p. 487.
1877. *Ostrea cortex* White (not Conrad), U. S. Geog. and Geol. Expl. Surveys W. 100th Mer. Rept., vol. 4, pt. 1, p. 170, pl. 15, figs. 2a-c.
1883. *Ostrea soleniscus* Meek. White, U. S. Geol. and Geog. Survey Terr. 12th Ann. Rept. for 1878, pt. 1, p. 9, pl. 11, figs. 2a, b.
1884. *Ostrea soleniscus* Meek. White, U. S. Geol. Survey 4th Ann. Rept., p. 300, pl. 42, fig. 1.
1893. *Ostrea soleniscus* Meek. Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 206, pl. 35, fig. 3.
1893. *Ostrea lyoni* Cragin (not Shumard). Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 204.
1893. *Exogyra ferox* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 185, pl. 32, fig. 1; pl. 33, fig. 5; pl. 34, fig. 1; pl. 36, fig. 6.
1894. *Ostrea soleniscus* Meek. Stanton, U. S. Geol. Survey Bull. 106, p. 56, pl. 2, fig. 1; pl. 3, figs. 1, 2.
1907. *Ostrea soleniscus* Meek. Veatch, U. S. Geol. Survey Prof. Paper 56, pl. 9, fig. 2; pl. 10 figs. 1, 1a. (Figures only.)
1926. *Ostrea soleniscus* Meek. Reagan, Pan-Am. Geologist, vol. 46, no. 3, p. 194, pl. 10, figs. 1, 2.
1928. *Ostrea soleniscus* Meek. Adkins, Texas Univ. Bull. 2833, p. 102.
1932. *Ostrea soleniscus* Meek. Reagan, Kansas Acad. Sci. Trans., vol. 35, p. 243, pl. 1-F, figs. 1-4.
1933. *Ostrea soleniscus* Meek. Warren, Royal Soc. Canada Trans., 3d ser., sec. 4, vol. 27, p. 112, pl. 1, fig. 1.
1951. *Ostrea soleniscus* Meek. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 3 (following p. 163).

Among the many molluscan species composing the fauna of the Woodbine formation none is more common and characteristic than *Ostrea soleniscus* Meek. As evidenced by the accompanying synonymy, the species has been repeatedly described, but its extremely wide individual variation in form and outline, though mentioned in some of the descriptions, has not been sufficiently emphasized.

The typical form of the species is long, narrow, and thick shelled; an extreme length (in the direction of the height) of 18 inches has been recorded. All variations in outline, from almost circular to the typical elongated form, are represented in the collections, and there are innumerable variations in form. The differences in size, outline, and form are believed to be due to differences in local environmental conditions in the shallow sea in which the Woodbine sediments were deposited. In a crowded colony that lived under conditions favorable for growth the shells developed the typical long, narrow form; in less favorable and less

crowded situations, where the composition of the water was such as to inhibit vigorous growth and suitable food was scarce, smaller, shorter, more ovate or broadly rounded shells were developed. Where all the shells in a given bed are small there is a strong suggestion that they are depauperate. A typical elongated shell and several individual variants are illustrated in this paper.

The form of the beak is exceedingly variable on different individuals, being strikingly exogyroid in some shells, straight in others, and showing all intermediate variations of form in others. At localities where the shells are abundant, both extremes and all intermediate forms of the beak may be present in the same bed. Most of the shells present only concentric markings on their outer surfaces, but a few left valves are ornamented in the umbonal region with costae, which range in development from weak to strong, and in spacing from fine to coarse. One young right valve (pl. 16, fig. 3) shows radiating brownish color markings spaced 2 to 4 mm apart (loc. 85, coll. 18233), and brown color markings are also present on one young left valve (loc. 184, coll. 18256).

The dimensions of the elongated shell shown in plate 16, figure 1, are: Length (in direction of height) 237 mm, width (in direction of length) 57 mm. The proportionately shorter shell attached to the elongated one in the same figure has a length of 122+ mm, and a width of 69 mm.

On the interior the ligamental channel may be alined in the longitudinal direction of the shell, or it may be curved to conform to the exogyroid beak, as in the true *Exogyra*; when curved the ligamental pit is wider than it is in *Exogyra*. The inner margins may be smooth or partly rimmed with fine crenulations, and in some young shells these fine crenulations extend all the way around the margin. The adductor scars may be broadly ovate or they may be elongated to conform to the great elongation of some of the shells.

The species has been observed, but not collected, at many localities intermediate between the recorded localities. It has not been found in Texas in strata younger than the Woodbine formation.

The shells described by Cragin under the names *Ostrea lyoni* Shumard and *Exogyra ferox* are here interpreted to be variants of *O. soleniscus*. The type of *E. ferox* is preserved in the collections at Austin (left valve in the Department of Paleontology, University of Texas; right valve, in the Bureau of Economic Geology).

This oyster, which in Texas is restricted to the Woodbine formation (Cenomanian), has a longer time range in the Western Interior. Meek's cotypes came from the Bear River formation (Cenomanian) at Bear River City, Wyo. Stanton (1894, p. 37) states that the species ranges through almost the whole thickness of the Cre-

taceous sandstones near Coalville, Utah, which would indicate that its range includes all of Benton time (Turonian) and much of Niobrara time (Coniacian).

Types.—Four cotypes (2 figured by White), from Bear River City, Wyo., the now abandoned site of which is near Evanston, Wyo., U.S.N.M. 7780. Two topotypes (plesiotypes) from Bear River City, U.S.N.M. 22858. Plesiotypes from Texas, U.S.N.M. 21840, 105203-105209.

Occurrence.—McLennan County: Loc. 1; Hill County: loc. 73; Tarrant County: locs. 11-14, 16, 23, 26, 29, 31, 34, 36, 37, 39, 43-45; Denton County: locs. 56, 68 (figured), 71, 72 (many specimens), 73 (1 figured), 74 (many specimens), 75, 78, 79 (many specimens, 1 figured), 80-84, 85 (2 figured), 88, 89, 91, 94; Cooke County: locs. 98, 99; Grayson County: locs. 106, 109, 114, 117, 122, 123, 127, 128, 130-132, 135, 140, 143, 152, 155, 158, 161, 164-166, 171-173, 219, 224; Fannin County: locs. 179, 180, 182-184, 186 (1 figured), 187 (1 figured), 188, 190-192; holotype of *E. ferox*, Univ. Texas (no number); Lamar County: locs. 201 (1 figured), 203, 206, 228-230; Red River County: loc. 208.

Range in Texas.—Dexter member to Templeton member.

Range in Western Interior.—Ranges from beds of early Bear River age (Cenomanian), through beds of Benton age (Turonian), into beds of early Niobrara age (Coniacian).

Ostrea carica Cragin

Plate 17, figures 1-3

1893. *Ostrea carica* Cragin (in part), Texas Geol. Survey 4th Ann. Rept. for 1892, p. 200, pl. 45, fig. 11.

1928. *Ostrea carica* Cragin. Adkins, Texas Univ. Bull., 2838, p. 100.

1951. *Ostrea carica* Cragin. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 2 (following p. 163).

The description here given is based entirely on the 22 available cotypes. Shell thin, of small to medium size, ranging from elongate through broadly ovate to subcircular in outline. Left valve moderately inflated and usually narrow to pointed in the umbonal region; right valve flat to broadly concave. There is much individual variation in form and outline. Beaks small, typically pointed. The outer surface without costae. The growth lines are fine, and growth undulations range from fine to irregularly coarse.

Dimensions of a selected cotype of average size: Length 36 mm, height about 51 mm, thickness 13 mm; larger shells may attain a height of 65 mm.

Hinge small; ligamental pit short, triangular, flaring widely toward the interior. Adductor scar of medium size, subovate, situated back of the midlength and below the midheight.

Types.—The whereabouts of the cluster of shells illustrated by Cragin is not known and it is presumed to be lost. Two trays in the collection of the Bureau of Economic Geology, Austin, contain shells labeled *Ostrea carica* Cragin. One of the trays bears the Bureau number R17395, and is labeled in pencil "*Ostrea carica*, typical." This lot consists of two clusters of agglutinated shells, each of four individuals, and a vial containing shell fragments and a small loose red ticket bearing the number 48 (indicating Timber Creek west or southwest of Lewisville). On one of the clusters is a nearly illegible red ticket bearing a number, one digit of which appears to be "7."

These red tickets suggest a mixture from two localities. The name of J. A. Taff appears on the old label as collector.

According to Taff (in Hill, 1901, p. 309) *Ostrea carica* is present in a thin zone at the base of a sandstone section (Lewisville member) above a lignitic layer on Timber Creek within 1 mile upstream from the Shiloh road crossing, about 3 miles west by south of Lewisville. This is probably the type locality of the species. These clusters include elongate-ovate and subcircular shells that, as judged by Cragin's illustration, are typical of *Ostrea carica*. Figures of the two clusters are given on plate 17, figures 1, 2. (See plastotypes, U.S.N.M. 106012 a-c.) The other tray (Bureau no. 17396) contains 5 thin shells that appear to be typical of *O. carica*, and 3 thick shells that I would refer to *O. leveretti*. One of the shells of *O. carica* bears a red ticket no. 48; it is illustrated (pl. 17, fig. 3), and measured. Two red tickets were found loose in this tray, one bearing the number 48 (=Timber Creek beds) and the other 62 (=Comanche series, Lower Cretaceous). The former is probably the correct number.

A tray in the collection of the University of Texas contains 9 apparently typical shells (and some fragments) of *Ostrea carica*, two of which bear red tickets no. 48. The old label reads: "*Ostrea carica* Cragin (types). Timber Creek, southwest of Lewisville, Denton County, Texas. Collector J. A. Taff."

With the exception of the three shells in one of the Bureau trays, referred to *Ostrea leveretti*, the shells enumerated, 22 in all, appear to be cotypes of *O. carica* Cragin.

Occurrence.—Denton County: The cotypes from base of Lewisville member on Timber Creek, west of Lewisville.

Ostrea subradiata Cragin

Plate 18, figures 7-11

1893. *Ostrea carica* Cragin (in part), Texas Geol. Survey 4th Ann. Rept. for 1892, p. 200. (Not plate 45, figure 11.)

Shells of the kind here described were considered by Cragin to be a so-called phase of *Ostrea carica*. He says (1893, p. 200):

An interesting phase of this species has been obtained by Mr. [S.] Leverett from the highest part of the Lower Cross Timber sands on Bear Creek, in Tarrant County, near the Tarrant-Dallas County line. It has the anterior part of both valves ornamented with more or less pronounced and rather numerous, narrow, radial plications, which are usually irregular, or considerably interrupted in their course.

Four specimens were obtained. Three of these have the left beak small and pointed; the fourth has it strongly arched and so formed and placed that the valve imitates externally, and in striking manner, one of the Pholadomya. They were associated with *Arca galliennei* var. *tramitensis*, and *Neritopsis tramitensis*.

This form was at first considered distinct, and described in my MS, as *Ostrea subradiata*; but I now consider it an individual phase of *O. carica*. Some of the specimens recently collected are thicker than those above described.

Among 21 available shells that are believed to be cotypes of *carica* none show the characteristic radial costae of *O. subradiata*. Costae are also wanting on the shells in the cluster illustrated by Cragin. Although the cotypes might conceivably be regarded as individual smooth variants, the absence of costae on so many examples, and the fact that many of them are elongated in outline, seem to justify treating the costate, subcircular to broadly subovate forms as a separate species. It seems desirable to preserve the name *sub-*

radiata, which Cragin originally intended to apply to these costate shells, although the legality of ascribing the authorship to him may be open to question.

Shell thin, small for the genus, subcircular to broadly subovate in outline. Left valve moderately inflated; right valve flat to broadly concave. Individually the shells vary greatly in form and outline. Some of the more typical shells show a decided warping and broad folding to the left in the posteroventral part. Beaks small, nonprominent, typically situated somewhat in advance of the midlength. The outer surface of typical left valves is ornamented with distinct to obscure costae that are irregular with respect to spacing, but some variants may be nearly or quite smooth. The ribbing is strongest on the middle and anterior parts of the shell; some of the costae may be represented by series of elongated nodes. Right valves much smoother than left ones, with obscure radiating costae showing only on an occasional specimen. The growth lines are fine, and growth undulations if present, may range from fine to irregularly coarse.

Dimensions of the larger of the two plesiotypes: Length 50 mm, height 56 mm, thickness 15 mm.

Hinge small, narrow; ligamental pit short, triangular, flaring inward. The adductor scar is not uncovered on most specimens, but on one or two examples it appears to be small and pyriform in outline.

The shells of this species occur in considerable numbers in Denton and Tarrant Counties in a narrow zone in the upper part of the Lewisville member, within 10 or 12 feet of its top. The species is as a rule easily recognizable, although some of its individual variants are not easily separable from some of the variants of *Ostrea leveretti*.

Types.—Cragin's specimens are presumed to be lost. One plesiotype, U.S.N.M. 105210, from Timber Creek southwest of Lewisville, Denton County. One plesiotype, U.S.N.M. 105211; 30+ examples, unfigured, U.S.N.M. 105212; 5 selected unfigured examples, U.S.N.M. 105213.

Occurrence.—Tarrant County: Locs. 34, 38, 39, 40, 42, 44, 46 (31+ examples, 1 figured), 51 (5 unfigured examples), 52; Denton County: locs. 73 (1 plesiotype), 80, 90; Cooke County: loc. 98.

Range.—Lewisville member.

Ostrea leveretti Stephenson, n. sp.

Plate 18, figures 12-16

Shell of medium size, subcircular to broadly subovate in outline, thick and sturdy; left valve low-convex, right valve flat or broadly concave. The left valve slightly overlaps the right valve around the margin. The shells exhibit much individual variation in outline, form, and ornamentation. Beaks nonprominent, subcentrally located, twisted a little toward the rear. Anterodorsal, anterior, and ventral margins typically regularly

rounded, but with notable variations; although variable there is a tendency for the posterior margin to be sharply rounded at about the midheight; the postero-dorsal margin is steeply descending, nearly straight, or broadly concave. The surface exhibits a rather coarse development of growth lines and overlapping lamellae; the left valve may or may not be ornamented with radiating costae, which, if present, may be obscure or may be fairly conspicuous, generally fade out before reaching the margins of adults, and never cover the whole surface; the costae on any given shell are irregular in strength and thickness and are generally more or less rounded on the crest; the left valve generally lacks radial costae but may have very obscure radial lining near the beak.

Dimensions of the holotype, a left valve: Length 53 mm, height 62 mm, convexity 14 mm. This is about average size, but a few shells attain a height of 75 or 80 mm.

Area rather broad, conforming to the thickness of the shell; ligamental pit of left valve elongate, broad, moderately impressed, curved to conform to the twist of the shell; on the right valve the pit is shallower than on the left valve. Adductor scar large, elongate-ovate, approximately parallel to the posteroventral margin, not deeply impressed. The inner margin of most right valves is finely crenulated for greater or less distances from the hinge line, and in some shells extends practically all the way around; where the crests are worn off, these crenulations are seen to be hollow. Crenulations are obscure or wanting on left valves.

In its general outline and in its radial ornamentation this species is similar to *Ostrea subradiata* Cragin, but its shell is consistently larger, thicker, and more rugged, and it lacks the broad fold or warp to the left that characterizes typical examples of Cragin's species. The twist of the beak toward the rear and the elongation of the adductor scars seem also to be features not possessed by *O. subradiata*. Although the shells are numerous at several of the recorded localities, none of them exhibits the great elongation seen in many of the shells of *O. soleniscus* Meek; there may be difficulty in distinguishing some of the young shells of *O. soleniscus* from this species, but in general the two species are easily separable.

Types.—Holotype, U.S.N.M. 105214; 1 figured paratype, U.S.N.M. 105215; both from the Lewisville member on Johnson Creek, 1.5 miles northeast of the Methodist Church at Arlington, Tarrant County. Ten unfigured paratypes, U.S.N.M. 105216; 1 figured paratype, U.S.N.M. 105217; 19 unfigured paratypes, U.S.N.M. 105218; 1 figured paratype, U.S.N.M. 105219. Named in honor of S. Leverett.

Occurrence.—Johnson County: Loc. 10 (20 paratypes, 1 figured); Tarrant County: locs. 21, 34 (includes 1 figured paratype), 35, 47 (holotype and one figured paratype).

Range.—Eules member to Lewisville member.

Ostrea lyoni Shumard

1861. *Ostrea lyoni* Shumard, Boston Soc. Nat. History Proc., vol. 8, p. 200.
 1928. *Ostrea lyoni* Shumard. Adkins, Texas Univ. Bull. 2838, p. 101.

This small species was briefly described but not illustrated, and the whereabouts of the type material is not known. A few small shells of *Ostrea* recently found at the type locality, at Pine Bluff, on the Red River, Red River County, are so imperfectly preserved that it seems unsafe to regard them as representing Shumard's species. They may be young, depauperate shells of a larger species. This mention of *O. lyoni* is included merely for historical purposes, for in the absence of illustrations and types it seems futile to continue the use of the name as valid.

Genus *EXOGYRA* Say, 1820

Type species: *Exogyra costata* Say, by monotypy (1820, p. 43), from the Upper Cretaceous of New Jersey.

Exogyra columbella Meek

Plate 17, figures 4-6

1876. *Exogyra columbella* Meek, in Macomb, Rept. Expl. Exped. Santa Fé, N. Mex., to junction of Grand and Green Rivers, p. 124, pl. 1, figs. 3a-d.
 ?1877. *Exogyra costata* var. *fluminis* White, U. S. Geog. and Geol. Expl. Surveys W. 100th Mer. Rept., vol. 4, pt. 1, p. 174, pl. 17, figs. 3a-d.
 1884. *Exogyra columbella* Meek. White, U. S. Geol. Survey 4th Ann. Rept., p. 304, pl. 55, figs. 5, 6.
 1893. *Exogyra columbella* Meek. Cragin, Texas Geol. Survey 4th Ann. Rept., for 1892 p. 184.
 1894. *Exogyra columbella* Meek. Stanton, U. S. Geol. Survey Bull. 106, p. 63, pl. 8, figs. 2-4.
 1900. *Exogyra columbella* Meek. Herrick and Johnson, Denison Univ., Sci. Lab. Bull., vol. 11, p. 203.
 1927. *Exogyra columbella* Meek. Reagan, Indiana Acad. Sci. Proc., vol. 36 (1926), p. 125, text figs. 3-7.
 1928. *Exogyra columbella* Meek. Adkins, Texas Univ. Bull. 2838, p. 115.
 1951. *Exogyra columbella* Meek. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 1 (following p. 163).

Shells considered referable to the typical form of this species are fairly common in the Lewisville member of the Woodbine formation. The left valves are moderately convex and the beaks are twisted toward the rear in the manner characteristic of the genus. The umbonal part converges quickly to the small beak, whose degree of twisting is moderate. Umbonal ridge weak or wanting. The surface of the left valve is finely costate, but the degree of fineness and the extent of surface covered with costae vary greatly on different individuals; some are nearly smooth. The right or upper valve is thin, broadly concave, and is overlapped around the margins by the left valve; the surface presents concentric growth lamellae and rare specimens may show weak radiating costae.

A rather large left valve measures: Length 29 mm, height 27 mm, convexity 11 mm.

The cotype figured by Meek to show the sculpture of the left valve is ornamented nearly all over with relatively coarse costae and possesses a rather pronounced umbonal ridge. It may be that in its ornamentation, this specimen is an extreme example of the species, for it is more strongly marked than most of the available shells from the Western Interior that are usually referred to Meek's species. The relatively large shell (U.S.N.M. 8654) described by White under the name *Exogyra costata* var. *fluminis*, which is listed questionably in the synonymy of *Exogyra columbella*, might more appropriately be regarded as a variety of *E. columbella*, or perhaps even as a distinct species.

Although the shells from Texas exhibit a fairly wide range of individual variation, the average specimens compare favorably in size, form, and ornamentation with the cotypes from the Mancos shale near Covero (= Cobero), N. Mex. The species ranges upward into the basal beds of the Eagle Ford shale and, in the area here treated, has been found in that formation at two localities as follows: Branch west of the Katy Lines, 1.25 miles south of Grandview, Johnson County (U. S. G. S. coll. 14145); road ditch 0.75 mile east of Lloyd, 0.5 mile north of Pleasant Home School, Denton County (U. S. G. S. coll. 18225). It has also been found in beds of problematical Woodbine age intervening between the Buda limestone below and overlying Eagle Ford shale, on Bouldin Creek, 1.75 miles south of the Capitol at Austin, Travis County (coll. 14124).

Types.—Cotypes, U.S.N.M. 20254, from sandstone (in the Mancos shale) reported to be of early Colorado age at Covero (= Cobero), N. Mex. A rubber cast of one of the cotypes is illustrated for comparison (pl. 17, fig. 4). Two figured plesiotypes, U.S.N.M. 105220a-b. Two unfigured examples, U.S.N.M. 105221.

Occurrence.—Tarrant County: Locs. 12, 37, 38, 41, 42, 44, 48 (4 specimens, 2 figured), 52; Denton County: locs. 72, 73, 76, 79, 80, 81, U.S.G.S. coll. 18225 (base of Eagle Ford shale); Grayson County: locs. ?108, 112, ?126, ?132, 151, 162, 165, 169; Lamar County: locs. 201, 203, 206, 230.

Western Interior: From beds of Graneros (Cenomanian) and Benton (Turonian) age.

Range.—Dexter member (?) to basal part of Eagle Ford shale.

Exogyra columbella levis Stephenson, n. var.

Plate 18, figures 1-3

The typical *Exogyra columbella* Meek (U.S.N.M. 20254) from sandstone of early Colorado age at Covero, N. Mex. (1876a, p. 124, pl. 1, fig. 3a), is a costate shell (pl. 17, fig. 4). The varietal form here described is larger than the typical shells and is prevailingly smooth, although an occasional specimen is ornamented with very fine radiating costae in the umbonal region only.

Shell of small to medium size, subcircular to broadly subovate in outline. Left valve plumply convex, with

a rounded umbonal inflation and no umbonal ridge; greatest inflation a little in advance of the midlength and well above the midheight; the anterior and posterior slopes round down steeply and the ventral slope broadly and less steeply; surface of holotype smooth, with the exception of fine growth lines; fine more or less obscure radiating costae are present on the umbonal area of some left valves. Right valve flat to broadly concave, slightly overlapped by the margins of the left valve; in the holotype about one-fourth of the surface, representing the young stage, is relatively smooth, with the exception of fine growth markings and a few fine, very obscure radiating costae below the beak; the rest of the surface is roughened by the closely packed, upturned edges of overlapping growth layers.

Dimensions of the holotype: Length 39 mm, height 43 mm, thickness 29.5 mm. The largest measured shell in the collections is 54 mm long and 57 mm high.

Hinge narrow and curved to conform to the twist of the shell. Adductor scar of medium size, not deeply impressed, situated above the midheight and back of the midlength.

The species named by Richards, *Exogyra woolmani* (1947, p. 35), from a well near Norfolk, Va., is similar to this one, but averages much smaller and is proportionately narrower and shorter. He records *E. woolmani* from two other wells in Virginia, and questionably from a well on Parris Island, S. C. I have identified it from a core sample at a depth of 2,565 to 2,575 feet in the H. B. Salter well of the Carolina Petroleum Company, 16.5 miles north of Beaufort, N. C. A similar smooth *Exogyra* was obtained from a core sample submitted by H. A. Sellin, geologist, taken between depths of 5,145 and 5,153 feet in Magnolia well no. 1-A, located in State Block 5-B, St. Vincent Sound, Franklin County, Fla. The subsurface beds yielding these small smooth *Exogyras* are believed to be of later Woodbine age, and presumably of Tuscaloosa age (Eoline formation).

Types.—Holotype, U.S.N.M. 105222; 1 paratype, figured, U.S.N.M. 105223; about 20 selected unfigured paratypes, U.S.N.M. 105224; all from Martins Spring Branch, 0.2 mile south of road, 2.9 miles west by north of Pottsboro, Grayson County.

Occurrence.—Grayson County: Locs. 152 (holotype and 21 paratypes, 1 figured), 153, 155, 157-159, 161, 162, 167, 171, 173; Lamar County: loc. 206.

Range.—Templeton member.

Unidentified specimens of *Exogyra*

Numerous small left valves of *Exogyra* (pl. 18, figs. 4-6) from hard, calcareous sandstone of the Lewisville member, on Aquilla Creek, 1.2 miles east of Aquilla, Hill County (loc. 6), appear to be the dwarfed individuals of a larger species. Most of the shells are less than 17 mm in their greatest dimension but a few exceed that measurement, the largest being 23 mm. The shells are smooth, strongly convex, and narrow in the umbonal

region; unless modified by the scar of attachment, the beak of the left valve is sharply twisted at the tip. The shells are all more or less imperfect, being represented mainly by internal molds to which some shell substance adheres. In form the species bears some resemblance to *Exogyra arietina* Roemer, but it lacks the extended ram's-horn twist of that species. U.S.N.M. 105225a-b; many unfigured examples, U.S.N.M. 105226.

One internal mold of a small *Exogyra* in a matrix of ferruginous sandstone of the Eules member from State Highway 183, within 1.2 miles west-southwest of Eules, Tarrant County (loc. 28), is very narrow in the umbonal region and strongly convex, and the pallial line is marked all around by a series of short, fine, transverse striations. The mold measures: Length 11.5 mm, height 12.5 mm, convexity about 9 mm. The beak is exogyrate, and the hinge is narrow and curves around parallel to the dorsal margin. U.S.N.M. 105227

Superfamily NAIADACEA

Family UNIONIDAE

Genus UNIO Retzius, 1788, sensu lato

Type species: *Mya pictorum* Linné (designated by Gray, 1847). Recent, in fresh waters of Europe.

The fresh-water genus *Unio* Retzius is represented in the Woodbine formation at several localities in Tarrant, Cooke, and Grayson Counties. With the exception of one internal mold in gray sandstone, the specimens are external and internal molds in reddish and brownish ferruginous sandstone; all are poorly preserved. Although none of the specimens is in satisfactory condition for specific identification, enough of the features are preserved to show that at least three species are represented.

Unio sp. a

Plate 19, figures 10-12

The molds referred to *Unio* sp. a, may represent more than one species but they possess the following features in common: All are elongate forms of moderate inflation. Some of the external molds exhibit rather coarse growth markings; otherwise their surfaces are smooth. The adductor scars, as indicated by the internal molds, are rather deeply submerged in the shell, especially the anterior one; back of the anterior scar is a rather pronounced buttress that produces a notch in the internal mold (pl. 19, fig. 10; loc. 31, U.S.N.M. 105228). One of the figured specimens (loc. 96; U.S.N.M. 105230) is 63+ mm long, 35+ mm high, about 24 mm thick. Another figured specimen (loc. 102; U.S.N.M. 105229) is 85 mm long, 46 mm high, and about 20 mm thick.

Unio vetustus Meek, from the Bear River formation, Bear River, near the mouth of Sulphur Creek, Wyo., is a similar elongated form lacking oblique folds, but its beaks are nearer the anterior extremity of the shell.

Occurrence.—Tarrant County: Loc. 31 (includes 1 figured example); Cooke County: loc. 96 (includes 1 figured example); Grayson County: locs. 101, 102 (figured), 103, 105.

Range.—Eules member and Red Branch member.

Unio sp. b

Plate 19, figure 13

Several elongated internal molds of *Unio* exhibit a group of 3 or 4 coarse folds extending obliquely from the anterodorsal slope backward and downward to the posteroventral margin. The shell is most inflated in the umbonal region somewhat below the beaks, and thins gradually, wedgelike, to the posterior extremity. The beaks are moderately prominent, are prosogyrate, and are situated well forward, perhaps 8 or 9 mm back of the anterior extremity in adults. The medium-sized figured specimen (loc. 102, coll. 20316) is incomplete; as preserved it measures: Length 47+ mm, height 27 mm, thickness 22 mm. Another specimen on which similar folds appear is 70 mm long, 39 mm high, and 23+ mm. thick. U.S.N.M. 105231a, 105232, 105233.

This species is related to *Unio belliplicatus* Meek (1877, p. 165, pl. 17, figs. 4, 4a) from the Bear River formation, near old Bear River City, Wyo., which possesses similar oblique folds; but on Meek's species the folds are smaller, more closely spaced, and more numerous, and the beaks are so subdued as to be scarcely recognizable.

Occurrence.—Cooke County: Locs. 95, 97; Grayson County: locs. 102 (figured example), 105 (measured).

Range.—Red Branch member.

Unio sp. c

Plate 19, figure 14

Ferruginous material from Grayson County, mainly in the form of molds, indicates a relatively large, rather plump species, ovate in outline, with broad, prosogyrate, but nonprominent beaks situated about 35 mm back of the anterior extremity in the incomplete figured specimen. This specimen and one other from the same locality afford evidence of the presence of 2 or 3 coarse folds low on the side of the shell. The surface is sculptured with coarse, concentric growth markings.

Dimensions of the very incomplete figured shell: Length 65+ mm, height 60 mm, thickness 38 mm. None of the shells is sufficiently complete to show its full length. U.S.N.M. 105234.

Occurrence.—Grayson County: Locs. 102 (includes 1 figured example), 103-105.

Range.—Red Branch member.

Superfamily PECTINACEA

Family PECTINIDAE

Genus PECTEN Müller, 1776

Type species: *Ostrea maxima* Linné. Recent, in the Northern seas of Europe.

Subgenus CAMPTONECTES Agassiz, 1864

Type species: *Pecten lens* Sowerby, from the Lower Oolite (Jurassic) of Oxfordshire, England.

Pecten (*Camptonectes*) *moodyi* Stephenson, n. sp.

Plate 19, figures 8, 9

Shell of medium size, depressed-convex, slightly higher than long, slightly inequivalve, the left valve more inflated than the right. Beaks small, depressed, direct, not projecting above the hinge line, situated at the midlength. Right anterior ear about twice as long (measured on upper border) as high, with lower border parallel to the dorsal border and with the anterior end truncated, the upper corner squarish, the lower corner rounded; this ear is separated from the main body by a narrow, shallow, oblique, beaded sinus, which terminates below at the inner end of a profound byssal notch. Posterior ear of right valve smaller than the anterior ear, triangular in outline, with its long, sharply defined inner margin forming the line of separation from the main shell. The anterodorsal margin of the main shell is broadly concave upward in trend, and the posterodorsal margin is straight; these margins diverge from the beak at an angle of about 85°. The surface is covered with numerous, crowded, flat-topped, low, radiating bifurcating ribs, separated by sharp, narrow interspaces. As the ribs pass downward away from the umbo they trend in broad curves, on the one hand, toward the anterior margin and, on the other, toward the posterior margin. On the holotype the shell layer bearing the ribs has been peeled off on the central and umbonal parts of the surface. On the remaining surface the ribs are markedly irregular in trend, in width, and in arrangement on different parts of the shell; the ribs near the ventral border are narrower and more numerous than those on earlier stages of the shell. On the figured paratype, a left valve, the ribbing is somewhat more regular than on the holotype. On the right anterior ear of the holotype radial ribbing is obscure; the ribbing of the posterodorsal slope of the main shell continues out across the posterior ear with diminishing strength.

Dimensions of the holotype, a right valve: Length 35 mm, height 38 mm, convexity about 5 mm.

Hinge line straight, about two-thirds as long as the shell. A narrow crural ridge closely parallels the upper hinge margin. Under the beak is a small triangular ligamental pit opening inward, and from this a narrow crural ridge runs forward and downward on the inner surface of the right anterior ear; no corresponding ridge is present on the left anterior ear.

Compared with *Pecten* (*Camptonectes*) *bellisculptus* Conrad, from the Woodbury clay at Haddonfield, N. J. (1869b, p. 99), the radial sculpture of this species is very much coarser. The species has many features in common with *Pecten* (*Camptonectes*) *bubonis* Stephenson,

from the Owl Creek formation, 2.5 miles northeast of Ripley, Miss. (1941, p. 131), but is more coarsely and less regularly sculptured, and has the right anterior ear only obscurely ribbed and a little higher in proportion to its length. The fact that the Lewisville species, *P. (Camptonectes) moodyi* (early Upper Cretaceous), and the Owl Creek species, *P. bubonis* (late Upper Cretaceous), are so similar in their specific characters indicates that representatives of the subgenus *Camptonectes* lived through Upper Cretaceous time without marked change. *Pecten (Camptonectes) platessa* White (1877, p. 176), from Cretaceous strata 5 miles west of Mineral Springs, Ariz., is a closely related species, but the outer surface of the holotype is too imperfectly preserved for specific identification.

Types.—Holotype, U.S.N.M. 105235; 2 unfigured paratypes, U.S.N.M. 105236; 1 figured paratype, U.S.N.M. 105237; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County. Three unfigured paratypes, U.S.N.M. 105238. Named in honor of Clarence L. Moody of Shreveport, La.

Occurrence.—Grayson County: Loc. 160; Lamar County: locs. 201 (holotype, 3 paratypes, 1 figured), 203 (3 unfigured paratypes).

Range.—Templeton member.

Pecten (Camptonectes) ellsworthensis Stephenson, n. sp.

Plate 19, figures 5, 6

In general form, size, and type of sculpture this species is very much like the species *P. (C.) moodyi*. It differs, however, in that the radial ornamentation is much finer and is developed more uniformly over the surface. Ribs pass from the main shell out over the ears with little diminution in strength, except on the right anterior ear, whose ribs are weaker than those on the body. None of the ears is completely preserved, but on the holotype the right anterior ear has lost a little more from its anterior end than the others. The left valve is considerably more inflated than the right. Although the ribbing is comparatively fine, it is markedly coarser than that on *Pecten (Camptonectes) bellisculptus* Conrad (1869b, p. 99). The antero- and postero-dorsal margins of the main shell diverge from the beak at an angle of about 88°.

Dimensions of the holotype, the two valves of which are intact: Length 29 mm, height 32 mm, thickness about 11 mm.

Types.—Holotype, U.S.N.M. 105239; 1 unfigured paratype, U.S.N.M. 105240; both from Ellsworth School, 4 miles southwest of Denison, Grayson County.

Occurrence.—Grayson County: Locs. 155 (types), 158, 161, 171; Fannin County: loc. 199; Lamar County: locs. 206, 229.

Range.—Templeton member.

Pecten (Camptonectes) martinsensis Stephenson, n. sp.

Plate 19, figures 1-4

This species has the general form and type of ornamentation of *Pecten (Camptonectes) moodyi*, but dif-

fers in several of its characters. It averages smaller, has a much weaker development of the radial sculpture, being practically smooth over the central more inflated part of the shell, and the right anterior ear is proportionately shorter and higher; even where the flat, weak radials are present the surface has a smooth polished appearance, as preserved at the type locality. The radial ribbing is present on all the ears, but is noticeably weaker on the right anterior ear. The ribs are smaller and more closely crowded on the ears than on the main shell. The inner margins of the anterior and posterior ears diverge from the beak at an angle of about 85°. A narrow, sharp, radiating sulcus is present at the inner margin of the anterior right ear where it joins the main shell; the other three ears are rather sharply delimited at their inner margins.

Dimensions of the young cototype shown in plate 19, figures 3, 4: Length 11.1 mm, height 13.5 mm, thickness 3.3 mm. In measuring the larger shell shown in plate 19, figures 1, 2, an allowance of 4 mm is made for the width of the calcite vein that cuts it: Length 23.5 mm, height 24 mm, thickness 5.5 mm. The largest shell in the collection is about 30 mm long.

Types.—Two figured cotypes, U.S.N.M. 105241a-b; 9 unfigured cotypes, U.S.N.M. 105242; all from the Templeton member on Martins Spring Branch, 0.2 mile south of a road, 2.9 miles west by north of Pottsboro, Grayson County.

Occurrence.—Grayson County: Locs. 128, 137, 152 (cotypes), 162, 164, 171; Fannin County: loc. 191.

Range.—Lewisville member to Templeton member.

Pecten (Camptonectes) cavanus Stephenson, n. sp.

Plate 19, figure 7

Shell small, depressed-convex, subcircular in outline, a little higher than long, subequivalve. Beaks small, depressed, not projecting above the hinge line, situated at the midlength. Right anterior ear partly broken away; it is separated from the main part of the shell by a narrow, deep groove. Right posterior ear partly broken away but more complete than the anterior ear; it is ornamented with fine, sharp concentric growth lines, crossed transversely by fine obscure radiating riblets; this ear is separated from the main part of the shell by an abrupt, nearly right-angled upturn of the surface. The antero- and postero-dorsal margins of the main part of the right valve are nearly straight and diverge from the beak at an angle of about 92°. The main surface is covered with fine, sharp concentric growth lines or riblets. Corroded parts of the surface reveal radiating structure lines curved in the same manner as the radiating ribs of the subgenus *Camptonectes*; these lines and the radiating riblets on the posterior ear are interpreted as indicating close relationship with that subgenus. The left valve is represented by an internal mold with some shell substance adhering.

Dimensions of the holotype: Length 9 mm, height 10.4 mm, convexity about 1 mm.

The species is characterized by its fine, sharp concentric sculpture and its obscure radiating sculpture.

Types.—Holotype, a right valve, U.S.N.M. 105243; 1 unfigured paratype, U.S.N.M. 105244; both from a road cut, 2.2 miles west of Arthur City, Lamar County, 20 to 25 feet above road level.

Occurrence.—Lamar County: Loc. 206.

Range.—Templeton member.

Pecten (Camptonectes) sp.

Two small specimens from the Templeton member on a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County (loc. 165), show only internal molds and the interior of the shell. One of the specimens measures: Length 10.8 mm, height 9 mm. U.S.N.M. 105245.

Family SPONDYLIDAE

Genus PLICATULA Lamarck, 1801

Type species: *Plicatula gibbosa* Lamarck. Recent, in the West Indies.

***Plicatula goldenana* Stephenson, n. sp.**

Plate 13, figures 3-5

Shell of medium size, compressed, thick, broadly subovate in outline, subequilateral, inequivalve; the left valve is flattish to slightly convex, and the right valve is slightly more inflated than the left. Surface of left valve covered with rugged, irregular, roughly nodose, bifurcating costae, numbering 35 or more along the margin of the holotype. Resting stages in growth are indicated by concentric depressions, which may be sharp and deep. No well-preserved right valves present in the available material, but one incomplete, corroded specimen among the paratypes (pl. 13, fig. 4) indicates more regularly arranged radiating, spinose costae, narrower than on the left valve and with wider interspaces.

Dimensions of the holotype, a left valve: Length 25.5 mm, height 26.5 mm, convexity about 4 mm.

Hinge features not clearly seen, but the presence of two strong diverging crural ridges, one on either side of the submerged resilifer, is indicated by impressions on molds among the paratypes. Adductor scar large, broadly subovate, situated near the midheight, with the anterior edge at about the midlength. Inner margin irregularly and finely crenulated.

The species does not appear to be closely similar in its ornamentation, to any described species in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain or of the Western Interior.

Types.—Holotype, a left valve, U.S.N.M. 105246; 2 figured paratypes, U.S.N.M. 105247a-b; 6 unfigured paratypes, U.S.N.M. 105248; 1 unfigured paratype, U.S.N.M. 105249; all from Golden Bluff, Red River, 3 miles east of Arthur City, Lamar County.

Occurrence.—Fannin County: Loc. 198; Lamar County: locs. 201, 203 (holotype and 3 paratypes 2 figured).

Range.—Templeton member.

Family LIMIDAE

Genus LIMA (Bruguière) Cuvier, 1797, sensu lato

Type species: *Ostrea lima* Linné. Recent, in the Mediterranean.

Unidentified specimens of Lima

Plate 12, figure 5

As used in a broad sense, the genus *Lima* is represented in collections of the National Museum from the Woodbine formation by two poorly preserved specimens from two localities.

One specimen, from the Templeton member near old Slate Shoals, Red River, Lamar County (loc. 201), has the two valves intact, but is somewhat crushed, broken, and corroded. (Pl. 12, fig. 5.) The ribs are narrow, subangular to subrounded on the crests, number about 30 on each valve, and are separated by deep interspaces about as wide as the ribs. As preserved, the ribs appear smooth on the crests. The shell is moderately inflated and is elongated in the posteroventral direction. Approximate dimensions: Length 10 mm, height 13 mm, thickness 9 mm. U.S.N.M. 105250.

The other specimen is the internal mold of a right valve with some shell material adhering, from the Lewisville member at Hyatts Bluff, Red River, Fannin County (loc. 179, coll. 10555). The shell is moderately inflated and is elongated in the posteroventral direction. The ribs are not preserved but crenulations along the margin indicate that they are narrow, and closely spaced, perhaps numbering as many as 60. The specimen certainly belongs to a species different from the one found near Slate Shoals in Lamar County. Approximate dimensions: Length 6.5 mm, height 7.5 mm, convexity 2.5 mm. U.S.N.M. 105251.

Superfamily ANOMIACEA

Family ANOMIIDAE

Genus ANOMIA (Linné, 1758) Müller, 1776

Type species: *Anomia ephippium* Linné. Recent, in European seas.

***Anomia ponticulana* Stephenson, n. sp.**

Plate 20, figures 1-4

Shell of left valve thin to moderately thick, inequivalve, subcircular to subovate in outline, but exceedingly variable in both outline and form, depending upon the shape of the object of attachment, varying in individuals in the same lot from depressed-convex to strongly inflated. In general the surface rounds down broadly from the most inflated part, which is at or above the midheight, to the anterior, ventral, and posterior margins. Beaks small, slightly prominent, situated centrally back from the margin 1.5 to 2 mm in adults. Evidence of the presence of a right valve is afforded by only one individual in the Woodbine fauna (loc. 47, coll. 18639). This is a large, moderately con-

vex, subcircular shell attached all around the margin to a shell of *Ostrea leveretti*. The inflated or left valve is partly broken away, revealing parts of the very thin right valve loosely adhering to the supporting oyster shell beneath. On the outer surface the growth lines are fine, and more or less irregular growth undulations may or may not be present. Most of the many available shells appear to lack radiating sculpture, but a few exhibit very fine, irregular, obscure to fairly distinct, finely and irregularly tuberculated riblets. Fine riblets are well developed on the holotype. The absence of radiating sculpture on any given shell may be due to mechanical attrition before fossilization, to corrosion after fossilization, or the individual variation may be such that the riblets may be wanting or so weakly developed that they were easily obliterated.

Dimensions of the holotype: Length 18.5 mm, height 19.5 mm, convexity about 2.5 mm.

Hinge edentulous, thick on an adult. Resilifer internal, a submerged elongated pit, deeply impressed, about 1.5 mm from the dorsal margin in the holotype. The muscle scars were not seen completely preserved, but on the interior of one paratype the anterior retractor is small and lies high in the shell just in front of the resilifer; the byssal scar is large and situated centrally above the midheight; the posterior retractor is smaller and is closely crowded up against the lower side of the byssal scar; and the adductor scar appears to be against the posterior retractor at a position a little lower toward the rear.

It is difficult to describe the distinguishing features that separate it from *Anomia argentaria* Morton, which is exceedingly common in stratigraphically higher units, including the Taylor marl, the Navarro group, and equivalent beds in the Atlantic and Gulf Coastal Plain. In general, however, *A. ponticulana* is more irregular in outline and form and has a weaker and finer development of radiating riblets. *Anomia olmstedii* Stephenson (1923, p. 217), from the Snow Hill marl member of the Black Creek formation of the Carolinas, is a similar species, but attains a larger size, has stronger and more crowded radiating riblets, and presents a conspicuous development of overlapping, slightly upturned growth lamellae. *A. subquadrata* Stanton (1894, p. 66), from the "Pugnellus sandstone" (middle or late Eagle Ford age) on Williams Creek, Huerfana Park, Colo., is a related species, but the type material is too imperfectly preserved to permit critical comparison. Compared with *A. propatoris* White (1883, p. 14; author's edition 1880), from the "third ridge" (Eagle Ford age) at Coalville, Utah, this species has less distinctly developed radiating riblets.

Types.—Holotype, U.S.N.M. 105252, from the Lewisville member on Timber Creek, 2.5 miles southwest of Lewisville, Denton County. One unfigured paratype, U.S.N.M. 105253; 1 figured paratype, U.S.N.M. 105255; 10 unfigured paratypes, U.S.N.M.

105256; 1 figured paratype, U.S.N.M. 105257; 11 unfigured paratypes U.S.N.M. 105258; one unfigured paratype, U.S.N.M. 105254.

Occurrence.—Tarrant County: Locs. 20, 27, 34, 35, 37, 38, 47 (paratype), 50; Denton County: locs. 58, 72-77, 78 (holotype), 79, 81, 85, 89, 92, 94; Grayson County: locs. 117, 133, 135, 136, 152, 164, 165; Fannin County: locs. 179, 180, 184 (23 paratypes, 2 figured), 191, 195, 197; Lamar County: loc. 200.

Range.—Dexter member to Templeton member.

Family MYTILIDAE

Genus VOLSELLA Scopoli, 1777

Type species: "*Mytilus*" *modiolus* Linné. Recent, in northern seas. (Scopoli, 1777, p. 397.)

VolSELLa tarrantana Stephenson, n. sp.

Plate 20, figures 7, 8

Shell relatively small, thin-walled, elongate, inequilateral, equivalve, moderately inflated, greatest inflation about one-third the length of the shell from the anterior end. Beaks small, slightly prominent, broad, strongly incurved, strongly prosogyrate, closely approximate, situated about one-tenth the length of the shell from the anterior end. Umbonal ridge long, rather pronounced near the beak, becoming progressively less pronounced and more rounded toward the posteroventral margin. A broad, very shallow depression extends from the beak, with increasing breadth to the middle of the ventral margin. Anterior margin sharply rounded well above the midheight, becoming more broadly rounded below; ventral margin long, very broadly and very slightly concave centrally; posterior margin sharply rounded below, rounding very broadly above into the long, nearly straight posterodorsal margin. Surface marked only with fine growth lines and gentle growth undulations.

Dimensions of the holotype, a left valve: Length about 34 mm, height 15 mm, convexity 5 mm. Maximum measured length among the paratypes 50 mm.

Ligamental groove opisthodontic, short, sharply incised, submerged. Hinge apparently edentulous. Inner margin smooth.

Types.—Holotype, a left valve, U.S.N.M. 105259; 1 figured paratype, U.S.N.M. 105260; 10 unfigured paratypes, U.S.N.M. 105261; all from the Chicago, Rock Island and Gulf Railroad, 0.9 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Loc. 38.

Range.—Lewisville member.

VolSELLa alveolana Stephenson, n. sp.

Plate 20, figures 5, 6

The holotype of this species is a left valve adhering to the shell of *Cyprimeria patella*. Shell small for the genus, of medium length, inequilateral, inflated, the greatest inflation being along the umbonal ridge a little in advance of the midlength and above the midheight. Umbonal region broad, rising well above the hinge line. Umbonal ridge long, sinuous, extending obliquely downward to the distant terminus. Beak strongly incurved,

prosogyrate, situated about 2 mm back of the anterior extremity. A broad shallow depression extends from the beak in sinuous trend backward and downward, reaching the ventral margin a little back of the midlength. Dorsal margin very broadly and gently arched; anterior margin sharply rounded well above the midheight; ventral margin long, broadly excavated centrally, curving upward at each end; posterior margin narrowly rounded below at the end of the umbonal ridge, curving broadly and obliquely upward and forward and rounding into the dorsal margin. Surface ornamented with many small, sharp concentric lirae of irregular size and spacing, with intermediate fine growth lines; the sculpture becomes progressively a little coarser from the midlength toward the posterior extremity.

Dimensions of the holotype: Length 25 mm, height about 15.5 mm, convexity about 6 mm.

Hinge and internal features not uncovered.

The species is proportionately shorter and more coarsely sculptured than *Volsella tarrantana* and is longer and much more coarsely sculptured than *V. modesta*.

Volsella stonewallensis (Cragin), originally described as *Modiola* (1893, p. 196), appears to be very similar in form and sculpture to this species, but is much larger (length about 75 mm), and apparently has a somewhat more subdued umbonal ridge. Cragin's species is recorded from several poorly defined localities in the Comanche series of Texas, the nearest one to Grayson County being Brown's Ferry, Red River, Cooke County.

Holotype.—U.S.N.M. 105262; from a gully south of a barn, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson County. Two unfigured paratypes, U.S.N.M. 105263; 4 unfigured paratypes, U.S.N.M. 105264.

Occurrence.—Grayson County: Locs. 164 (2 unfigured paratypes), 165 (4 unfigured paratypes), 171 (holotype).

Range.—Templeton member.

Volsella modesta Stephenson, n. sp.

Plate 20, figures 9

Shell small, thin, moderately long, inequilateral, moderately inflated, greatest inflation on the umbonal ridge a little in advance of the midlength and about at the midheight. Beaks small, nonprominent, apparently situated a little back of the anterior extremity, strongly prosogyrate. Umbonal ridge long, descending with sinuous trend to the posteroventral margin, broadly rounded. Anteroventral slope steep centrally, bulging forward above. Anterior margin incompletely preserved, but apparently short, sharply rounded, situated well up toward the dorsal margin; anteroventral margin long, descending, broadly concave; posterior margin sharply rounded well below the midheight, broadly rounded and inclined forward above, and rounding

broadly into the very broadly arched dorsal margin. Surface smooth except for fine growth lines.

Dimensions: Length 17.5+ mm, height 11 mm, convexity about 3.5 mm.

The hinge margin is incompletely preserved but appears to be essentially edentulous.

Type.—Holotype, the external and internal mold of a right valve, U.S.N.M. 105265, from the Eules member in a cut on the Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant County.

Occurrence.—Tarrant County: Loc. 25 (holotype); Cooke County: loc. 99; Lamar County: loc. 203.

Range.—Eules member to Templeton member.

Genus BRACHIDONTES Swainson, 1840

Type species: *Modiola sulcata* Lamarck. Recent, in the Indian Ocean. (Swainson, 1840, p. 384.)

Brachidontes filisculptus (Cragin)

Plate 20, figures 19-21

1893. *Modiola filisculpta* Cragin. Texas Geol. Survey, 4th Ann. Rept. for 1892, p. 194.

1928. *Modiola filisculpta* Cragin. Adkins, Texas Univ. Bull., 2838, p. 137.

1951. *Brachidontes filisculptus* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 4 (following p. 163).

Shell medium to large for the genus, elongate, sub-trigonal in general outline, plump centrally, strongly inequilateral, equivalve. Beaks small, strongly prosogyrate, curving around a little away from the margin at the tip, situated only slightly back of, and a little above, the anterior terminus. Umbonal ridge prominent, sinuous, sharply rounded near the beak, becoming progressively more broadly rounded toward the rear, with steepest slope below. A well-marked broad radial depression in front of and below the umbonal ridge extends from the beak to the ventral margin. Between the umbonal ridge and the dorsal margin a broad, shallow depression extends radially, fading out toward the rear. Anterior margin very sharply rounded well above the midheight; anteroventral margin inclined, broadly rounded anteriorly and posteriorly and broadly excavated centrally; posterior margin sharply rounded below, passing above into a broadly arched posterodorsal and dorsal margin.

The whole outer surface is covered with closely crowded, fine radiating ribs that vary in strength on different parts of the shell; the coarsest ribs are on the umbonal inflation and the finest on the anterodorsal slope in the umbonal region; several short ribs close to the anterior extremity below the beak are relatively coarse. Ribs may bifurcate at almost any distance from the beak, and groups of ribs may bifurcate at the same radial position, thus reducing the ribbing to a finer pattern distally than it is nearer the beak. On well-preserved shells the ribs on the posterodorsal surface and on the anterior surface are finely beaded and the beading

may be more or less obscurely developed on other parts of the shell. The strength of the beading is unequally developed on different individuals. Fine as is the ribbing, most of the many shells in the collections from Denton County, chiefly from Timber Creek, are still more finely ribbed, and it is possible to divide them fairly satisfactorily into two sets, those having typical ornamentation and those having the finer kind; a few seem to be intermediate and difficult to place in one or the other group. The extremes seem to justify separation, and elsewhere the varietal name *microcostae* is given to the shells having the fine sculpture.

The shells of this species and its variety are abundant locally in the Lewisville member.

Dimensions of the cotype shown in plate 20, figure 21: Length (parallel to hinge line) about 62 mm, height about 44 mm, thickness 33 mm. This is the specimen measured by Cragin, who used maximum dimensions regardless of proper orientation.

Hinge below the beak with two or three short, transverse, shallow, weakly developed channels separated by low dental ridges broader than the channels; otherwise the hinge is edentulous. Anterior adductor scar very small, elongated, situated far forward just above the lower margin. Posterior adductor relatively large, about three times as long as the anterior scar, subovate-elongate, situated high on the interior at or a little in advance of the midlength. Inner margin finely crenulated except along the dorsal margin.

Types.—Two cotypes, each with both valves intact but incomplete, bearing the original number 707, are in the collection of the Bureau of Economic Geology at Austin (see pl. 20, fig. 21, and plastotype, U.S.N.M. 105266), and another smaller cotype, a right valve, is in the collection of the University of Texas (see plastotype, U.S.N.M. 105267). One nearly complete specimen in the collections of the U. S. National Museum (U.S.N.M. 32694), collected by Cragin from the Lewisville member on Timber Creek, and accompanied by an old label apparently in his handwriting, may reasonably be considered a cotype. Someone has penciled the word "type" on the label. One plesiotype, U.S.N.M. 105268.

Occurrence.—Tarrant County: Locs. 13, 16, 20, 21, ?27, 28, 30, 36; Denton County: locs. ?56, 70 (cotype? figured), 72, 74-76, 78, 79 (1 plesiotype), 80, 81, 84, 85, 87, 89, 94; Bur. Econ. Geology 707 (1 figured cotype); Cooke County: loc. 99; Grayson County: locs. 106, 107, 115, 117, 123, 130, 131, 137, 142; Fannin County: locs. 180, 184, 186; Red River County: loc. 208.

Range.—Dexter member to Lewisville member.

Brachidontes filisculptus microcostae Stephenson, n. var.

Plate 20, figures 16-18

Associated with the typical *Brachidontes filisculptus* are many shells of similar size and form whose radiating sculpture is markedly finer, having 30 ribs to the centimeter on a selected area, in contrast to 20 or fewer on a corresponding area on the holotype of *filisculptus* proper. Except for a few shells whose ribbing seems to be of intermediate fineness, little difficulty was ex-

perienced in separating the typical from the varietal specimens. Other differences observed in this varietal form include less pronounced inflation, a less prominent umbonal ridge, a less prominent anteroventral bulge, and a more slender and less strongly curved outline. In most lots the shells having the finer sculpture outnumber those having the coarser ribs characteristic of the typical form.

In form this variety resembles the specimens of *Modiola laticostata* (White), figured by Stanton (1916, p. 311, pl. 79, figs. 9, 10) and reported by him to be a fresh-water species from the Fruitland formation (late Upper Cretaceous) of New Mexico, but the latter has a coarser and more irregular type of radial ribbing.

Types.—Holotype, U.S.N.M. 105269; 5 unfigured paratypes, U.S.N.M. 105270; from the Lewisville member on Timber Creek, 4 miles [sic; 3 miles] west by south of Lewisville, all in Denton County.

Occurrence.—Johnson County: Loc. 9; Tarrant County: locs. 29, 35; Denton County: locs. 72 (type lot), 74, 76, 78, 79, 81, 84.

Range.—Eules member to Lewisville member.

Brachidontes fulpensis Stephenson, n. sp.

Plate 20, figures 10-13

Shell of medium size, subtriangular in outline, moderately inflated, equivalve, strongly inequilateral. Beaks small, nearly terminal, strongly prosogyrate, bending away from the margin a little at the tip. Umbonal ridge prominent, broadly curved, rounded on the crest, asymmetrical in cross section; the slope below the ridge is steep and slightly excavated and the slope above is more gentle and rounds broadly away toward the dorsal and posterior margins. The posterodorsal part of the shell is compressed, the margins of the two valves coming together to form a pronounced keel. Anteroventral margin inclined downward and backward at an angle of about 45°, broadly convex toward each end, and broadly concave centrally; posteroventral margin sharply rounded; posterior margin broadly rounded, inclined forward, meeting the dorsal margin at a wide subobtuse angle; dorsal margin very gently arched. The outer surface is covered with fine, closely spaced radial ribs that vary in fineness on different parts; the coarsest ribs are on the umbonal inflation, and the finest and weakest ribs are in the umbonal region in front of and below the umbonal ridge; ribs may bifurcate on any part of the surface and are individually variable in this habit; groups of ribs may bifurcate in such a manner as to increase the fineness of the ornamentation toward the outer margin, as on the posterior slope of the holotype.

Dimensions of the holotype: Length 42 mm, height 39 mm, thickness 21 mm.

Ligamental groove narrow, paralleling the upper margin back of the beak for about 5 mm. From near the inner end of the ligamental groove a long, narrow crural ridge extends rearward parallel to and 1 mm or

less below the dorsal margin; on the figured paratype the terminus of this ridge is broken away. A narrow groove parallels the ridge below. Below the groove a second narrow and weaker ridge extends rearward, dying out about halfway to the end of the dorsal margin. The shell is thick in the cardinal region, where the hinge is scored with 3 or 4 deep, transverse channels, rather long in the holotype, with intervening sharp ridges; the ridges on the left valve fit into the channels on the right valve, and the ridges and channels seem therefore to function as teeth. It is clear from two available specimens that these teeth are extreme modifications of crenulations produced by the intersection of surface costae with the anterior margin. The teeth are longer and stronger than in the typical *Brachidontes*. Inner margin finely crenulated, except on the dorsal side, the crenulations corresponding to the radial ribs of the outer surface. Adductor scars not well exposed in the available material.

Compared with *Brachidontes filisculptus* (Cragin) this species is shorter, curves down more steeply toward the rear, has a more prominent and less broadly rounded posterodorsal keel, a more pointed anterior outline, a thicker shell in the cardinal area, and a stronger and longer development of dental ridges and channels. The surface ribbing on the average is noticeably coarser than on Cragin's species.

The species is closely related to *Modiola* (*Brachidontes*) *multilinigera* Meek, from the first sandstone ridge (Lewisville? age) at Coalville, Utah (1873, p. 492). Meek's types (U.S.N.M. 7781) are internal and external molds in sandstone and are not well enough preserved for critical comparison. The outline and form appear to be essentially identical in the two species, but the ribbing on *Volsella* (*B.*) *multilinigera* is generally a little coarser, with less of a tendency to bifurcate and form finer sculpture toward the margins.

In 1861 W. M. Gabb (1861, p. 371) described the species *Perna* (*Modiola*) *texana*, which he recorded as having come "From a coarse brown, highly fossiliferous Eocene sandstone from Caddo Peak, Tex." In a personal communication H. B. Stenzel states that he has been unable to locate a "Caddo Peak" anywhere in the Tertiary of Texas, and directs attention to a peak by that name in the area of outcrop of the Woodbine formation in Johnson County, Tex. At the time Gabb's paper was written the strata of the Woodbine formation in Johnson County were believed to be of Tertiary age. Stenzel therefore raises the question as to whether the Caddo Peak in Johnson County was the locality at which Gabb obtained his species. I have examined the type of *Perna* (*Modiola*) *texana* Gabb (Acad. Nat. Sci. Philadelphia 3959; plastotype, U.S.N.M. 108235) and find that it belongs to the genus *Brachidontes*, and is clearly similar in form and external surface features to the holotype of *B. fulpensis*, but differs in that the

radiating ribs on the anteroventral slope are a little more clearly defined, and that anteriorly the forward end of this slope bulges downward more strongly. Although these differences are slight I hesitate to refer the species I have called *B. fulpensis* to Gabb's species, until it can be shown that his species occurs in Woodbine strata at Caddo Peak, Johnson County. Caution in making this reference is further justified by the fact that species of *Brachidontes* of different ages have a general similarity in form and ornamentation, and their recognition as separate species must necessarily be based on relatively small differences.

Types.—Holotype, U.S.N.M. 105271; 1 figured paratype, U.S.N.M. 105272; 4 unfigured paratypes, U.S.N.M. 105273; 5 unfigured paratypes, U.S.N.M. 105274; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of center of Savoy, Fannin County.

Occurrence.—Tarrant County: Locs. 11, 12, 14, ?15, 20, 22, ?24, 35, 47; Cooke County: loc. 98; Grayson County: locs. 131, 135, 136; Fannin County: locs. 179, 180, 184 (holotype and 10 paratypes, 1 figured), 191, 195.

Range.—Dexter member to Lewisville member.

Brachidontes arlingtonanus Stephenson, n. sp.

Plate 20, figures 14, 15

Shell of medium size, subtriangular in outline, moderately inflated, equivalve, strongly inequilateral. Beaks small, strongly prosogyrate, situated a little back of the anterior terminus. Umbonal ridge prominent, a little sinuous, rounded on the crest. Posterodorsal slopes compressed, the margins of the two valves forming a pronounced keel. Anteroventral margin inclined downward and backward, broadly excavated centrally; posteroventral margin sharply rounded; posterior margin nearly straight to broadly arched, strongly inclined forward, meeting the dorsal margin at an angle of about 130°; dorsal margin nearly straight. Surface covered with radiating costae which are coarser on the average than in any other described species or variety in the Woodbine formation but which exhibit marked differences in coarseness or fineness on different individuals and on different parts of the same shell. As in the related forms, the costae may bifurcate individually or in groups and may subdivide so extensively as to increase the fineness of the sculpture toward the margins of the shell. In general the ribs are coarsest on the inflated part of the shell. There is considerable individual variation in form and fineness of sculpture.

Dimensions of the holotype, an incomplete left valve: Length 34+ mm, height 29 mm, convexity about 6.5 mm.

Cardinal margin thick and bearing three or four transverse teeth. Inner margin crenulated except on the dorsal side.

The species is similar in form and outline to *Brachidontes fulpensis* but averages considerably smaller and possesses a definitely coarser type of sculpture.

Types.—The specimen selected as holotype is not complete but shows the coarser sculpture over the greater part of the shell. Holotype, U.S.N.M. 105275; 1 figured paratype, U.S.N.M. 105276; 22 selected unfigured paratypes, U.S.N.M. 105277; all from Johnson Creek (=Trading House Creek), 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Loc. 35 (types); Red River County: loc. 209.

Range.—Lewisville member.

Unidentified specimens of *Brachidontes*

The remains of *Brachidontes* Swainson, too incomplete or too poorly preserved for specific identification, were found at the following localities:

From the Eules member in a gully, 21 feet below the track of the Chicago, Rock Island and Pacific Railroad, just south of Dorothy Siding, Tarrant County (loc. 26), U.S.N.M. 105278.

Poorly preserved internal and external molds of a small species of *Brachidontes* are present in coarse ferruginous sandstone of the Dexter member on an east-west road 50 feet east of a T-road to the north, 0.5 mile north-northwest of a church, 2.4 miles northeast of Keller, Tarrant County (loc. 17). The molds exhibit considerable individual variation in the number and strength of the radiating costae and may represent more than one species. They may be young stages of already described species. Some with the coarser ribbing suggest *Brachidontes arlingtonanus*, and those with finer ribs are more like *B. filisculptus* (Cragin). The largest of the imprints are about 19 mm long. U.S.N.M. 105279.

Two-tenths mile southeast of the preceding locality similar imprints were found in coarse ferruginous sandstone of the same member (loc. 18), U.S.N.M. 105280.

Many poorly preserved imprints of a small species of *Brachidontes* are present in coarse ferruginous sandstone of the Red Branch member on the east slope of a knoll, 200 feet south of an east-west road, about 400 feet southwest of a road corner near a house, 3.3 miles north of Pilot Point, 1.3 miles west of the Grayson County line, in Cooke County (loc. 95). The umbonal ridge is rather sharp and subangular near the beak, and the umbonal region and the anteroventral slope are feebly ornamented with fine radiating ribs. One external mold measures: Length 14 mm, height 11.5 mm, convexity about 3 mm. Selected examples, U.S.N.M. 105281.

From tuffaceous sandstone of the Lewisville member near a west-flowing branch 1.05 miles east and 0.2 miles south of Penland (Terrace station), Grayson County (loc. 122). U.S.N.M. 105282.

Lewisville member at Hyatts Bluff, Red River, 5 miles northwest of Ravenna, Fannin County (loc. 179). U.S.N.M. 105283.

Lewisville member at Pine Bluff, Red River, near the northwestern corner of Red River County (loc. 209). U.S.N.M. 105284 and 105285.

Genus *CRENELLA* Brown, 1827

Type species: *Mytilus decussatus* Montagu. Recent, in European seas (Brown, 1827, tab. 31).

Crenella subcircularis Stephenson, n. sp.

Plate 19, figures 15, 16

Shell small, subcircular in outline, slightly higher than long, inflated, subequilateral, equivalve. Beaks moderately prominent, strongly incurved, prosogyrate, approximate, situated centrally. Dorsal margin arched; anterior margin broadly rounded; ventral margin regularly and less broadly rounded than the anterior; posterior margin subtruncated near midheight, passing into the dorsal margin in a broadly subobtuse angle. Surface ornamented with fine, closely spaced, nonprominent ribs numbering about 9 to the millimeter at the ventral margin. The ribs are crossed by fine growth lines that produce a finely cancellated pattern.

Dimensions of the holotype, the only available specimen: Length 5.3 mm, height 5.9 mm, thickness 4.4 mm.

Type.—Holotype, U.S.N.M. 105286, from a branch of Cornelius Creek, 3.3 miles N.16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Loc. 165.

Range.—Templeton member.

Genus *BOTULA* Mörch, 1853.

Type species: *Mytilus fuscus* Gmelin, designated by Dall, Bartsch and Rehder (1938, p. 59). Recent, West Indies.

Winckworth (1943, p. 187) shows that *Botula* Leske, cited by Neave in *Nomenclator Zoologicus*, is an error for *Rotula* Klein, a pre-Linnean name applied to an echinoid. Therefore *Botula* Mörch is not preoccupied.

Several Cretaceous bivalve species heretofore referred to *Lithophaga* Bolton, by me and other authors, seem clearly to belong to *Botula* Mörch. *Mytilus lithophagus* Gmelin, the type species of *Lithophaga*, differs from *Mytilus fuscus* Gmelin, the type species of *Botula*, in that the beaks are not quite terminal and are nonprominent, the shell is more elongate and more streamlined, the ventral margin is nearly straight or very broadly rounded, instead of broadly concave, an anteroventral bulge is wanting, and the shell is highest near the midlength, tapering somewhat both toward the front and toward the rear. The Cretaceous shells closely resemble *Botula* in that the beaks are terminal, the anteroventral margin is noticeably bulging, the ventral margin is broadly concave, and the shell lacks the graceful streamlined outline of *Lithophaga*, as viewed in lateral profile.

The following previously described American Cretaceous species appear to possess the shell characters of *Botula* Mörch: *Lithophaga ripleyana* Gabb (probably), *L. carolinensis* (Conrad), *L. affinis* Gabb (possibly), *L. conchafodentis* Gardner, *L. twitchelli* Gardner, and *L. oviformis* Gabb. If the individual variations in form, outline, and size of the shells listed were better known, some of the names might prove to be synonyms.

In the simple, boring shells of this group, it is difficult to fix upon characters having classificatory value. The slight differences noted among the shells of the different species as recorded may or may not indicate that they belong to separate species. Because of their long range and slight differentiation from time to time the shells of the group are of little value in correlation.

Botula carolinensis (Conrad)?

Plate 21, figure 18

1875. *Arcoperna carolinensis* Conrad, North Carolina Geol. Survey Rept., vol. 1 (by W. C. Kerr), App. A, p. 5, pl. 1, fig. 6.
 1923. *Lithophaga carolinensis* (Conrad). Stephenson, North Carolina Geol. and Econ. Survey, vol. 5, p. 243, pl. 62, figs. 4-9.
 1941. *Lithophaga carolinensis* (Conrad) Stephenson, Texas Univ. Pub. 4101, p. 155, pl. 22, figs. 18, 19.

Shell small, thin, elongate-subelliptical in outline, plump centrally and anteriorly, tapering wedge-like posteriorly, very inequilateral, equivalve. Umbonal region broad, prominent; beaks terminal, strongly incurved, strongly prosogyrate, approximate, protruding slightly toward the front. The inflated part of the shell is fullest above the midheight, rounding over steeply to the dorsal and anterior margins and less steeply to the ventral margin; a slight flattening in the umbonal area merges downward ventrally into a broad, shallow, radial depression. Anterior margin bluntly rounded; anteroventral margin broadly bulging; ventral margin broadly excavated; posterior margin evenly rounded less than a semicircle; posterodorsal margin broadly rounded and slightly rostrate. The surface is marked only with fine growth lines and gentle undulations.

Dimensions of the figured specimen: Length 7 mm, height 3.8 mm, convexity about 2 mm. Some of the poorly preserved shells are somewhat larger than the one measured.

The shells here questionably referred to *Botula carolinensis* (Conrad) are similar in essential features to typical shells of the species from Snow Hill, N. C., but appear to average a little less in the proportion of height to length. It is worth noting that whereas the Carolina shells are commensal borers in the thick shells of other bivalves, the shells from one of the Lewisville localities (4) are borers in rather soft, impure, ferruginous limestone. At the latter locality the adult shell occupies a self-bored cavity which is lachrymi-form and is lined with crystalline calcite that encases the shell and may be a secondary filling.

Types.—The whereabouts of Conrad's original figured specimen is unknown. Topotypes were subsequently figured by me (1923, p. 243, pl. 62, figs. 4-9) from the Snow Hill marl member of the Black Creek formation, Snow Hill, N. C. Three examples, 1 figured, U.S.N.M. 105287 and 105287a.

Occurrence in Lewisville member of Woodbine formation.—Hill County: Loc. 4 (includes 1 figured example); Cooke County: loc. 99; Grayson County: loc. 131; Fannin County: loc. 184.

Occurrence elsewhere.—Texas: Nacatoch sand, Corsicana marl, and Kemp clay, all of the Navarro group.

North Carolina: Snow Hill marl member of Black Creek formation.

Botula plumosa Stephenson, n. sp.

Plate 21, figures 15-17

Shell small, thin-walled, elongate-subelliptical in outline, plumply inflated anteriorly and medially above the midheight, compressed wedgelike posteriorly, inequilateral, equivalve. There is a slight gape at the posterior end. Beaks broad, strongly incurved, prosogyrate, closely approximate, situated slightly back of the anterior terminus. The umbonal region is broad and a shallow depression extends radially from the beak, becoming very broad and shallow toward the ventral margin. Anterior margin short, slightly subtruncated; ventral margin long and very broadly concave; posterior margin sharply rounded a little below the midheight, curving above into the long, very broadly arched, slightly rostrate, posterodorsal margin. The surface is ornamented, apparently all over, with fine, almost microscopic, closely spaced, irregular radial riblets that diverge plumelike from the inflated part of the shell to the anterior, ventral, and posterior margins. The available material indicates some individual variation in form and outline.

Dimensions of the holotype: Length 13.8 mm, height 6.6 mm, thickness about 6.5 mm.

The hinge and other internal features are not uncovered on the available specimens.

The species resembles *Botula carolinensis* (Conrad) in form but differs in the presence of radiating riblets over most or all of its surface.

Types.—Holotype, U.S.N.M. 105288; 1 figured paratype, U.S.N.M. 105289; 3 unfigured paratypes, U.S.N.M. 105290; all from a small branch, 0.2 miles south, 0.5 mile west of Star School, about 5 miles southeast of the center of Denison, Grayson County.

Occurrence.—Grayson County: Loc. 137.

Range.—Lewisville member.

Order ANOMALODESMACEA

Superfamily PANDORACEA

Family PHOLADOMYACIDAE

Genus PHOLADOMYA Sowerby, 1823

Type species: *Pholadomya candida* Sowerby. Recent, in the West Indies.

Pholadomya goldenensis Stephenson, n. sp.

Plate 21, figures 19-22

Shell of medium size for the genus, elongate, rather strongly inflated, inequilateral, equivalve. Beaks prominent, broad, strongly incurved, closely approximate,

prosogyrate, situated a little less than one-fourth the length of the shell from the anterior end. The place of greatest inflation is a little back of the umbones well above the midheight. The surface descends steeply to the front margin with a broad shallow radial depression on the anterodorsal slope; it rounds down broadly and less steeply to the ventral margin, and still less steeply to the posterior margin. The anterior margin is rounded, with a subtruncation on the end; ventral margin very broadly rounded; posterior margin evenly rounded; dorsal margin long and nearly straight. The two valves gape a little at the anterior end, above the midheight, and more strongly at the posterior end, also above the midheight. The growth lines are fine on the umbones and become somewhat coarser toward the margins; away from the umbones fine growth undulations begin to appear and become coarser outwardly, especially on the posterior portion of the shell. About 14 narrow, faintly noded radial ribs, narrower than the interspaces, cover most of the surface but become weaker distally; they are quite weak on the ventral slope and practically disappear from the antero- and posterodorsal areas.

Approximate dimensions of the holotype, a crushed internal mold with the external sculpture rather clearly impressed upon it: Length 43 mm, height 29 mm, thickness 24 mm.

The internal features are not observable.

The holotype and paratype from Golden Bluff are probably young individuals. Two large internal molds from the same stratigraphic position near old Slate Shoals (loc. 201), 5 miles east of Golden Bluff, are questionably identified as adults of this species. The larger, more complete mold measures: Length 72 mm, height 51 mm, thickness 41 mm. It exhibits pronounced narrow growth undulations; the dorsal surface is considerably worn, but obscure radial ornamentation can be detected; patches of shell substance remain attached to parts of the mold below the worn part, and on these and on the mold itself may be seen traces of weak radial ribs. The identification with *P. goldenensis* is made on the basis of similarity in form, outline, and character of ribbing. The specimen has been subjected to mechanical pressure in the posterodorsal-anteroventral direction, which squeezed the sides out a little, producing a pair of cracks extending outward and obliquely downward in such a manner as to simulate a pair of umbonal fissures; that these cracks are not true fissures, but accidents resulting from the mechanical pressure, is evidenced by the fact that similar cracks differently and less symmetrically oriented are present on the crushed holotype.

The species appears to be closely related to *Pholadomya papyracea* Meek and Hayden, from the Colorado group on Missouri Creek in northern Montana (Meek, 1876b, p. 217, pl. 5, figs. 4a, 4b), but the radial

ribbing in the umbonal region is more sharply developed, the concentric ribbing is less sharply and evenly developed, and the shell is less elongated.

Types.—Holotype, U.S.N.M. 105291; paratype, U.S.N.M. 105292; from Golden Bluff on Red River, about 3 miles east of Arthur City, Lamar County. One questionable example, U.S.N.M. 105293.

Occurrence.—Grayson County: Loc. 167; Lamar County: locs. 200, 201, 203 (holotype and paratype).

Range.—Templeton member.

Pholadomya? sp.

One small incomplete internal mold of a left valve with some shell adhering, from the Templeton member in a gully south of a barn 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson County (loc. 171), is questionably referred to *Pholadomya*. The cast is elongate, of medium inflation, with a moderately prominent beak that is farther removed from the anterior extremity than is the beak of *P. goldenensis*. Weak impressions of radial ribs are present on the cast. Dimensions: Length 30+ mm, height 18+ mm, convexity about 6 mm. U.S.N.M. 105294.

Family LATERNULIDAE

Genus LATERNULA (Bolten) Roeding, 1798

Type species: *Solen anatinus* Linné. Recent, in Oriental seas.

Laternula virgata Stephenson, n. sp.

Plate 21, figures 10-12

The holotype consists of internal and external molds with parts of the shell adhering to both. Shell of medium size, elongate-subovate in outline, low-convex, inequilateral, equivalve, gaping at the rear and probably also a little at the front. Beaks of medium prominence, incurved, slightly prosogyrate, situated a little back of the midlength, fissured downward and obliquely backward for a distance of about 6 mm from the tip. Greatest inflation a little in advance of the midlength, slightly above the midheight, from which point the surface curves over with moderate steepness to the dorsal margin above and broadly to the anterior and ventral margins. The posterior part of the shell is rather strongly compressed. Anterodorsal margin broadly arched; anterior margin evenly rounded, slightly narrower than a semicircle; ventral margin very broadly rounded; posterior margin narrowly rounded; posterodorsal margin slightly arched, gently descending. The anterior third or more of the surface is striped concentrically with narrow, gentle growth undulations that vary somewhat in coarseness on different parts of an individual and on different individuals, but in general range from 1 to 2 mm apart from crest to crest; finer concentric markings are present between the coarser undulations. Traced rearward the

concentric undulations fade out before reaching the midlength and merge into a central area covered with fine concentric threads, and still farther toward the rear, the threads merge into a still smoother area marked only by fine growth lines. The posterior part of the surface beginning a little back of the midlength is covered with many weak, somewhat irregularly spaced, radiating costae.

Dimensions of the holotype: Length about 45 mm, height 28 mm, thickness about 12 mm.

Hinge features not uncovered. An internal rib or buttress of medium strength extends from under the beak downward and backward just back of the umbonal fissure, fading out a little above the midheight. The pallial sinus is broad, of medium depth, and broadly rounded at the inner end.

The species is closely related to *Laternula scutulium* but differs in that the radiating costae are much finer and more numerous. The species is also related to *Anatina lineata* Stanton (1894, p. 117, pl. 26, figs. 3, 4), which, however, lacks radiating costae, with the exception of a few weak lines near the beak.

Types.—Holotype, U.S.N.M. 105295; 3 unfigured paratypes, U.S.N.M. 105296; all from the Templeton member on a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County. One paratype, figured, U.S.N.M. 105297.

Occurrence.—Tarrant County: Locs. 744, 53 (1 figured paratype); Grayson County: locs. 160, 165 (holotype and 3 unfigured paratypes).

Range.—Lewisville member to Templeton member.

Laternula scutulium Stephenson, n. sp.

Plate 21, figure 13

Shell rather large, compressed, subelliptical in outline, higher in front than behind, inequilateral, probably equivalve, fullest centrally and toward the front, a little compressed posteriorly, slightly gaping at the rear and probably also at the front. Beaks broad, non-prominent, prosogyrate, fissured, situated near or slightly back of the midlength; the fissure extends from the beak downward and backward, cutting obliquely across several of the radial costae. Anterodorsal margin broadly arched, rounding regularly into the evenly curved anterior margin; ventral margin very broadly rounded; posterior margin rather sharply rounded a little above the midheight; posterodorsal margin broadly arched. A little more than the anterior half of the surface is ornamented with fine concentric lines and many narrow growth undulations; radial lines are wanting on this part of the shell. Just back of the midlength of the shell is a space 9 or 10 mm wide (maximum) on which can be seen obscure traces of 4 or 5 radiating lines, and back of this space are 10 or 11 distinctly developed narrow radiating ridges, narrower than the interspaces. Still farther back the slightly

excavated posterodorsal slope is smooth with the exception of fine growth lines and undulations.

Approximate dimensions of the holotype, a left valve: Length 58 mm, height 37 mm, convexity about 8 mm. The paratype, the only other positively identified specimen, is about 66 mm long and 43.5 mm high.

Compared with *Laternula virgata* this species is larger and has a much stronger and coarser development of radiating ribs on the posterior part of the shell.

Types.—Holotype, an internal mold of a left valve, with some shell substance adhering, U.S.N.M. 105298; 1 paratype, a similar, less completely preserved left valve, U.S.N.M. 105299; both from near old Slate Shoals, Red River, Lamar County.

Occurrence.—Lamar County: Loc. 201.

Range.—Templeton member.

Laternula tofana Stephenson, n. sp.

Plate 21, figure 9

Shell of medium size, elongate-subovate in outline, rather low-convex, inequilateral, probably equivalve, gaping at the rear above the midheight. Beaks broad, of medium prominence, incurved, prosogyrate, situated about three-fifths the length of the shell from the anterior extremity, fissured from the tip obliquely downward and backward for a distance of about 6 mm. Greatest inflation central above the midheight, from which point the surface curves over rather steeply to the dorsal margin above and broadly and gently to the ventral margin below. The shell is slightly compressed adjacent to the upper anterior margin, and more strongly compressed in the posterior and posterodorsal areas. Dorsal margin broadly arched; anterior margin evenly rounded, narrower than a semicircle; ventral margin broadly rounded, fullest toward the front; posterior margin more narrowly rounded than the anterior. Surface marked by fine lines of growth, which are sharpest on the posterodorsal area; gentle, more or less irregular growth undulations are also present. On the lower posteroventral slope of the holotype is a group of eight faint radial lines, each produced by a closely spaced series of short, very fine hachure lines; the physiologic meaning of these lines is not clear.

Estimated dimensions of the holotype: Length 55 mm, height 32 mm, convexity 8 mm.

The hinge and internal features are not available for observation.

The species is similar in form to *Laternula virgata*, but differs in the relative smoothness of its surface features.

Types.—Holotype, U.S.N.M. 105300; 1 unfigured paratype, U.S.N.M. 105301; both from near a small branch, 1.05 miles east and 0.2 mile south of Penland (Terrace Station), 0.3 mile south-east of Dugans Chapel, Grayson County.

Occurrence.—Cooke County: Loc. 99; Grayson County: loc. 122 (holotype and paratype).

Range.—Lewisville member.

Laternula johnsonana Stephenson, n. sp.

Plate 21, figure 14

Shell small, thin-walled, subpyriform in outline, moderately inflated, compressed at the posterior end, equivalve, inequilateral, the anterior part of the shell longer and higher than the posterior part, posterior end slightly gaping. Beaks moderately prominent, incurved, approximate, fissured, slightly opisthogyrate, situated about three-fifths the length of the shell from the anterior extremity. Anterodorsal margin broadly arched; anterior margin rather sharply rounded; ventral margin broadly rounded, rising steeply at the rear; posterior margin short, subtruncated above the mid-height; posterodorsal margin nearly straight, somewhat inclined.

Dimensions of the holotype, a left valve: Length 10.4 mm, height 7.5 mm, convexity about 2 mm.

Internal features not uncovered. External surface marked with fine growth lines and somewhat irregular, narrow, shallow growth undulations.

Types.—Holotype, a left valve, U.S.N.M. 105302; 5 unfigured paratypes, U.S.N.M. 105303; all from Johnson Creek (=Trading House Creek), 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 35 (types), 50.

Range.—Lewisville member.

Laternula gemmea Stephenson, n. sp.

Plate 21, figure 8

Shell small, very thin-walled, pearly, subovate in outline, moderately inflated centrally, inequilateral, the anterior part longer and a little higher than the posterior, slightly gaping at the rear. Beaks moderately prominent, opisthogyrate, situated about three-fifths the length of the shell from the anterior extremity; the shell has been mechanically crushed inward just back of the beak and the position of the front edge of this break appears to have been determined by a short transverse fissure. Anterodorsal margin broadly arched; anterior margin rather sharply rounded; ventral margin broadly rounded; posterior margin subtruncated, inclined a little forward; posterodorsal margin short and apparently nearly straight.

Dimensions of the holotype, a right valve: Length 14 mm, height 10 mm, convexity about 3 mm.

The hinge appears to be edentulous. Surface marked with very fine growth lines and with small, irregular growth undulations that are strongest on the antero- and posterodorsal slopes.

Compared with *Laternula johnsonana*, this shell has a more pearly texture, is more delicately sculptured, and is proportionately higher in the posterior part, with a consequent longer posterior margin.

Type.—Holotype, a right valve, the only available specimen, U.S.N.M. 105304, from Sheep Creek, 4.2 miles N. 35° E. of center of Savoy, Fannin County.

Occurrence.—Fannin County: Loc. 184.

Range.—Lewisville member.

Unidentified specimens of *Laternula*

One incomplete external mold from the Eules member on State Highway 183, within 1.2 miles west of Eules, Tarrant County (loc. 28), resembles *Laternula johnsonana* but is larger and is proportionately shorter and higher. In height it measures about 13 mm. U.S.N.M. 105305.

An incomplete internal mold, broadly subovate, approaching subcircular, in outline (pl. 21, fig. 7), from the Templeton member in a bluff south of the Missouri-Kansas-Texas Railroad, 1 mile north and 1.85 miles east of Sadler, Grayson County (loc. 167), is referred questionably to *Laternula*. The mold indicates a shell of medium convexity with the maximum inflation well above midheight and near midlength. From the highest point the surface slopes uniformly to the margins. The beaks are of medium prominence, nearly direct and centrally situated; they are fissured as in *Laternula*. Impressions of subdued, concentric, somewhat irregular growth markings are present on the cast. Dimensions: Length 34 mm, height 29+ mm, thickness about 16.5 mm. This form is readily distinguished from the previously described elongate species of *Laternula* by its subovate outline. U.S.N.M. 105306.

Genus *ANATIMYA* Conrad, 1860

Type species: *Pholadomya (Anatimya) anteradiata* Conrad (1860, p. 276), here designated. From the Owl Creek formation (Upper Cretaceous), Tippah County, Miss.

Anatimya longula Stephenson, n. sp.

Plate 21, figures 1-3

Shell of medium size, thin-walled, elongate, inequilateral, subequivalve, gaping slightly in front and more widely behind. The shell is somewhat inflated centrally, becoming a little compressed anteriorly and more compressed posteriorly. Beaks broad, nonprominent, incurved, slightly prosogyrate, closely approximate, fissured, situated about two-fifths the length of the shell from the anterior extremity; the fissure extends from the beak outward and slightly backward for a distance of 3 to 6 mm. A broad, shallow depression extends from the beak down to the ventral margin. Anterodorsal margin slightly arched; anterior margin nearly regularly rounded, but showing a slight tendency to subtruncation; ventral margin nearly straight to broadly concave; posterior margin rather sharply rounded below, subtruncated above, rounding into the nearly straight posterodorsal margin.

The surface presents fine concentric growth lines and numerous small growth undulations. The radial sculpture varies considerably in detail on different individuals and is generally different on the opposite valves of the same individual. The central part of each side of the shell is nearly smooth, and several radial ribs are present both in front and behind this smooth area. On

the holotype the right anterior side bears three rather weak, narrow, nearly evenly spaced ribs, much narrower than the interspaces; back of the smooth area are seven similar ribs somewhat irregularly spaced. The left side is similarly ornamented posteriorly but appears to be nearly smooth anteriorly.

Approximate dimensions of the holotype, an internal mold on which the external features have been impressed: Length 62 mm, maximum height 34 mm, thickness 17.5 mm. The posterior part of the shell is a little higher than the anterior part.

The internal mold bears diverging channels that mark the presence on the interior of each valve of a strong buttress that extends from under the beak backward and downward, dying out about halfway to the posteroventral margin. The pallial sinus, as rather obscurely impressed on the holotype and on one paratype, is wide, deep, and rounded on the front but falls short of reaching the midlength of the shell.

This species is similar in form to *Pholadomya* (*Anatimya*) *anteradiata* Conrad, the type species of *Anatimya*, but differs from it in the presence of radiating costae on the anterior as well as on the posterior half of the shell. Attention is called to Conrad's erroneous orientation of the shell with respect to its front and rear, the costae described by him being on the posterior instead of the anterior part of the shell.

Types.—Holotype, U.S.N.M. 105307; 1 paratype, figured, U.S.N.M. 105308; 8 unfigured paratypes, U.S.N.M. 105309; all from Johnson Creek, 1.5 miles northeast of Methodist church at Arlington, Tarrant County.

Occurrence.—Tarrant County: Loc. 34, 35, 47 (types); Grayson County: locs. 126, 223, 227; Fannin County: locs. 179, 180; Red River County: loc. 209.

Range.—Lewisville member.

Anatimya eulessana Stephenson, n. sp.

Plate 21, figures 4-6

Shell of medium size, elongate, slightly inflated centrally, rounding off broadly to the front and becoming somewhat compressed toward the rear, inequilateral, equivalve; anterior gape 1 or 2 mm wide, posterior gape 5 or 6 mm wide. Beaks broad, nonprominent, incurved, slightly prosogyrate, fissured, situated slightly back of midlength; in the holotype the trace of the fissure on the mold extends from the beak radially and obliquely a little backward for a distance of 12 mm. A very broad, weak radial constriction extends from the beak to the ventral margin, and at the forward edge of this constriction a shallow, inconspicuous radial depression extends from the beak to the margin somewhat in advance of midlength. Anterodorsal margin gently descending, broadly arched; anterior margin regularly rounded, a little narrower than a semicircle; ventral margin nearly straight, rounding up steeply at the front and more gently at the rear; posterior margin more narrowly rounded than the anterior, becoming subtrun-

cated in some individuals. The surface presents fine growth lines and gentle concentric undulations, and centrally and a little back of center obscure radiating ridges may be present; the latter feature is variable on different individuals.

Dimensions of the holotype: Length 62 mm, height 33 mm, convexity about 11 mm.

Hinge and internal features not clearly preserved. The pallial sinus is faintly discernible on the internal mold of the holotype; it is wide and deep, extending nearly to midlength.

In general form this species resembles *Anatimya longula*, but is much smoother, lacking well-defined radiating ribs, and its beaks are situated a little back of, instead of in front of, midlength.

Types.—Holotype, the external and internal mold of a left valve, U.S.N.M. 105310, from Euless member on State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant County. One figured paratype, U.S.N.M. 105311; 9 unfigured paratypes, U.S.N.M. 105312.

Occurrence.—Tarrant County: Locs. 14, 19 (10 paratypes, 1 figured), 27 (holotype); Grayson County: locs. 133, 219.

Range.—Dexter member to Lewisville member.

Unidentified specimens of *Anatimya*

One small, mechanically deformed internal mold (pl. 54, fig. 12) from the Lewisville member, on Sheep Creek, 4 miles N. 37° E. of Savoy, Fannin County (loc. 181), questionably referred to *Anatimya*, exhibits sculpture, both concentric and radiating, similar to that of *Anatimya longula*, but, as preserved, the shell is much shorter and higher, and the ribbing on its posterior is finer and more closely spaced. The approximate dimensions are: Length 25 mm, height 19 mm, thickness 10 mm. U.S.N.M. 105313.

The internal and external molds of about the front half of a right valve of *Anatimya* (pl. 54, fig. 13), from the Euless member, in a shallow cut of a north-south road, 1 mile northeast of Kennedale, Tarrant County (loc. 22), pertains to a short, proportionately high undetermined species with rather strong, sharp concentric markings. A fissure is present in the beak. There is an indication on the internal mold of several radial lines extending in the posteroventral direction. The shell is about 29.5 mm high. U.S.N.M. 105314.

Superfamily POROMYACEA

Family POROMYACIDAE

Genus PSILOMYA Meek, 1876

Type species: *Poromya lata* Forbes, from the Trichinopoly group (Cretaceous, Turonian) of India.

The specimens here referred to the genus *Psilomya* Meek (1876b, p. 229), which is based on *Poromya lata* Forbes from the Cretaceous at Trichinopoly, southern India, is similar in form and in the presence of radiating rows of tiny spine scars to Forbes' original figures (1846, p. 141, pl. 15, figs. 14a, b). The hinge of *P. lata*

is neither illustrated nor described, and the generic assignment is here made with some reservation. The Texas shells are certainly congeneric with those in the Western Interior referred to *Psilomya* by White (1874, p. 26; 1877, p. 186) and Stanton (1894, p. 118), which include *Liopistha (Psilomya) meeki* White, *L. (P.) concentrica* Stanton, and *L. (P.) elongata* Stanton.

Psilomya concentrica (Stanton)

Plate 22, figures 13-20

1894. *Liopistha (Psilomya) concentrica* Stanton, U. S. Geol. Survey Bull. 106, p. 119, pl. 26, figs. 8-10.

1894. *Liopistha (Psilomya) meeki* White (not Stanton). Stanton, U. S. Geol. Survey Bull. 106, p. 118, pl. 26, figs. 5, 6.

Shell of medium size, thin-walled, subovate to broadly subtrigonal in outline, inequilateral, equivalve, broadly and strongly inflated, becoming compressed near the posterior extremity, slightly gaping at the rear. The available material includes specimens with more or less of the shell preserved and internal molds on which the thin shell, where preserved, is stained and partly replaced with oxide of iron; the surface is more or less corroded on most specimens. Beaks very prominent, strongly incurved, prosogyrate, approximate, situated a little in advance of midlength. Lunule not sharply outlined. Escutcheon long, narrow, deep, with fine transverse striations on the slopes. Dorsal margin broadly arched; anterior margin rather sharply rounded a little below midheight; ventral margin broadly rounded, rising more steeply toward the front than toward the rear; posterior margin short, faintly subtruncate. Outer surface, where not corroded, marked with very fine growth lines and, on the umbonal part, with narrow, gentle, fairly regular growth undulations; the latter are of unequal strength on different individuals, being pronounced on several specimens, but obscure or present only near the tip of the beak on others. Specimens with the shell well preserved bear numerous very faint, obscure radial lines on which are tiny spine scars spaced a little more than half a millimeter apart; these scars are best seen on one of the figured specimens from Grayson County (loc. 165). The poor preservation of some specimens accounts for the fact that these lines and scars have not been observed.

Dimensions of the large plesiotype shown in plate 22, figures 18-20, the two valves of which are partly spread apart: Length 33.5 mm, height 28 mm, thickness about 24 mm.

The ligament is external and is 4 or 5 mm long in adults; it occupies a narrow, sunken, opisthodontic groove that lies above a narrow nymph. The hinge is narrow and fragile and is not completely preserved in the available material. In the left valve a short, prominent, trigonal cardinal tooth stands a little in advance of the beak. Its forward end is at the margin, but rearward it diverges inward and is separated from the mar-

gin by a deep socket that opens to the interior back of the tooth. In the right valve a short, rather prominent cardinal tooth stands below and somewhat removed from the beak. It appears to fit into the socket of the left valve a little back of the cardinal of that valve. Just within the margin, in front of, and above, the large cardinal of the right valve is a second small cardinal tooth.

The specimens from the Woodbine formation appear to be identical with *Liopistha (Psilomya) concentrica* Stanton, from the so-called *Pugnellus* sandstone, on Williams Creek, Huerfano Park, Colo. (1894, p. 119, pl. 16, figs. 8-10). *Liopistha (Psilomya) meeki* White, from near Paria, Utah, is also closely related, but is smaller and is ornamented on the posterodorsal slope with radial ribs which, though weak, are easily seen with the naked eye. Specimens from Upper Kanab, Utah, figured by Stanton as *L. (P.) meeki* (1894, p. 118, pl. 26, figs. 5, 6), seem to lack the posterior radiating ribs and probably belong to *P. concentrica*.

Types.—Cotypes, U.S.N.M. 22898, from the "*Pugnellus* sandstone" on Williams Creek and in Huerfano Canyon, Huerfano Park, Colo. Three plesiotypes, U.S.N.M. 105315a-c; 4 unfigured examples, U.S.N.M. 105317; 3 plesiotypes, U.S.N.M. 105316a-c.

Occurrence.—Tarrant County: Loc. 11; Grayson County: locs. 152, 165 (3 figured plesiotypes), 171; Lamar County: locs. 201, 203 (3 figured plesiotypes and 4 unfigured examples), 207. Western Interior: From the "*Pugnellus* sandstone" on Williams Creek and Poison Canyon, Huerfano Park, Colo. The "*Pugnellus* sandstone" is now referred to the Codell member of the Carlile shale (late Turonian).

Range in Texas.—Dexter member to Templeton member.

Psilomya levis Stephenson, n. sp.

Plate 22, figures 21-24

Shell small, thin-walled, inequilateral, equivalve, subovate in outline, moderately inflated, compressed and slightly gaping at the rear. Beaks prominent, strongly incurved, prosogyrate, approximate, situated a little in advance of midlength. The outer surface is smooth except for fine incremental lines and radial rows of closely spaced small pits or spine scars on the umbonal portion. These pits are recognizable only on the figured paratype, a right valve, and appear to be wanting on the five unfigured paratypes, all of which are left valves.

Dimensions of the holotype, a left valve: Length 17.5 mm, height 13.2 mm, convexity 6 mm.

There is a short, external, opisthodontic ligamental groove, bounded on the inner side by a sharp, thin nymph; this feature is not well-preserved in the available material. The hinge is not very clearly preserved, but the figured paratype shows a relatively prominent tooth directly below the beak, between which place and the tip of the beak is a deep channel or socket.

In general form and outline this species resembles *Psilomya concentrica* (Stanton) but is smaller, less

strongly inflated, and smoother, being practically devoid of concentric undulations in the available material.

Stoliczka (1871, pp. 47, 48, pl. 2, figs. 8, 8a, 9, 9b) describes two teeth in the left valve of *Poromya lata* Forbes, the genotype of *Psilomya*, the anterior one large and the posterior one small, but his figure 9b shows only one tooth.

Types.—Holotype, U.S.N.M. 105318; 1 figured paratype, U.S.N.M. 105319; 5 unfigured paratypes, U.S.N.M. 105320; all from near the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, Tarrant County.

Occurrence.—Tarrant County: Locs. 38 (types), 44.

Range.—Lewisville member.

Psilomya sp.

The imprint of a shell fragment from the Euless member along State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant County (loc. 28), shows the presence of many closely spaced radiating rows of tiny tubercles or spines such as characterize the genus *Psilomya* Meek. The fragment is too incomplete to show the form of the shell, and the tubercles are more sharply developed and more evenly distributed than they are on other recorded American species. U.S.N.M. 105321.

Genus *LIPISTHA* Meek, 1864

Type species: *Cardium elegantulum* Roemer, from the Austin chalk (Upper Cretaceous), Guadalupe County, Tex. (Kreidebildungen von Texas, etc., 1852, p. 48, pl. 6, fig. 5). (Meek, 1864, p. 32.)

Liopistha sp.

Plate 22, figure 25

The genus *Liopistha* Meek is represented in the collections from the Woodbine formation by the external mold of part of one right valve, from the Lewisville member, on Johnson Creek, "2 miles [probably 1.5 miles] northeast of Arlington, Tarrant County" (loc. 34). The shell appears to be elongate-ovate in outline, rather plump, and is ornamented with 18 or more low, inconspicuous radiating ribs that are about 1.5 mm apart near the venter. The specimen is too incomplete for specific assignment. U.S.N.M. 105322.

Family *CUSPIDARIIDAE*

Genus *CUSPIDARIA* Nardo, 1940

Type species: *Tellina cuspidata* (Olivi). Recent, in waters around the British Isles.

Cuspidaria alaeformis (Shumard)

Plate 22, figures 7-12

1861. *Neaera alaeformis* Shumard, Boston Soc. Nat. History Proc., vol. 8, p. 203.

Shell of medium size, subtrigonal-elongate in outline, nearly equivalve, very inequilateral, strongly and plumply inflated anteriorly, strongly compressed, long

and narrow posteriorly. Beaks large, prominent, inflated, opisthogyrate, strongly incurved, approximate, situated about 0.45 the length of the shell from the anterior extremity. Anterodorsal margin broadly arched, steeply inclined; anterior margin rather sharply rounded; ventral margin broadly rounded anteriorly, rising and becoming broadly concave posteriorly; posterior margin very short, truncated; posterodorsal margin long, broadly concave. The posterodorsal edge of the right valve is prominent, sharp-edged, and slightly overlaps the edge of the left valve. On the right valve this sharp edge is bordered by a shallow radial depression 1 to 2 mm wide; a similar, though shallower and less sharply defined, depression is present on the adjacent part of the left valve. On each valve a narrow flattish band extends radially from the beak to the posterior extremity. On well-preserved shells the surface sculpture consists of somewhat irregular, sharp, concentric ridges with relatively wide interspaces in which are fine growth lines; this sculpture is not as well preserved on the neotype as it is on some other shells referred to the species.

Dimensions of the neotype, a specimen with both valves, which is somewhat distorted by mechanical compression: Length 17.7 mm, height 9+ mm, convexity 7+ mm. An incomplete left valve from another locality in Fannin County measures: Length 19 mm, height 12 mm, convexity 5 mm.

Hinge edentulous. On one left valve a small, short, thick, spoon-shaped chondrophore extends in a tilted attitude forward and downward, its posterior edge standing slightly out, toothlike. A right valve has a socket into which the projection fits. The inner edge of the anterior margin of this right valve bears a narrow groove into which the slightly overlapped edge of the left valve fits. The pallial sinus is short and broadly rounded.

This species is not apt to be confused with any previously described American species.

Types.—The type material of this species is presumed to be lost. It is recorded as having been collected by G. G. Shumard at the "bluffs of Red River, Fannin County." This probably means Hyatts Bluff, 5 miles northwest of Ravenna. This locality has yielded a few poorly preserved shells from the Lewisville member that seem to fit Shumard's description of *Cuspidaria alaeformis*, and one somewhat crushed specimen is selected as neotype (loc. 179, 18618), U.S.N.M. 105323, and one measured specimen, U.S.N.M. 105324. Shells of the species in a better state of preservation were collected on Sheep Creek in the same county (loc. 184, 3 plesiotypes, U.S.N.M. 105325a-c, and 3 unfigured examples, U.S.N.M. 105326). One plesiotype, U.S.N.M. 105327; 2 unfigured examples, U.S.N.M. 105328.

Occurrence.—Tarrant County: Locs. 16, 20, 22, 27, ?28, 31, 34, 35 (includes 1 plesiotype and 2 examples), 47; Denton County: loc. 93; Cooke County: locs. 98, 99; Fannin County: locs. 179 (neotype and 1 measured example), 180, 184 (includes 3 plesiotypes and 3 examples), 191.

Range.—Dexter member to Lewisville member.

Family POLLICIDAE

Genus POLLEX Stephenson, n. gen.

Type species: *Pollex obesus* Stephenson.

Etymology: Latin *pollex*, the thumb.

This bivalve is of medium size, elongate, plump, inequilateral with subelliptical outline. The surface appears to be nearly smooth, but the genotype exhibits fine growth lines, and on well-preserved shells, microscopic, closely spaced radial lining is present, and microscopic spine scars may be seen on the radials, on the umbonal ridge, and posterior slope. The ligament is preserved on the holotype and on some of the paratypes. It is external and opisthodontic. The cardinal dentition of the right valve includes a prominent, strongly oblique, upcurved anterior cardinal, the crest of which presents an anterior and a posterior cusp, separated by a central sag; a weak, nearly direct medial cardinal; and a strongly oblique posterior cardinal of medium strength. The posterior lateral dentition is distant and of moderate strength; anterior lateral dentition is wanting. Presence or absence of pallial sinus not determined. Inner margin smooth.

Pollex obesus Stephenson, n. sp.

Plate 23, figures 14-20

The holotype of this species (loc. 191) and one of the paratypes (loc. 184, coll. 19715) are from the *Ostrea soleniscus* reef zone in Fannin County. There is nothing in the occurrence of these two shells to indicate that they were borers. They were found in a matrix of sandy marl in association with a large assemblage of nonboring marine mollusks. However, a dozen or more smaller shells having the same form and the same hinge features are preserved in borings in a small piece of fossilized wood in Grayson County (loc. 137) near the same stratigraphic position. These appear to be younger shells of the same species. The positions they occupy in the wood seem to indicate that they occupy borings of their own making.

Shell of medium size, elongate, plump, subelliptical in outline, equivalve, strongly inequilateral, moderately inflated below the beaks, more strongly inflated about midway of the umbonal ridge; on some shells the two inflations are separated by a broad, shallow radial depression extending from the beak to the ventral margin. Beaks broad, nonprominent, incurved, prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity. Umbonal ridge broadly rounded and broadly humped centrally. The anterior slope is rather steep and broadly excavated anterodorsally. Posterodorsal slope gentle, flattened, becoming slightly and broadly excavated toward the rear. Surface nearly smooth to the naked eye, but some well-preserved shells are ornamented all over with

closely spaced, microscopic, radiating lines; under sufficiently high magnification the surface is microscopically punctate, and in places on the umbonal ridge and posterior slope, tiny spine scars can be seen on the radial lines. These markings are best seen on the paratype from Fannin County.

Dimensions of the holotype: Length 34 mm, height 18 mm, thickness 12.4 mm.

Ligament external, opisthodontic, about 8 mm long in adults; it is preserved in the holotype (see illustration). There is no certain evidence of an internal ligamental element; if present, it is closely associated with the external ligament. Nymph narrow and rather prominent. The cardinal dentition is peculiar and apparently different from any genus, or even family, with which I am familiar. In the right valve there is a prominent, moderately thick, strongly oblique, upcurved, anterior cardinal, which is separated from a thin, slightly concave shell margin by a profound, moderately elongated, trigonal socket; the crest of the cardinal presents two dull, elongated cusps separated by a broadly concave sag. Back of this cardinal, and separated from it by a shallow socket, is a short, nonprominent, nearly direct ridge or tooth that is weakly bifid on its crest. Farther back, with peak about 2 mm from the tip of the beak, is an elongated, strongly oblique, rather thin posterior cardinal that is much less prominent than the anterior cardinal; this tooth is separated from the medial short tooth by a moderately deep U-shaped depression bearing a tiny, weak radial ridge at the bottom and is separated from the forward end of the nymph by a narrow, rather deep socket. Distant from the cardinal area is an elongated, rather prominent, thin lateral tooth (partly broken away) that has a twisted appearance, bending up more strongly toward the front than toward the rear; this lateral is separated from the shell margin by a long, deep channel that merges anteriorly into the ligamental groove. The left valve, as seen in a small paratype from the Grayson County locality, possesses a thin, strongly oblique anterior cardinal, a medial short, thick cardinal below the beak (tip broken away in the figured specimen), and a long, thin, strongly oblique posterior cardinal below and closely paralleling the anterior end of the nymph. The lateral dentition consists of a pair of claspers, the inner element of which is rather strong and the outer element of which is merged with the outer shell margin, the two elements separated by a moderately deep socket. The presence or absence of a pallial sinus was not determined. Inner margin smooth.

Internal molds from one locality in Grayson County are referred questionably to this species.

Types.—Holotype, U.S.N.M. 105329, from a gully near fence 1,250 feet north of east-west road, about 3.5 miles N. 28° E. of Savoy, Fannin County. Two figured paratypes, U.S.N.M. 105330, 105333; 12 unfigured paratypes, U.S.N.M. 105331.

Occurrence.—Grayson County: Locs. ?106, ?123, 137 (12 paratypes, unfigured); Fannin County: locs. 184 (1 figured paratype), 191 (holotype).

Range.—Lewisville member.

Pollex? angulatus Stephenson, n. sp.

Plate 23, figures 12, 13

This species is represented by one specimen, the two valves of which are present and closed, except for a slight gape at the posterior extremity. It was found in fossil wood, apparently as a borer, in close association with *Pollex obesus*. The hinge and internal features are not observable and the questionable reference to the genus *Pollex* is based on the close similarity of the shell in general form and outline to shells of that genus. The species differs from *Pollex obesus* in the possession of a rather sharply angular umbonal ridge having a wide obtuse angle in cross section, and in the presence of 6 or 2 weak, narrow radiating ribs on the broadly excavated posterodorsal slope. No trace can be seen of the microscopic radiating riblets such as are present on certain of the well-preserved examples of *P. obesus*. No microscopic spine scars can be seen on any part of the surface. The ligament is external and partly preserved; it is opisthodontic and about 5 mm long.

Dimensions of the holotype: Length 15.7 mm, height 9 mm, thickness 6 mm.

Holotype.—U.S.N.M. 105332; from a small branch 0.2 mile south, 0.5 mile west of Star School, about 5 miles southeast of Denison, Grayson County.

Occurrence.—Grayson County: Loc. 137.

Range.—Lewisville member.

Pollex sp.

The internal molds of two left valves in ferruginous sandstone of the Euless member in a cut on the Arlington highway, one mile west by south of Euless, Tarrant County (loc. 25), appear to belong to this genus. The molds indicate a shell relatively longer, less inflated, and more pointed posteriorly, than the shell of *Pollex obesus*. The hinge is not well-preserved but suggests that of *Pollex*. The best specimen measures: Length 27 mm, height 12 mm, convexity about 4 mm. U.S.N.M. 105334.

Order TELEODESMACEA

Superfamily CYPRICARDIACEA

Family PLEUROPHORIDAE

Genus VENIELLA Stoliczka, 1870

Type species: *Veniella conradi* Morton, from Upper Cretaceous strata at Arneytown, N. J., presumably from the Navesink marl. (Stoliczka, 1871, p. 189.)

Veniella? sp.

Plate 23, figures 5, 6

One incomplete left valve of a large pelecypod from a layer of calcareous sandstone in the Lewisville member in the bed of Walnut Creek, 150 feet downstream

from an abandoned road crossing, 4.5 miles east-north-east of Mansfield, Tarrant County (loc. 43), appears to belong to the family Pleurophoridae, and the hinge shows a fairly close relationship to the genus *Veniella* Stoliczka. The shell is thick and measures roughly about 55 mm long and the same in height. Incremental lines strong, posterodorsal slope well defined, presenting a flattish, sinuous surface separated from the main surface by a subdued obtusely angular umbonal ridge. Beak situated well in advance of midlength. Hinge thick and set with three well-defined cardinal teeth, the posterior one oblique and proportionately thin, the middle one thick and plainly, though not deeply, bifid, and the anterior one thick and oblique toward the front; a deep socket of moderate width separates the posterior from the medial cardinal, and a deep, wide triangular socket separates the medial from the anterior cardinal; in the bottom of the latter socket, covering its middle and anterior part, is a well-defined spoon-shaped pit that sinks well below the floor of the socket. The ligamental groove is long and deep and is bordered by a well-developed nymph that is partly broken away. Just beyond the posterior end of the ligamental groove is a short, somewhat irregular, non-prominent lateral tooth. This tooth is not very well preserved but appears to be much shorter and less prominent than the corresponding lateral in the true *Veniella*.

Compared with *Veniella conradi* Morton, this shell is more compressed and the umbonal ridge is much less sharply angular. It certainly belongs to an undescribed species, and probably to an undescribed genus, in the family Pleurophoridae, but is too incomplete to serve as type material. U.S.N.M. 105335.

Superfamily ASTARTACEA

Family ASTARTIDAE

Genus OPIS Defrance, 1825

Type species: *Opis cardissoide* Defrance (?=*Trigonia cardissoides* Lamarck), by monotypy, from the Jurassic of Germany (Defrance, 1825, tome 36, p. 219, pl. 70, figs. 3a and 3b; pl. 100, fig. 1).

The specimens here referred questionably to *Opis* Defrance are similar in outline and form to the incomplete shell on which the genus is based. However, the hinge of the present species is too poorly preserved for critical comparison and the lunule is not only not profoundly excavated, as it is in the typical *Opis*, but is so faintly outlined as scarcely to be recognized as a lunule at all. Considering these differences and the difference in age, it seems highly probable that this species should be treated as generically distinct from *Opis*, and doubtless will be when the features of the hinge are better known.

There is so little in common in outline, form, and hinge features between the typical *Astarte* Sowerby and the *Opis*-like shells that the appropriateness of includ-

ing the latter group in the family Astartidae seems questionable. The desirability of erecting a new family to include *Opis* and related genera should be considered.

Opis? elevata Stephenson, n. sp.

Plate 22, figures 2-6

Adult shell of medium size, thin-walled, subtriangular in outline, strongly inflated, with the umbonal region high and narrow, inequilateral, equivalve; the anterodorsal slope is abruptly steep and rounds rather sharply back into the elevated lateral surface; the posterodorsal slope is also steep and joins the lateral surface at a subangle, somewhat wider than a right angle. Beaks very prominent, narrow, strongly incurved, slightly prosogyrate, standing well apart at the tips, situated about one-third the length of the shell from the anterior extremity. Anterodorsal margin gently arched, steeply descending; anterior margin subtruncated, nearly vertical; ventral margin very broadly convex; posterior margin subangular below, truncated and inclined a little forward above, rounding broadly into the arched, steeply descending posterodorsal margin. On the posterodorsal slope a broad, shallow depression extends from the beak to the truncated posterior extremity. Neither lunule nor escutcheon are present as well-defined features. On the holotype the sides of the shell are ornamented with numerous small, closely spaced, fairly regular concentric ridges that become finer as they pass over to the antero- and posterodorsal slopes. Fine radial lining covers the internal mold beneath the thin shell. Radial ribs are wanting on the outer surface.

Dimensions of the holotype, a half-grown shell: Length 19.5 mm, height 21.5 mm, thickness 20 mm. A paratype, a large internal mold, measures: Length 32 mm, height 39 mm, thickness 34 mm.

The margins of the two valves, as seen on the holotype, are in contact all the way around, except between the beaks, where there is a small triangular opening for the short, sunken ligament; what appears to be a remnant of the ligament, remains in the opening. Viewed from the front, a transverse bulging wall about 1.5 mm high, extends across the shell between and a little below the tips of the beaks, half on one valve and half on the other; from the crest of this wall the surface slopes gently away toward the rear on either side of the ligamental opening. The hinge and other internal features are not exposed on the holotype. On an incomplete right valve from another locality (no. 160, coll. 18257) the hinge may be seen in imperfect state of preservation. The ligamental groove is short and deeply sunken; in front of the groove a rather strong cardinal tooth points downward and rearward; anteriorly this is followed in succession by a wide, deep socket and a nearly vertical strong tooth. As seen on a paratype, an internal mold,

the adductor scars are small, subovate, and subequal, and the pallial line is simple.

Types.—Holotype, U.S.N.M. 105336; 1 figured paratype, U.S.N.M. 105337; 1 unfigured paratype, U.S.N.M. 105338; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County. One figured paratype, U.S.N.M. 105339, 1 unfigured paratype, U.S.N.M. 105340.

Occurrence.—Grayson County: Loc. 160 (2 paratypes, 1 figured), 170, 171; Lamar County: loc. 201 (holotype and 2 paratypes, 1 figured).

Range.—Templeton member.

Family CRASSATELLIDAE

Genus CRASSATELLA Lamarck, 1799

Type species: *Crassatella gibba* Lamarck, from the Eocene of the Paris Basin. (See Stewart, 1930, pp. 134-137.)

Crassatella sp.

Plate 22, figure 1

Two internal molds of left valves from tuffaceous sandstone of the Lewisville member near a small branch, 1.05 miles east and 0.2 miles south of Penland (Terrace station), Grayson County (loc. 122), appear to belong to the group typified by *Crassatella vadosa* Morton. Mainly on the basis of differences in outline and form, several species and varieties have been recognized among the shells of the group, which are common in several stratigraphic levels in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain. The two specimens are relatively short, high, and convex, and the concentric sculpture, as it appears impressed upon the molds, is rather coarse; the posterodorsal slope is prominent and steeply descending to the posterior extremity. The hinge and ligament are not preserved. The larger specimen, which is not complete, measures: Length 35+ mm, height 30 mm, convexity 9 mm. U.S.N.M. 105341.

Superfamily CYRENACEA

Family CYRENIDAE

Genus FULPIA Stephenson, 1946

Type species: *Fulpia pinguis* Stephenson, from the lower part of the Lewisville member of the Woodbine formation, Sheep Creek, 3.5 miles northwest of Fulp, Fannin County, Tex. (Stephenson, 1946, p. 69.)

Outline broadly ovate to subtrigonal; beaks not strongly prosogyrate and ranging in position from near the midlength to well forward; three cardinal teeth, an anterior lateral tooth in the left valve that extends from just in front of the cardinal area around to and more than halfway past the anterior adductor scar, a still longer posterior lateral that extends in a broad curve from the distal end of the ligament nearly past the posterior adductor scar; a pallial sinus that is narrow, steeply rising, and moderately extended; a smooth inner margin; a broad lunule, not sunken but outlined by an impressed line.

The type species is small, with a maximum measured length of about 20 mm.

Fulpia pinguis Stephenson

Plate 23, figures 1-4

1946. *Fulpia pinguis* Stephenson, Jour. Paleontology, vol. 20, no. 1, p. 68, pl. 12, figs. 1-4.

Shell small, subovate to subtrigonal in outline, shell wall of medium thickness, moderately inflated, slightly to rather strongly inequilateral, equivalve; there is considerable individual variation in the proportion of length to height and in the degree of inflation, as seen in many individuals from the type locality. Umbonal ridge weak, with a slightly flattened radial band just back of it. Beaks of medium prominence, incurved, prosogyrate, approximate, on different individuals situated from slightly in advance of the midlength to well toward the front. Lunule long, very broad, slightly concave near the beaks, becoming swollen to a low keel anteriorly, outlined by an impressed line that varies in distinctness on different individuals. Anterodorsal margin steeply descending, slightly arched; anterior margin regularly rounded; ventral margin more broadly rounded than a semicircle; posterior margin rather narrowly rounded below, rounding above into the broadly arched posterodorsal margin. Surface ornamented with fine, closely spaced, sharp-crested, fairly regular, concentric ridges, asymmetric in cross section with the short, steep slope above; on the lunule the concentric markings are finer, sharper, and more regular than on the main surface. Obscure, fine radial lining may be seen on either side of the umbonal ridge of well-preserved specimens.

Dimensions of the holotype, a shell of medium size, with the two valves intact: Length 15 mm, height 14.3 mm, thickness 9.8 mm. The largest shell measured is 20 mm long and 20.5 mm high.

Ligament external, about 4 mm long in the holotype, seated on a narrow, slightly roughened nymph, bordered by a narrow, sharply impressed ligamental groove. Cardinal teeth three in each valve. Anterior cardinal in left valve thin, prominent, weakly bifid, slightly oblique forward; medial cardinal thick, weakly bifid, slightly oblique backward; posterior cardinal thin, rather long, strongly oblique, slightly arched in trend. The medial separating socket is trigonal, of medium width, profound; posterior socket long, wide, trigonal, slightly arched above; in front of the anterior cardinal is a narrow socket. Anterior left lateral long, thick, and rugose at posterior end, becoming thinner and smoother anteriorly along its curved trend, ending a little past the middle of the anterior adductor scar. Posterior left lateral long, narrow, extending from the end of the ligamental groove in a broad curve nearly past the posterior adductor scar. Anterior right cardinal thin, oblique; medial cardinal thick, weakly bifid;

posterior cardinal long, thick, oblique, weakly bifid; well-developed claspers receive the long lateral teeth of the left valve. When viewed with sufficient magnification in a strong light, very fine transverse striations may be seen on the sides of the laterals of both valves of some shells. Adductor scars small, subequal, not deeply impressed. Pallial line slightly punctate in adults; pallial sinus trigonal, rising steeply, moderately deep, narrowly rounded on inner end. Inner margin smooth.

In many well-preserved specimens from several closely associated concretions restricted to a thickness of about 1 foot in stratigraphic position, there is a considerable individual variation in outline and in the position of the beak, which ranges from slightly in advance of midlength to well forward; the outline varies from subequilateral-trigonal to slightly elongate subovate, the latter feature produced by a noticeable posteroventral extension of the shell.

The genus is represented in Maryland in the Larry G. Hammond well no. 1 of the Ohio Oil Company, 6 miles east of Salisbury, Wicomico County, at a depth of 1,588 to 1,603 feet, by the nearly related species *Fulpia wicomicoensis* (Richards) (1947, p. 35). (See also Stephenson, 1946, pp. 69-71; 1949, in Anderson and others, p. 125.)

Types.—Holotype, U.S.N.M. 103862; 2 figured paratypes, U.S.N.M. 103863; 20 selected unfigured paratypes, U.S.N.M. 103864; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, 3.5 miles northwest of Fulp, Fannin County.

Occurrence.—Tarrant County: Locs. 14, 16, 20, 22, 25, 27, 34 (includes 1 figured paratype), 35, 47, 54; Denton County: loc. 75; Cooke County: loc. 98; Grayson County: locs. 115, 117, 132, 133, 134, 135, 219, 223; Fannin County: locs. 179, 180, 184 (holotype, 5 figured paratypes, 18 selected unfigured paratypes), 186, 191, 195; Lamar County: loc. 201; Red River County: loc. 209.

Range.—Dexter member to Templeton member.

Fulpia? sp.

Three medium-sized shells, very poorly preserved and mechanically distorted, from the Lewisville member, 3.4 miles N. 15° E. of center of Savoy, Fannin County (loc. 186), are referred questionably to *Fulpia*. The shell appears to be broadly ovate in outline, probably a little longer than high, moderately convex, inequilateral, equivalve. Beaks prominent, incurved, prosogyrate, situated near midlength. No indication of a line delimiting a lunule can be detected on the corroded shell. The surface as exhibited on one corroded specimen, appears smooth on its umbonal half and coarsely sculptured concentrically on its ventral half. The approximate dimensions of the largest specimen are: Length 29 mm, height 27 mm, thickness 18+mm. The hinge as partly preserved on one right valve presents three well-developed cardinals separated by deep sockets; the anterior cardinal is simple; the medial cardinal is a little thicker than the anterior one and is weakly bifid; and the posterior cardinal is pro-

portionately thin and oblique. The laterals are not preserved. The largest of the three specimens is larger than the largest available shell of *Fulpia pinguis*, but closely resembles that species in form. U.S.N.M. 105342.

Genus **DENTONIA** Stephenson, n. gen.

Type species: *Cytherea leveretti* Cragin.

Etymology: Named for John B. Denton, a pioneer settler, for whom Denton County and Denton town were named.

The distinguishing features of this genus include: moderately plump form; broadly subovate to subtriangular outline; a moderately long and broad lunule bounded by a weakly impressed to obscure line; a weak umbonal ridge bounding a moderately steep posterodorsal slope on which the concentric growth lines are a little sharper and coarser than on the main surface; a long external ligament; three cardinal teeth in each valve, of which the two posterior ones in the right valve, and the two anterior ones in the left valve, are more or less distinctly bifid; well-developed, short, single anterior and posterior laterals in the left valve that fit into corresponding claspers on the right valve; the anterior lateral dentition closer to the beaks than the posterior; transverse striations wanting on the laterals; pallial line showing a slight indentation, scarcely a sinus, near the posterior adductor scar.

This shell appears to be related to *Corbiculopsis* Whitfield (1891, p. 408) from the Cretaceous (Aptian) of Syria, but Whitfield's type species, *C. viridi*, is a much more elongated species, lacking a defined lunule and possessing three teeth in each valve, none of which, as described, is bifid. The two posterior teeth of Whitfield's right valve, as figured, may, however, be one bifid tooth. His figure also seems to show a much narrower hinge plate in front of the cardinal teeth of the right valve, and the hinge elements are conspicuously stretched out in their spacing.

There is also a relationship between this shell and *Corbicula* (*Batissa*?) *hamlini* Whitfield from the Cretaceous (Aptian) of Syria (Whitfield, 1891, p. 407). As in *Dentonia*, the posterior and medial cardinal teeth of the right valve of *hamlini* are bifid, and in the left valve the medial cardinal is bifid and the anterior cardinal appears also to be narrowly bifid. However, in *hamlini* the anterior lateral dentition is narrower, more extended, and approaches the cardinals more closely than does the lateral dentition of *Dentonia*.

Batissa Gray (1853, p. 38) to which *hamlini* is questionably referred by Whitfield, is based on *Batissa tenebrosa* Gray (designated by Stoliczka, 1870-1871, p. xviii), a Recent species inhabiting the fresh and brackish waters of the Fiji Islands. It is sufficiently different in its dentition to justify its generic separation from *Dentonia*; the weight, spacing, and direction of its teeth are quite different and the lateral teeth and sockets are striated.

A Recent species having a form similar to and dentition remarkably like that of *Dentonia* is *Polymesoda caroliniana* (Bosc), a fresh- and brackish-water bivalve living adjacent to the Atlantic and Gulf Coast from the Carolinas to Mexico (see Rafinesque, 1820, Ann. Gén. Sci. Phys., vol. 5, p. 319, Bruxelles); it has three teeth of similar size and spacing in each valve, with corresponding weakly bifid teeth, and the laterals are non striated. The Recent species differs, however, in that it does not have a lunule and does have a narrow, ascending pointed pallial sinus of moderate length.

The species from the Eocene of the Paris Basin figured by Cossmann and Pissarro (1904-1906, pl. 13, figs. 57-6 and 6') under the names *Cyrena compressa* Deshayes and *Cyrena compressa* var. *charpentieri* Deshayes, appear to be congeneric with *Dentonia*.

Dentonia leveretti (Cragin)

Plate 24, figures 23-27

1893. *Cytherea leveretti* Cragin, Texas Geol. Survey, 4th Ann. Rept. for 1892, p. 182.

Shell medium to large, thick-walled in adults, moderately convex, subovate, subtriangular in outline, inequilateral, equivalve; there is a weakly developed umbonal ridge, between which and the posterior and posterodorsal margins is a broad, shallow radial depression. Lunule wide and long, not sunken, and represented on each valve only by a very faintly impressed, obscure limiting line. Escutcheon wanting. Beaks of moderate prominence, incurved, slightly separated, prosogyrate, situated about one-fourth the length of the shell from the anterior extremity. Anterodorsal margin broadly arched; anterior margin a little more narrowly rounded than a half circle; ventral margin broadly rounded; posterior margin rather sharply rounded below, becoming subtruncated and inclined forward above, rounding regularly into the broadly arched posterodorsal margin. Surface marked only by sharp and somewhat irregular, rather fine concentric growth lines and ridges, which become a little coarser toward the margin and considerably coarser on the posterodorsal slope; on the lunule these ridges become sharper, more regular, and more closely crowded.

Dimensions of the largest and best-preserved of the four cotypes: Length 40 mm, height 35 mm, thickness 22 mm. This is the larger of the two specimens measured by Cragin.

Ligament external, opisthodontic, long, lanceolate, being about two-fifths as long as the shell. Hinge of left valve with three cardinals; anterior cardinal thick in the adult stage, faintly bifid, and nearly direct; median cardinal thick, bifid, a little oblique backward; posterior cardinal entire, long, thin, strongly oblique; of the two sockets separating these teeth the anterior one is deep and narrow and the posterior one is deep, long, oblique, and much wider than the anterior one. Anterior

lateral not distant from the cardinal area, short, strong; posterior lateral more than twice as distant as the anterior one, a little longer, and of moderate prominence and thickness. Transverse striations are wanting on the sides of the lateral teeth. Right valve with three cardinals; the anterior one of medium thickness and nearly direct; the middle one of medium thickness and faintly bifid; and the posterior one longer, oblique, thick, and distinctly bifid. Each pair of claspers is separated by a deep socket for the reception of the lateral tooth of the left valve; in each pair the inner element is thick and strong, the outer element weak and close to the margin. Inner margin smooth. The adductor scars are situated rather high in the shell, the posterior one being considerably larger than the anterior one. The impression of part of the pallial line is observable on one internal mold and shows a shallow indentation at the position of the pallial sinus.

Attention is called to the similarity of this species to *Cyrena compressa* Deshayes, from the Eocene (Lutetian) of the Paris Basin, France. (See Cossmann and Pissarro, 1904-1906, pl. 13, figs. 57-6.)

The species is represented in the collections by about 75 specimens, all but 5 of which came from Timber Creek, southwest of Lewisville, Denton County. Several good specimens were found as far to the northeast as western Fannin County.

Types.—Four cotypes at Austin, Tex.: One in the laboratory of the Bureau of Economic Geology, collected by Robert T. Hill and Storer Leverett on "Timber Creek, about 2 miles below [above?] the old Dallas-Lewisville road, Denton County"; 3 in the laboratory of the Department of Geology of the University of Texas (1 here figured), collected by Hill from the same locality. (See plastotypes of 2 cotypes, U.S.N.M. 105347, 105348.) One plesiotype, U.S.N.M. 105343; 2 plesiotypes (topotypes), U.S.N.M. 105344a-b; 11 topotypes, unfigured, U.S.N.M. 105345; 11 topotypes unfigured, U.S.N.M. 105346.

Occurrence.—Denton County: Locs. 71, 72, 73 (13 topotypes, 2 figured), 74, 75, 76 (includes 1 plesiotype), 78 (11 selected topotypes from, at, or near type locality, unfigured), 79, 81, 84; the cotypes from Timber Creek.

Grayson County: Locs. 132, 135, 142; Fannin County: loc. 185.

Range.—Lewisville member.

Superfamily CARDITACEA

Family CARDITIDAE

Genus VENERICARDIA Lamarck, 1801

Type species: *Venus imbricata* Gmelin, from the Eocene of the Paris Basin.

One species in the Woodbine fauna is here named *Venericardia alveana*. Although the hinge of this species possesses all the principal elements of that of *V. imbricata*, the type species, it is not strictly typical. Comparison of the two hinges shows that in *V. alveana* the cardinal teeth are turned a little more to the front, in consequence of which the hinge presents the following differences: The large cardinal tooth below the beak in the right valve is shorter and more direct; the

deep socket in front of this tooth is also shorter and broadly trigonal; the small weak tooth in front of this socket on the genotype is represented on *V. alveana* only by a small protuberance just below the margin of the shell at the lunule; the hinge of the left valve shows corresponding differences. In addition to these differences, *V. alveana* has a very small, short anterior lateral tooth just below the anterior end of the lunule of the left valve, and this lateral fits into a small but distinct socket in the right valve, a feature that is wanting in *V. imbricata*.

Compared with the Recent *Chama calyculata* Linné, the genotype of *Cardita*, from the coast of southern Africa, the hinge of *V. alveana* is very much shorter; the large cardinal below the beak on the right valve of *C. calyculata* is greatly elongated, more so than in *Venericardia imbricata*, and is bipartite, including a long, oblique posterior element and a short, nearly direct, anterior one; the two elements are joined below the beak, and on the crest of the tooth at this junction are several tiny notches. In outline, form, and ornamentation *C. calyculata* contrasts strongly with *V. alveana*, being a greatly elongated, mytiloid shell with rather coarse, more or less irregular, radial ribs.

The hinge differences that separate *Venericardia* and *Cardita* are not very pronounced and, as judged by a comparison of the type species, appear to consist mainly of differences in hinge mechanism caused by the great elongation of the shell of *Cardita* and its pronounced inequilateral outline.

Venericardia alveana Stephenson, n. sp.

Plate 23, figures 7-11

This neat species was found at only one locality, in the bed of Red River near old Slate Shoals, Lamar County. In recent years this locality has been covered by the shifting sands of Red River and is no longer accessible. The shells were present in considerable numbers, some in a fair state of preservation.

Shell small, thick-walled, moderately convex, sub-trigonal in outline, equivalve, inequilateral. Beaks prominent, strongly incurved, prosogyrate, approximate, situated well in advance of the midlength. Lunule small, bulging centrally, bounded by a deeply impressed groove V-shaped in cross section. Escutcheon narrow, somewhat sunken, rather obscure on some shells. Anterior margin regularly rounded; ventral margin broadly rounded; posterior margin sharply rounded below, subtruncated above, rounding broadly into the posterodorsal margin. Surface ornamented all over with about 26 round-crested, rugged ribs separated by interspaces of equal or narrower width, the wider interspaces being toward the front. Well-preserved shells exhibit low, closely spaced, round-topped concentric ridges that override the radials; the surface of many shells is more or less damaged by corrosion.

Dimensions of the holotype, a specimen with both valves in place: Length 10 mm, height 9 mm, thickness 7.6 mm. The largest measured shell in the collection is 12 mm long.

Ligament external, opisthodic, arched upward in trend, about 3 mm long in adults; ligamental groove narrow, shallow; nymph thick on right valve, thin on left valve. Hinge of left valve with a small, prominent, trigonal cardinal tooth below the beak, striated in the direction of movement on the posterior side, separated from the thick margin of the lunule above by a moderately deep, horizontal channel that curves downward in front of the tooth; posterior cardinal obliquely elongated about parallel to the margin, moderately thick, transversely striated in the direction of movement; the socket between the two cardinals is profound, trigonal, elongated backward and downward; between the posterior cardinal and the ligamental groove is a long, shallow socket; a tiny, short, narrow lateral tooth lies just below the terminus of the groove bounding the lunule; toward the end of the escutcheon near the margin is a shallow channel bordered by low ridges or pseudoclaspers into which fits a corresponding part of the margin of the right valve. On the right valve a prominent, trigonal, pointed cardinal tooth lying below the beak is somewhat elongated backward along the interior margin, and is finely striated in the direction of movement on both its anterior and posterior faces; back of the cardinal is an elongated, narrow, profound oblique socket, bordered above by a long, narrow, nonprominent posterior cardinal that merges with the nymph; in front of the medial cardinal is a short, trigonal profound socket; on the upper side of the anterior socket below the margin of the lunule is a small protuberance, probably a rudimentary anterior cardinal; just below the end of the furrow bordering the lunule is a short, shallow channel parallel to the margin into which fits the tiny anterior lateral of the left valve. Adductor scars relatively large, subequal; just above and slightly back of the anterior scar is a small retractor scar. Pallial line simple. Inner margin crenulated, the indentations adjoining the ends of the exterior ribs.

Types.—Holotype, U.S.N.M. 105349; 1 figured paratype, U.S.N.M. 105350; 40 paratypes, unfigured, U.S.N.M. 105351; 1 paratype, figured, U.S.N.M. 105352; 1 figured paratype, U.S.N.M. 105353; 3 unfigured paratypes, U.S.N.M. 105354; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: loc 201 (holotype and 46 paratypes, 3 figured).

Range.—Templeton member.

Superfamily LUCINACEA

Family LUCINIDAE

Genus LUCINA Bruguière, 1797, *sensu lato*

Type species: *Venus pennsylvanica* Linné (= *Lucina pennsylvanica* (Linné)). Recent, in the waters adjacent to the Bahamas and Florida.

The small species of Cretaceous shells here referred to *Lucina* have both the cardinal and lateral dentition well developed. They differ from *Lucina pennsylvanica* (Linné) in that the anterior lateral dentition is more distantly removed from the cardinal area, the pronounced groove delimiting the posterodorsal area is wanting, the lunule is narrower and not so sharply grooved on the boundary, the concentric ornamentation as preserved is less sharp and regular, and there are other minor differences.

Lucina dentonana Stephenson, n. sp.

Plate 24, figures 13, 14.

Shell small, subcircular in outline, depressed convex, slightly inequilateral, equivalve. Beaks small, slightly prominent, slightly prosogyrate, situated a little back of midlength. Lunule narrow, deep, delimited by an angular outer margin. Escutcheon wanting. A broad, very shallow posterodorsal depression extends from the beak to the posterior margin; this depression is not separated from the main shell surface by either a ridge or a groove. The surface in the umbonal area is ornamented with sharp, thin, somewhat irregularly spaced ridges, which have been largely removed by corrosion; outwardly the rest of the surface presents rather conspicuous, closely crowded growth lines and narrow ridges, which also have suffered from corrosion.

Dimensions of the holotype, a left valve: Length 10.1 mm, height 10 mm, convexity 2.5 mm.

Ligament external, narrow, about 3 mm long in the holotype; groove narrow, sharply incised. Hinge with well-developed dentition. Cardinal teeth of left valve two, separated by a profound socket of moderate width. The anterior tooth is thick, nearly direct, and appears to be obscurely bifid; in front of this tooth is a small, rather shallow, triangular socket. The posterior cardinal is long, narrow, oblique, and is bordered behind by a narrow, shallow, oblique channel. Distant from the cardinal area is a thick, short, anterior lateral tooth, separated from the margin by a wide, deep socket. Equally distant posteriorly from the cardinal area is a pair of thick, short claspers, separated by a deep socket. Inner margin smooth. Other internal features not uncovered.

Types.—Holotype, a left valve, U.S.N.M. 105360; 2 poor internal molds (paratypes) and some fragments of shell, U.S.N.M. 105361; all from the Lewisville member on Timber Creek, a few hundred yards below the first or upper bridge, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Loc. 75 (types); Grayson County: locs. 135, 154; Lamar County: loc. ?201.

Range.—Lewisville member to Templeton member.

Lucina aspera Stephenson, n. sp.

Plate 24, figures 15, 16

Shell small, thick-walled, subcircular in outline, strongly convex for the genus, slightly inequilateral, probably equivalve. Beaks prominent, incurved prosogyrate, situated about midway of the length. Lunule small, moderately sunken, obscurely outlined as preserved. Escutcheon wanting. Posterodorsal slope obscurely excavated. Surface marked by fine growth lines and rendered rugged on the holotype by seven irregularly spaced, pronounced resting stages, the edge of each of which is marked by fine crenulations like those on the inner margin of the shell. Surface further marked by numerous, obscure radial ribs.

Dimensions of the holotype, a right valve, the only available specimen: Length 5.4 mm, height 5.5 mm, convexity 2.4 mm.

Ligamental groove external, short, very narrow. Hinge with well-developed dentition. On the right valve one thick, short, nearly direct cardinal tooth lies below the tip of the beak. In front of the cardinal is a deep socket of moderate width, bordered above by the rather thick margin of the lunule; behind the cardinal is a longer oblique, trigonal, much shallower socket. At a moderate distance from the cardinal area is a short, thick anterior lateral tooth, which is separated from the margin of the shell by a narrow, outwardly curved channel. At a slightly greater distance from the cardinal area is a short posterior lateral that is not perfectly preserved. Inner margin of shell crenulated, each protuberance marking the end of a rib on the outer surface of the shell. Anterior adductor scar elongated downward and inward away from the pallial line in the manner typical of the lucinoid group. Posterior adductor not clearly uncovered.

Types.—Holotype, a right valve, U.S.N.M. 105362; from borrow pit north of road 2.2 miles west of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 207.

Range.—Templeton member.

Unidentified specimens of *Lucina*

A pyritiferous concretion, weathered to brown limonitic oxide on the surface but unweathered in the interior, from the Lewisville member on Timber Creek, Denton County (loc. 72), contains many poorly preserved imprints and shells replaced by iron oxide, all belonging to *Lucina*. As partly preserved on some specimens the concentric ribs are narrow and are crenulated on their crests. The largest imprint is about 13 mm long and 12 mm high. This species is comparable in size to *Lucina dentonana*, but is more strongly ribbed and appears to be more strongly inflated. U.S.N.M. 105363.

Two internal molds of left valves of *Lucina*, from

the Templeton member in a pit north of road, 2.2 miles west of Arthur City, Lamar County (loc. 207), are specifically indeterminate. The larger mold is radially striated, the anterior adductor scar in both molds is elongated and diverges from the pallial line below, and the inner margin is finely crenulated. The larger mold measures: Length 8.3 mm, height 7.4 mm. U.S.N.M. 105364.

An internal mold of a small *Lucina* (about 6 mm long), with some shell material adhering, in dark-gray shale of the Templeton member from a dug well at Chicota, Lamar County (loc. 200), presents irregular concentric ridging and is crenulated on the inner margin. It is too imperfect for specific identification. U.S.N.M. 105365.

Family MACTROMYIDAE?

Genus *SEXTA* Stephenson, n. gen.

Type species: *Sexta navicula* Stephenson.

Etymology: By anagram from Texas. Gender, feminine.

A small, somewhat elongate, thin-shelled, moderately plump bivalve with broad, rather prominent umbones and a sinuous, sharply defined umbonal ridge that is obtusely angular in cross section. Ligament external, opisthodontic. As seen in one right valve, there is no defined cardinal area. The hinge is thin, with one small cardinal tooth below the beak and a pair of short, distinct anterior lateral claspers, the interior element of which is the stronger. Posterior lateral dentition wanting. Adductor scars small, subequal, subcircular to broadly subovate. Pallial sinus obscure but apparently very small and shallow. Inner margin smooth.

The family position of this species has not as yet been satisfactorily determined. In its narrow hinge and small cardinal tooth the genus resembles *Mactromya* Agassiz (= *Unicardium* D'Orbigny), but it differs from that genus in its more elongated form, its angular umbonal ridge, and its well-developed anterior lateral dentition.

Sexta navicula Stephenson, n. sp.

Plate 24, figures 20-22

Shell small, thin-walled, subtrapezoidal in outline, plumply inflated, inequilateral, equivalve. A sharply defined, subobtusely angular umbonal ridge extends to the lower posterior end, and between this and the posterodorsal margin is a broad, shallow, radial depression. Dorsal margin broadly arched; anterior margin regularly and more narrowly rounded than a semicircle; ventral margin broadly rounded; posterior margin subtruncated above the end of the umbonal ridge, joining the posterodorsal margin in a very broad subobtuse angle. Beaks broad, moderately prominent, incurved, prosogyrate, approximate, situated about three-tenths

the length of the shell from the anterior extremity. Lunule wanting. Escutcheon long, narrow, lanceolate. The surface presents fine, concentric growth lines and very gentle, narrow undulations; very obscure radial lining is present on the posterodorsal slope. Weak radial lining is also present on exposed patches of the internal mold.

Dimensions of the holotype: Length 22 mm, height 16 mm, thickness 11.4 mm. A large example, a right valve, measures: Length 27 mm, height 19 mm, convexity about 7 mm.

Ligament external, opisthodontic, set in a shallow groove about 5 mm long in the holotype. The hinge is very narrow. A small, short, but distinct, cardinal tooth is present in the right valve; the tooth is bordered in front by a rather deep, narrow, oblique slit or socket; above the slit the margin is modified to form a short, rather sharp upturned keel. On the figured right valve is a pair of distinct short anterior lateral claspers, the inner element of which is the longer and stronger. Posterior laterals wanting. Adductor scars small, subcircular to broadly subovate, subequal, situated high in the shell. Pallial line weakly impressed but apparently possessing a small, very shallow pallial sinus. Inner margin smooth.

Types.—Holotype, U.S.N.M. 105355; 1 figured paratype, U.S.N.M. 105356; 55 unfigured paratypes, U.S.N.M. 105357; all from a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Locs. 164, 165 (types), 167, 171.
Range.—Templeton member.

Sexta ethelana Stephenson, n. sp.

Plate 24, figures 17-19

This species is represented by two examples, a right and a left valve. In general form and surface features it is much like *Sexta navicula* except that it is much higher in proportion to its length. It possesses a sharply angular umbonal ridge, a narrow hinge, and a small cardinal tooth below the beak in the right valve. The anterior lateral claspers in the right valve are broken away, but the left valve shows a well-developed lateral tooth, which is separated from the margin by a narrow channel; this tooth is more elongated than the claspers in the right valve of *Sexta navicula*.

Dimensions of the holotype, a right valve: Length 24 mm, height 21.7 mm, convexity 7 mm.

Types.—Holotype, U.S.N.M. 105358; 1 figured paratype, U.S.N.M. 105359; both from a north-south road, 0.5 mile northwest of Ethel, Grayson County.

Occurrence.—Grayson County: Loc. 156.
Range.—Templeton member.

Superfamily **CARDIACEA**

Family **CARDIIDAE**

Genus **CARDIUM** Linné, 1758

Type species: *Cardium costatum* Linné, Recent, off north and west Africa. Designated by Children, 1923.

Subgenus **TRACHYCARDIUM** Mörch, 1853.

Type species: *Cardium isocardia* Linné, from West Indian waters. Designated by Martens (1869, p. 586). Original description, Mörch (1853, p. 34).

Cardium (*Trachycardium*) *tinninense* Stephenson, n. sp.

Plate 24, figures 1-7.

Shell of medium size, strongly inflated, subovate in outline, higher than long, inequilateral, equivalve. Beaks prominent, proportionately narrow, strongly incurved, prosogyrate, approximate, situated about centrally. Posterodorsal slope high, steep, slightly and broadly excavated. Umbonal ridge subobtuse in cross section, rounded on crest. Anterodorsal slope high, steep, becoming excavated toward beak. A very small, short lunule is limited outwardly by a pronounced groove. Anterior and ventral margins regularly rounded; posterior margin rather narrowly rounded below, long and truncated above, rounding into the inclined posterodorsal margin. The surface is largely covered with ribs, which number about 55 on the holotype and range from 55 to 65 on different specimens. All of the ribs are obscurely and irregularly noded and on all the specimens have the appearance of being more or less corroded. On the anterior half of the surface the ribs are squarish-topped and wider than the interspaces, the widest ribs being on the anterodorsal slope. On the posterior half the ribs are equal in width or narrower than the interspaces, the widest interspaces being just in front of the umbonal ridge. On the posterodorsal slope the ribs are small and many. In narrow areas bordering the antero- and posterodorsal margins of the holotype the ribs are obscure or wanting, but on some specimens very fine, weak ribs cover these surfaces to the margin; this accounts for the rather wide difference in the total number of ribs on different specimens, as stated above. More or less obscure granulation is present on the bottoms of most of the interspaces.

The dimensions of the holotype, a left valve of less than maximum size, are: Length 22 mm, height 27.4 mm, convexity 11.5 mm. The largest specimen measured is about 32 mm long.

The outer layer of the ligament is external, opisthodontic and short; the groove is narrow, deeply impressed, and borders a well-developed nymph. The inner layer of the ligament occupies a short shallow resilifer closely below the anterior end of the groove; this resilifer is somewhat sunken but is scarcely internal. Hinge dentition strongly developed and well preserved in some specimens. Left valve with two cardinals below the beak, the lower one of medium thickness, short, prominent, slightly up-hooked; back of this tooth is a profound socket wider than the tooth, and in front of it is a narrow shallow socket; above the deep socket is a thick, upraised rim, upon which the other, less prominent cardinal is situated. Above and slightly back of the

upper cardinal is the resilifer, already mentioned, on which the inner layer of the ligament was seated. Anterior lateral short, prominent, not distant. Posterior lateral longer, more distant, not prominent. Right valve with a prominent, thick, oblique posterior cardinal tooth. In front of this tooth is a small profound socket for the reception of the hooklike cardinal of the left valve. Above the deep socket is a small anterior cardinal tooth seated on the inner edge of the thickened margin of the shell; this tooth is separated from the posterior cardinal by a relatively shallow saddle or gap. The anterior lateral dentition consists of a pair of claspers in which the inner element is short and thick and the outer small and obscure, the two separated by a short, deep socket. The posterior dentition is longer, the inner element of the claspers being thick and strong and the outer one short and obscure; they are separated by a long deep socket. Adductor scars subtrigonal, the posterior one larger than the anterior one. Pallial line simple. Margin of shell serrated by intercostal notches.

Types.—Holotype, a left valve, U.S.N.M. 105366; 2 unfigured paratypes, U.S.N.M. 105367; 2 figured paratypes, U.S.N.M. 105368a-b; 13 paratypes, unfigured, U.S.N.M. 105369; 4 unfigured paratypes, U.S.N.M. 105370; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County. One figured paratype, U.S.N.M. 105371.

Occurrence.—Grayson County: Loc. 153 (1 figured paratype); Fannin County: locs. 186, 198; Lamar County: locs. 201 (holotype and 21 paratypes, 2 figured), 206, 229, 230.

Range.—Templeton member.

Genus *PROTocardia* Beyrich, 1845

Type species: *Cardium hillanum* Sowerby (1812, vol. 1, p. 41, pl. 14, fig. 1), from the Upper Greensand at Blackdown, England, listed from the zones of *Schloenbachia rostrata* and *S. varians* (Albian-Cenomanian). Original description of *Protocardia* Beyrich (1845, pp. 17-20).

Protocardia torta Stephenson, n. sp.

Plate 25, figures 15-17

Shell of medium size, thick-walled, subcircular in outline, moderately inflated, inequilateral due to a forward twist, equivalve; greatest inflation a little back of the midlength, well above the midheight. Anterodorsal slope steep, slightly excavated toward the beak; posterodorsal slope less steep, very slightly excavated toward the margin. Beaks moderately prominent, incurved, slightly prosogyrate, approximate, situated near midlength. The anterior and ventral margins are regularly rounded and the posterior margin is long and subtruncated, the posterodorsal margin is rather conspicuously humped. Lateral and anterior surface ornamented only with rather strong, irregular, concentric growth ridges and gentle undulations; posterodorsal slope covered with 10 or 12 low radiating costae, which are broad and separated by narrow interspaces on the upper slope, but which become progressively narrower and shorter toward the hinge margin.

Approximate dimensions of the holotype, a right valve: Length 35.6 mm, height 37 mm, convexity 13.5 mm.

Ligament external, short; groove narrow; nymph fairly well-developed. The hinge appears to be a little water-worn. The cardinal dentition on the right valve includes one large, prominent, triangular tooth below the beak, with a deep triangular socket in front of the tooth and a short, oblique, shallow socket above it, lying nearly parallel to the margin of the shell; above the deep socket the shell margin is thick. The anterior lateral tooth is distant from the cardinal area, is short and thick, bulging a little toward the interior; it is separated from the shell margin by a deep, rather wide socket. The posterior lateral is less distant, is short and thick, and is separated from the margin by a socket of moderate width and depth. The hinge of the left valve presents a large, prominent, triangular tooth with a shallow channel in front of it and a deep triangular socket behind it; above the socket is a thick, short, oblique, nonprominent cardinal. The anterior lateral is short, thick, and rather prominent and is separated from the margin by a narrow, shallow channel. The posterior lateral is submerged and nonprominent and is separated from the margin above it by a very shallow, narrow channel.

This species is related to *Protocardia tewana* (Conrad) from the upper part of the Comanche series of Texas but differs in outline and ornamentation, having a longer truncation on the posterior margin and finer concentric ribbing on the lateral surface and more weakly developed radial ribbing on the posterodorsal slope.

Types.—Holotype, a right valve, U.S.N.M. 105372; from Timber Creek, about 0.25 mile upstream from the third or lower bridge, 2.25 miles south-southwest of Lewisville, Denton County. One paratype, a left valve, U.S.N.M. 105373.

Occurrence.—Denton County: Locs. 81 (holotype), 84 (paratype), 91.

Range.—Lewisville member.

Protocardia timberensis Stephenson, n. sp.

Plate 25, figures 18-22

Shell of medium to large size, subtrigonal in outline, thick-walled, moderately inflated, inequilateral, equivalve; the anterodorsal slope is steep, rounding above into the lateral surface; posterodorsal slope abruptly steep, broadly excavated in the radial direction, the upper edge forming almost a right angle with the lateral surface. Beaks prominent, narrow, strongly incurved, nearly in contact, prosogyrate, situated a little in advance of midlength. Lunule and escutcheon wanting. Anterodorsal margin long, gently arched, steeply descending; anterior margin rather sharply rounded in the earlier stages, becoming broadly rounded in adults; ventral margin broadly convex; posterior margin in-

complete but apparently subangular below at the extremity, truncated above; posterodorsal margin arched. Lateral and anterodorsal surfaces marked by concentric lines that become rather coarse toward the margin; a few fine, obscure radial lines can barely be detected on the anterodorsal slope. The posterodorsal slope of the holotype is ornamented with about a dozen closely spaced, nonprominent ribs, which are strongest centrally and become weaker and fade out on the one hand toward the upper margin and on the other toward the angle of the slope with the lateral surface. The posterodorsal slope of the paratype is badly corroded and partly broken away and shows no radial lines.

Dimensions of the incomplete holotype, a right valve: Length 39+ mm, height 41+ mm, convexity 26 mm. The large paratype is 65+ mm high and about 44 mm thick.

The features of the hinge are best seen in the paratype, both valves of which are present, though incomplete in the posterior and posteroventral parts. Ligament external, of moderate length, set in a deep, sharply incised groove. Nymph well developed. Hinge of right valve with two cardinal teeth, the anterior one weak, nonprominent, not well preserved, the posterior one prominent, oblique toward the rear, of medium thickness, the two separated by a narrow, deep socket; between the posterior cardinal and the nymph is a strongly oblique socket of medium depth. The anterior lateral dentition consists of a distant pair of claspers, the inner element of which is short, rugged, and prominent and the outer of which is weak and fused against the inner marginal wall, the two separated by a profound, wide socket. Hinge of left valve with two cardinal teeth, the anterior one short, prominent, rather thin, almost pointed, slightly oblique, the posterior one long, oblique, weak, nonprominent, fused against the margin, the two separated by a rather wide, profound socket. The anterior lateral is distant, short, prominent, pointed and is separated from the margin by a narrow, shallow socket. The posterior lateral dentition is broken away on both valves of the paratype, but the holotype, a right valve, exhibits a short, narrow, nonprominent, lateral tooth, separated from the margin by a narrow channel and situated about as far from the beak as the anterior lateral dentition. The adductor scars and the pallial line are not uncovered on the types.

The greater convexity, the angular umbonal ridge, the finer radial ribbing, and the excavated surface of the posterodorsal slope of this species serve to distinguish it clearly from *Protocardia torta*.

The species described by Cragin (1894, p. 7), and later by Twenhofel (1924, p. 83), under the name *Roudaria quadrans*, from the Kiowa shale of Kiamichi (Comanche) age near Belvidere, Kiowa County, Kans., is a *Protocardia* similar to *P. timberensis*. The latter differs in that the lateral umbonal area broadens out

a little more rapidly, and the concentric sculpture is not quite so coarse.

Types.—Holotype, U.S.N.M. 105374; 1 figured paratype, U.S.N.M. 105375; both from near the mouth of a small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton County.

Occurrence.—Tarrant County: Loc. 44; Denton County: locs. 74, 79 (type locality), 91 (the first two localities may be the same).

Range.—Lewisville member.

Unidentified specimens of *Protocardia*?

A poorly preserved internal mold of a left valve of *Protocardia*? in sand matrix, with some shell material adhering, from the Lewisville member on Walnut Creek, 4.5 miles northeast of Mansfield, Tarrant County (loc. 43), shows rather coarse concentric ribbing, with several obscure radial markings at one end, and is questionably referred to *Protocardia* Beyrich. The concentric ribs are coarser than those on *P. torta*. The shell is 33+ mm long, 35 mm high, and has a convexity of 9 or 10 mm. U.S.N.M. 105376. An incomplete external mold of a *Protocardia* from 2 miles east of Whitney, Hill County (loc. 3), may belong to the same species; the concentric ribbing is well preserved (pl. 25, fig. 14). U.S.N.M. 105377.

Two small internal molds, right and left valves, having a form suggestive of *Protocardia timberensis*, in ferruginous sandstone, from the Dexter member at roadside exposure, 5.5 miles east-northeast of Roanoke railroad station, 3.5 miles south by west of Bartonville, Denton County (loc. 57), are questionably referred to *Protocardia*. The surface features are not preserved. Dimensions of the larger mold: Length 10 mm, height about 8.5 mm, convexity about 3.5 mm. U.S.N.M. 105378.

Superfamily ISOCARDIACEA

Family ISOCARDIIDAE

Genus ISOCARDIA Lamarck, 1799

Type species: *Chama cor* Linné, 1767 (= *Cardium humanum* Linné, 1758). (Linné, 1758, ed. 10, p. 682.) Recent, in European seas.

The available material here referred to *Isocardia* Lamarck does not afford well-preserved hinges, but enough can be seen to show that the specimens possess the essential dental elements of that genus. There are two elongated lamelliform teeth in each valve, separated by corresponding sockets. Distant short, weakly developed posterior laterals are also present. Irregularities seen in several hinges appear to be pathologic abnormalities. The relationship to *Isocardia* is further shown by the presence of a closely compressed fissure undercutting each umbo from the cardinal margin at the anterior end of the ligament around to the tip of the strongly twisted beak.

Isocardia slatana Stephenson, n. sp.

Plate 25, figures 8-13

Shell of medium size, strongly inflated, subtrigonal in outline, inequilateral, equivalve. Beaks very prominent, narrow, strongly incurved, strongly prosogyrate, with tips curving away from each other. Lunule very broad, relatively short, not sunken, and limited outwardly by a narrow, slightly impressed line. Escutcheon wanting. Anterodorsal slope steep, excavated; posterodorsal slope steep, overhanging the shell margin. Surface smooth with the exception of fine growth lines; fine radiating lines appear on some corroded portions of the surface.

Approximate dimensions of the holotype, an internal mold with the shell adhering over a considerable part of the surface: Length 28.5 mm, height 32 mm, thickness 24.5 mm. The available material indicates some individual variation in form, some shells being a little higher in proportion to their length than others.

Ligament external, narrow, about 9 mm. long in the holotype, set in a deep groove. Hinge of right valve not uncovered. Hinge of left valve incompletely preserved in two specimens. The broken surfaces seem to indicate an irregular, horizontally elongated, perhaps pathologic anterior cardinal tooth with a short, shallow, trigonal socket below it; above and back of this cardinal is a profound, elongated socket that curves broadly downward toward the rear; above and back of this socket is a narrow, elongated, prominent posterior cardinal, arched in trend, paralleled above by a long, narrow channel. Poorly preserved impressions indicate the presence of a short distant lateral tooth in each valve. Adductor scars small, subequal, elongated. Surface of internal mold covered with fine obscure to distinct radiating lines.

Types.—Holotype, U.S.N.M. 105379; 5 unfigured paratypes, U.S.N.M. 105380; all these are from the Templeton member near old Slate Shoals, Red River, Lamar County. Three paratypes, figured, U.S.N.M. 105381a-c; 1 paratype, unfigured, U.S.N.M. 105382.

Occurrence.—Hill County: Loc. ?3; Grayson County: loc. 152 (4 paratypes, 3 figured); Lamar County: locs. 201 (holotype and 5 unfigured paratypes), 203, 207.

Range.—Lewisville member (?); Templeton member.

Isocardia slatana parva Stephenson, n. var.

Plate 24, figures 8-12

This variety is represented by many individuals at its type locality. In form and surface features the variety appears to be essentially like the typical species but is consistently much smaller. The holotype is 15.7 mm long, 16.5 mm high, and 13.7 mm thick. The largest shell among the numerous paratypes, and the only one that approaches the dimensions of the typical species, is approximately 25 mm long and 24 mm high. The ligament is external and is about 5 mm long on the

holotype. Poorly preserved hinges show two elongated, lamelliform cardinal teeth and one distant, weak posterior lateral tooth in each valve.

Types.—Holotype, U.S.N.M. 105383; 2 figured paratypes, U.S.N.M. 105384; 20 selected unfigured paratypes, U.S.N.M. 105385; all from a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Locs. 163, 164, 165 (types), 171.

Range.—Templeton member.

Superfamily VENERACEA

Family VENERIDAE

Genus CALLISTINA Jukes-Browne, 1908

Type species: *Venus planus* Sowerby (well illustrated by Woods, 1908, vol. 2, pt. 5, p. 192, pl. 30, figs. 1-6) from the Upper Greensand (Albian) of Blackdown, England. Original description of *Callistina* (Jukes-Browne, 1908, p. 156).

Callistina Jukes-Browne, though closely related to *Aphrodina* Conrad (1869a, p. 246), differs in the following features: The anterior cardinal tooth of the right valve is much less oblique and the socket separating this tooth from the medial cardinal is much narrower; in *Aphrodina* this socket communicates freely by means of an open canal with the anterior lateral socket, whereas in the typical *Callistina* the anterior cardinal stands between the two sockets, which are completely separated from each other. In *Callistina* the pallial sinus is wider, shorter, and more trigonal than in *Aphrodina*. In both genera (typical) the long posterior cardinal of the right valve is widely bifid and the anterior lateral dentition is rugose. In the Woodbine species here referred to *Callistina* the anterior cardinal socket and the anterior lateral socket of the right valve are not quite so completely separated from each other as they are in the typical form, and the anterior cardinal of the left valve is faintly bifid; in all other features the species are closely like *Callistina*.

Callistina lamarensis (Shumard)

Plate 25, figures 1-7

1860. *Cytherea lamarensis* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 600. (Figured by White; see below.)
1883. *Cytherea lamarensis* Shumard. White, U. S. Geol. and Geog. Survey Terr. 12th Ann. Rept. for 1878, pt. 1, p. 39, pl. 18, figs. 4a, b (reproduction of unpublished drawing prepared by Shumard).
- ?1893. *Cytherea lamarensis* Shumard. Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 181. (Questionably in part.)
1928. *Meretrix lamarensis* (Shumard). Adkins, Texas Univ. Bull. 2838, p. 164.
1951. *Callistina lamarensis* (Shumard). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, fig. 7 (following p. 163).

Shell small for the genus, subovate in outline, moderately inflated, considerably longer than high, inequilateral, equivalve. Lunule of moderate length and

breadth, scarcely sunken, circumscribed by a fine, neat line. Beaks nonprominent, strongly incurved, prosogyrate, approximate, situated one-fourth or one-fifth the length of the shell from the anterior extremity. Anterodorsal margin descending, straight; anterior margin rather sharply rounded, fullest above; ventral margin broadly rounded; posterior margin less sharply rounded than the anterior margin, fullest below, rounding into the broadly arched posterodorsal margin. Surface nearly smooth, presenting only very fine growth lines and very gentle undulations, with widely spaced resting stages.

Dimensions of the neotype, a specimen with both valves intact, cut by a thin calcite vein: Length 20.3 mm, height 16 mm, thickness 10.6 mm.

Ligament external about 9 mm long in the neotype; groove narrow, deep; nymph narrow, plain. Hinge narrow. Cardinals three in each valve. Anterior cardinal of left valve of medium thickness, nearly direct downward, weakly bifid; medial cardinal thick, erect on rear side, sloping to the front; posterior cardinal strongly oblique, long, thin, slightly arched; the anterior of the two separating sockets is deep, trigonal, wide externally, narrow at bottom; the posterior socket is deep, long, trigonal, and strongly oblique; in front of the anterior cardinal is a deep socket of medium width. Anterior lateral short, thick, strongly rugose. No posterior lateral present. Anterior cardinal of right valve thin, nearly direct; medial cardinal thick, slightly oblique backward, erect on front side, sloping to the rear; posterior cardinal long, strongly oblique, moderately thick centrally, strongly bifid; separating sockets deep, trigonal, of medium width; back of and above the posterior cardinal is a long narrow socket of medium depth. In front of and near the cardinal area is a weak pair of claspers separated by a rugose socket; the inner element of the claspers is the thicker of the two. Evidence of a narrow posterodorsal marginal groove is obscurely seen in one right valve, but there is no lateral dentition proper along this margin. Pallial sinus of medium size, rather wide, subtrigonal, rising steeply, a little rounded on the inner end. Adductor scars subequal. Inner margin smooth.

The species described as *Aphrodina marina* Stephenson (1936, p. 393), from a boulder brought up in a fisherman's trawl from a depth of 200 fathoms, on Banquereau Bank off Nova Scotia, is a closely related species of about the same size and form, but having a more sharply developed concentric sculpture.

Types.—Shumard's type material is lost. It was collected from "septaria of the marly clay * * *, Red River, Lamar County." Drawings of one of the types, prepared by Shumard, and reproduced by White, are also reproduced in the present paper (Pl. 25, figs. 6, 7). Selected neotype, U.S.N.M. 105386; 1 figured example, U.S.N.M. 105387; 2 figured examples, U.S.N.M. 105388a-b; more than 20 selected unfigured examples, U.S.N.M. 105389.

Occurrence.—Grayson County: Locs. 154, 156, 162, 164, 165; Lamar County: locs. 200, 202, 203, 207 (neotype, 3 figured specimens, and selected specimens), 228, 231.

Range.—Templeton member.

Subgenus *LARMA* Stephenson, n. subgen.

Type species: *Callistina (Larma) munda* Stephenson.

Etymology: By anagram from Lamar, the name of the county in which the genotype was found.

Larma differs from the typical *Callistina* in that the anterior lateral dentition is smooth instead of rugose and is more completely separated from the anterior cardinal socket, and the long, oblique posterior cardinal tooth of the right valve is narrower and not so deeply bifid.

Callistina (Larma) munda Stephenson, n. sp.

Plate 26, figures 14-19

Shell of medium size and thickness, not strongly inflated, subtrigonal in outline, inequilateral, equivalve; there is a noticeable individual variation in the proportion of length to height, but all specimens are longer than high. Beaks of medium prominence, incurved, prosogyrate, approximate, situated about three-tenths the length of the shell from the anterior extremity. Lunule narrow, of medium length, moderately impressed, circumscribed by a sharply impressed groove. Anterodorsal margin descending, straight or slightly arched; anterior margin more narrowly rounded than a half circle; ventral margin broadly rounded; posterior margin rather sharply rounded below, rounding above into the broadly arched posterodorsal margin. Surface of well-preserved specimens polished, covered with conspicuous concentric ridges of unequal width and strength; superimposed on the ridges are many, very fine growth lines. Individual variation in the coarseness of the ribs is noticeable. The larger ribs are asymmetrical in cross section, with the long slope below, and there is a tendency for the broader ribs to break up into smaller ribs as they approach the posterior end. Fine, obscure, irregular radial lining may be seen on the umbonal and posterior slopes of some well-preserved shells, including the holotype.

Dimensions of the holotype, a right valve: Length 36 mm, height 30 mm, convexity 10 mm.

Ligament about 14 mm long in the holotype, broadly arched in trend; groove narrow, sharply incised; nymph narrow, plain. Hinge plate narrow, sinuous on lower edge. Cardinal teeth, three in each valve. Anterior cardinal of left valve nearly vertical, of medium thickness, weakly bifid as seen in well-preserved shells; medial cardinal oblique, thick; posterior cardinal long, narrow, strongly oblique, gently arched in trend; separating sockets profound, trigonal, the posterior one elongated, strongly oblique; in front of the anterior cardinal is a deep narrow socket. Anterior lateral relatively short, of medium thickness, smooth. Anterior

cardinal of right valve thin, short, nearly direct; medial cardinal thick, oblique a little backward; posterior cardinal long, thick at distal end, narrowly and weakly bifid about midway of length; separating sockets profound, the anterior one narrow, the posterior one wide, trigonal; anterior lateral claspers represented by a short, smooth, moderately impressed groove in the hinge plate. Posterodorsal margin narrowly grooved for the reception of the margin of the left valve. Pallial sinus of moderate width and indentation, subtrigonal, rounded on inner end, rising steeply. Inner margin smooth.

Collections from two localities in Grayson County (158 and 160), represented by many individuals, average smaller (the greatest observed length is 30 mm) than the shells from Lamar County, but seem to differ in no essential respect from them. Apparently the shells from Grayson County lived under less favorable conditions than those in Lamar County.

Compared with *Callistina taffi* this species, though similar in surface features, is proportionately longer, has a thinner shell and a narrower and lighter hinge.

Types.—Holotype, a right valve, U.S.N.M. 105390; 9 selected paratypes, unfigured, U.S.N.M. 105391; 3 figured paratypes, U.S.N.M. 105392a-c; 6 selected unfigured paratypes, U.S.N.M. 105393; all are from the Templeton member near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Denton County: Loc. 74; Grayson County: locs. 120, 153, 158, 160, 161, 170, 171; Lamar County: locs. 201 (holotype and 18 paratypes, 3 figured), 206, 229, 230.

Range.—Lewisville member to Templeton member.

Callistina (Larma) taffi (Cragin)

Plate 26, figures 5-9.

1893. *Cytherea taffi* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 182.

1951. *Callistina taffi* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 3, figs. 8, 9 (following p. 163).

Shell of medium size for the genus, thick-walled, subtrigonal in outline, not strongly inflated, broadly humped back of the beak, inequilateral, equivalve; the outline ranges on different individuals from slightly to considerably longer than high. Beaks of medium prominence, incurved, prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity. Lunule rather long, lanceolate, of moderate width, not deeply impressed, outlined by an impressed line. Escutcheon wanting but represented by a troughlike depression formed by the inflection of the opposing margins. Anterodorsal margin inclined, nearly straight; anterior margin regularly rounded; ventral margin broadly rounded; posterior margin narrowly rounded; posterodorsal margin broadly arched, overtopped by the adjacent, strongly humped shell. Surface ornamented with somewhat irregular, conspicuous, concentric ridges that average about 1 mm in width and are asymmetrical in cross section, the slope on the upper side being short and steep and the one below being longer and much less steep. Most of the con-

centric ribs are continuous around the shell, but an occasional one may be introduced by intercalation between entire ribs. The ribs tend to become coarser radially away from the umbones; they tend to smooth out toward the posterior margin.

Dimensions of the selected neotype, a left valve: Length 38 mm, height 35 mm, convexity about 11.5 mm.

The ligament is external and is about 13 mm long in the neotype; groove narrow, deeply impressed; nymph well developed, narrow. The hinge plate is wide and thick, with a rounded inner edge, the trend of which is sinuous, convex downward in front, and broadly concave upward centrally. The hinge of each valve bears three prominent cardinal teeth. In the left valve the anterior cardinal is thin, prominent, and directed nearly vertically downward; the medial cardinal is thick, oblique, with the rear surface standing normal to the hinge plate and the front surface sloping in a convex curve; posterior cardinal long, thin, gently arched in trend, and nearly parallel to the ligamental groove; the anterior of the separating sockets is narrow and deep, and the posterior one is wide, long, deep, and trigonal; there is a deep socket in front of the anterior cardinal; the anterior lateral is narrow, smooth, nonprominent, 5 or 6 mm long, and is situated near the cardinal area but separated from it by the anterior cardinal socket. In the right valve the anterior cardinal is short, thin, and nearly vertical in trend; the medial cardinal is thicker, longer, and slightly oblique backward; the posterior cardinal is long, moderately thick distally, weakly bifid, and strongly oblique; the anterior of the two separating sockets is narrow and deep, and the posterior socket is wide, deep, and trigonal; back of the posterior cardinal is a long, narrow socket, slightly arched in trend; closely in front of the cardinal area is a shallow lateral socket in the hinge plate for the reception of the lateral tooth of the right valve; very weak, obscure claspers border the socket which connects with the anterior cardinal socket by means of a shallow channel that bends around the lower end of the anterior cardinal tooth. The adductor scars are of medium size, subequal, and only moderately impressed. The pallial sinus is subtrigonal and rounded on the inner end, which points obliquely forward and upward toward the beak. Inner margin entire.

The hinge of this species possesses all the elements present in the hinge of *Callistina plana* (Sowerby), the type species of the genus. It differs in that the lateral dentition is smooth, and the posterior cardinal of the right valve is narrower and less deeply bifid.

Compared with *Callistina (Larma) munda* this species averages somewhat larger, is proportionately shorter and higher, and has a much heavier hinge.

Types.—The whereabouts of Cragin's type material is not known. It was found in the Lewisville member on Sheep Creek about 3 miles northwest of Fulp, 4 miles N. 37° E. of Savoy, Fannin County; this is believed to be at or near the locality of

our collection 18248 (loc. 182). Selected neotype, a left valve, believed to be from a place near the type locality, U.S.N.M. 105394; 3 figured examples, U.S.N.M. 105395a-c; 18 selected unfigured examples, U.S.N.M. 105396; all from the Sheep Creek locality 182.

Occurrence.—Grayson County: Locs. 118, 170, 171, 173; Fannin County: locs. 182 (neotype, 3 figured and 18 selected specimens), 183; Lamar County: loc. 206.

Range.—Lewisville member to Templeton member.

Callistina (Larma) alta Stephenson, n. sp.

Plate 26, figures 1-4.

Shell of medium size, thick-walled, broadly sub-trigonal in outline, moderately inflated, humped in the posterodorsal region, inequilateral, equivalve. There is considerable variation in outline, the individuals ranging from a little longer than high to several millimeters higher than long. Beaks of medium prominence, incurved, prosogyrate, approximate, situated about fifteen-hundredths the length of the shell from the anterior extremity. Lunule of medium length, wide, not deeply sunken, outlined by an impressed line. Anterodorsal margin slightly arched, steeply inclined; anterior margin regularly rounded; ventral margin broadly rounded; posterior margin narrowly rounded below, curving above into the broadly rounded posterodorsal margin. Surface conspicuously ornamented with concentric ridges of irregular strength.

Approximate dimensions of the holotype, a right valve: Length 37 mm, height 37.5 mm, convexity 12.5 mm.

The ligament and hinge features are essentially as in *Callistina (Larma) taffi*, but the shells on the average are higher and shorter, the hinge plate is wider and heavier, and the right posterior cardinal is narrower and not so distinctly bifid. Pallial sinus subtrigonal, with rounded inner end directed steeply upward. Inner margin entire.

Types.—Holotype, a right valve, U.S.N.M. 105397; 1 figured paratype, U.S.N.M. 105398; 11 selected unfigured paratypes, U.S.N.M. 105399; all from the right bank of a branch 500 feet south of U. S. Highway 82, 2.4 miles east by south of Whitesboro, Grayson County.

Occurrence.—Grayson County: Locs. 108, 109, 111, 112 (types), 115, 134, 141, 222.

Range.—Lewisville member.

Genus *CYPRIMERIA* Conrad, 1864

Type species: *Cytherea excavata* Morton, by monotypy, from the Navesink marl (Upper Cretaceous), Arneytown, N. J. Original description of *Cyprimeria* (Conrad, 1864, p. 212).

Cyprimeria patella Stephenson, n. sp.

Plate 27, figures 12-18.

Shell of medium size for the genus, subcircular to broadly subovate in outline, depressed convex, noticeably flexed to the left at the rear, subequilateral, right valve a little more convex than the left. Beaks small,

rising slightly above the margin, incurved, prosogyrate, slightly separated, situated about one-third the length of the shell from the anterior extremity. The lunule is of moderate length and breadth and is outlined by a faintly impressed line; on the holotype this line is scarcely discernible, and it is completely obliterated on the corroded surfaces of most of the available shells; a narrow, shallow, marginal V-shaped trough divides the lunule. The escutcheon is represented by a long, deep, V-shaped depression that permits the valves to open. The surface is covered with rather fine concentric growth ridges of irregular strength, which become a little coarser toward the margins; resting stages appear at irregular intervals.

Dimensions of the holotype, a nearly complete shell with both valves in place: Length 52 mm, height 50 mm, thickness 21.5 mm. Individuals range in the proportion of length to height from nearly equal to 6 mm longer than high.

Ligament external, about 17 mm long in the holotype; groove narrow, deep; nymph apparently plain but showing fine cross striations under a lens. Hinge with three cardinal teeth in each valve and no laterals. Anterior cardinal of right valve thin, non-prominent, strongly oblique forward, shorter than the others; medial cardinal broad trigonal, thick at base, rising abruptly on the front, sloping gently away to the rear; posterior cardinal long, of medium thickness, strongly oblique toward the rear, sharply bifid along the crest. The anterior and medial cardinals are separated by a narrow deep socket and the medial and posterior cardinals by a broad, trigonal, relatively shallow socket; back of the posterior cardinal is a long, narrow, strongly oblique socket of medium depth, along the upper rim of which is a thin, slightly raised, slightly roughened rim. This rim corresponds to a narrow, rugose ridge in the same position on the hinge of *Cyprimeria alta* Conrad (Stephenson, 1941, p. 212, pl. 41, fig. 2); attention is called also to an analogous, strongly rugose area on the hinge of *Venus mercenaria* Linné and its allied species in the Miocene of the Atlantic Coastal Plain. Anterior cardinal of left valve simple, of medium thickness, oblique forward; medial cardinal broad, trigonal, rising abruptly on the posterior side, where it is capped by a narrow thin ridge, and sloping gently forward; posterior cardinal simple, long, narrow, very oblique; the anterior of the two separating sockets is wide, trigonal, and moderately deep, and the posterior one is oblique, of medium width, and deep. Adductor scars subequal, high in the shell. Pallial line nearly simple but having a shallow indentation at the position of the sinus. Inner margin smooth.

Types.—Holotype, U.S.N.M. 105400; 2 figured paratypes, U.S.N.M. 105401a-b; 7 selected paratypes, unfigured, U. S. N. M. 105402; 1 figured paratype, U.S.N.M. 105403; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Grayson County; Locs. 152-155, 157-161, 163-165, 169-173; Fannin County: loc. 198; Lamar County: locs. 200, 201 (holotype, 10 selected paratypes, 2 of which are figured), 203, 207.

Range.—Templeton member.

Genus PHARODINA Stephenson, n. gen.

Type species: *Pharodina ferrana* Stephenson.

Etymology: By anagram from *Aphrodina*. Gender, feminine.

This new genus, *Pharodina*, is similar in form to *Veniella conradi* (Morton), the genotype of *Veniella* Stoliczka, but has 3 cardinal teeth, instead of 2, and is smooth on the exterior, in contrast to the prominent concentric lamellae of Stoliczka's genus. The umbonal ridge is prominent and subangular, and the beak is well forward and strongly incurved. The lunule is short, wide, and weakly outlined. The escutcheon is long, of moderate width, and outlined by a low subangular ridge. The hinge of the right valve bears three cardinal teeth, of which the posterior one is strong, rather narrow, oblique rearward; the medial one is shorter, thicker, and slightly oblique rearward; and the anterior one is short, weak, and slightly oblique forward. The anterior lateral dentition consists of a short, apparently smooth socket that opens with only a slight constriction into the anterior cardinal socket. The posterior lateral dentition consists of a long, narrow, distant, weakly developed tooth separated from the margin by a long, narrow, shallow socket. The ligament is external, of moderate length, and rests on a thick nymph. In the left valve the short smooth anterior lateral is separated from the small short anterior cardinal by a narrow, shallow socket; the medial cardinal is moderately long and thick and is oblique rearward, and the posterior cardinal appears to merge with the nymph; the posterior lateral appears to be little more than a slight enlargement of the margin fitting into the long socket of the right valve. The only indication of a pallial sinus is a straightening out of the pallial line as it rises to join the posterior adductor scar.

Pharodina is similar in form to a group of English species referred to the genus *Cyprina* by Woods (1906-07, vol. 2, pts. 3 and 4, pp. 131-147), which range from the Lower Greensand through the Upper Greensand into the Lower Chalk. The hinge features of the English species were not seen.

Pharodina ferrana Stephenson, n. sp.

Plate 27, figures 1-7

Shell of medium size, subtrigonal, strongly convex, longer than high, inequilateral, equivalve. Lunule short, wide, weakly outlined. Escutcheon long, of medium width, limited by a low, round-crested ridge. Beaks prominent, strongly incurved, prosogyrate, situated about fifteen-hundredths the length of the shell from the anterior extremity. Umbonal ridge subangu-

lar, sinuous. Posterodorsal slope long, steep, overhanging at the beak, divided longitudinally by the low, subangular ridge that bounds the escutcheon. Anterodorsal slope steep to overhanging. Umbonal area narrow, flattened in a widening band that passes ventrally into a broadly convex surface. Anterodorsal margin short, steep, nearly straight; anterior margin rather sharply rounded; ventral margin long, broadly rounded; posterior margin sharply rounded below, with a short subtruncation just above the extremity; posterodorsal margin long, descending broadly arched. Surface marked only by fine growth lines and gentle undulations.

Dimensions of the holotype, a medium-sized left valve: Length 21.5 mm, height 20 mm, convexity 7.5 mm.

Ligament external, opisthodontic, of medium length, seated on a strong, thick nymph. Hinge thick and heavy in the cardinal area, with three cardinal teeth in each valve. The posterior lateral dentition is distant and weakly developed, and the anterior lateral dentition is short, weak, and approximate to the cardinal area. More details are given under the generic heading. Adductor scars a little sunken, subequal. Pallial line entire, but straightens out as it rises to the adductor scar. Inner margin smooth.

Types.—Holotype, U.S.N.M. 105406; 1 figured paratype, U.S.N.M. 105407; 7 unfigured paratypes, U.S.N.M. 105408; all from a small stream gorge, 1.9 miles S. 54° W. of the center of Ambrose, Grayson County. One figured paratype, U.S.N.M. 105409; 3 unfigured paratypes, U.S.N.M. 105410; 1 figured paratype, U.S.N.M. 105404; 1 unfigured paratype, U.S.N.M. 105405.

Occurrence.—Cooke County: Loc. 98; Grayson County: locs. 116 (2 paratypes, 1 figured), 117, 132 (4 paratypes, 1 figured), 135 (holotype, 8 paratypes, 1 figured).

Range.—Lewisville member.

Pharodina? sp.

Plate 27, figure 8

One large incomplete internal mold in ferruginous sandstone of the Lewisville member in a branch east of north-south road, 1.5 miles north of Mineral Creek, 2.5 miles north of Sadler, Grayson County (loc. 132), probably belongs to *Pharodina* Stephenson. It is proportionately shorter and higher than *P. ferrana* and has a prominent beak and an entire pallial line. The cardinal and anterior lateral dentition are not preserved, but the imprint indicates a well-developed elongated posterior lateral dentition, the left valve having a long tooth that fits into a socket between an inner tooth and the margin of the shell of the right valve. The shell measures: Length 48 mm, height 42+ mm, convexity about 14 mm. U.S.N.M. 105411.

Genus CYCLORISMA Dall, 1902

Type species: *Cyctothyris carolinensis* Conrad. (See Stephenson, 1923, p. 316.) Considered by Dall (1902, p. 357) a subgenus of *Cyprimeria* Conrad.

Cyclorisma orbiculata Stephenson, n. sp.

Plate 26, figures 10-13

Shell small, subcircular to broadly subovate in outline, moderately inflated, most inflated a little above the midheight, slightly inequilateral, equivalve. Beaks small, slightly prominent, incurved, prosogyrate, slightly separated, situated a little in advance of the midlength. Lunule proportionately large, not impressed, faintly outlined by a fine, weak line; escutcheon wanting. Surface smooth, with only very fine incremental lines; resting stages appear at wide intervals on some specimens.

Dimensions of the holotype, a left valve: Length 12 mm, height 13 mm, convexity 4.7 mm. A small complete individual measures: Length 6.7 mm, height 6.9 mm, thickness 3.8 mm.

Ligament external, about 4.5 mm long in the holotype; nymphs plain, groove sharply incised. Hinge with three cardinal teeth in each valve; lower margin sinuous, broadly convex downward in front, broadly concave below the beaks; laterals wanting. Anterior cardinal of left valve rather long, of medium thickness, oblique forward; medial cardinal rather thick and short, slightly oblique backward; posterior cardinal long, thin, strongly oblique. There is a long deep socket in front of the anterior cardinal, a short trigonal socket between the anterior and medial cardinals, and a long, wide, trigonal socket between the medial and posterior cardinals. Anterior cardinal of right valve long, thin, strongly oblique forward; medial cardinal short, rather thick, nearly direct, partly isolated by a narrow channel at the upper end, which connects the sockets on either side of the tooth; posterior cardinal long, oblique backward, trigonal, broad inwardly, strongly bifid. The socket between the anterior and medial cardinals is narrow and deep; the one between the medial and posterior cardinals is short, wider, and not so deep; and there is a long, narrow, oblique socket behind the posterior cardinal. The pallial sinus, the imprint of which is partly exposed on one internal mold, appears to be of moderate width and depth, as in the type species of the genus.

In form, ligament, hinge, and other internal features this species appears to be essentially like *Cyclorisma carolinensis* (Conrad), the type species of the genus, but the meager available material indicates a much smaller species.

Types.—Holotype, a left valve, U.S.N.M. 105412; 2 figured paratypes, U.S.N.M. 105413a-b; 1 unfigured paratype, U.S.N.M. 105414; all from near old Slate Shoals, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Locs. 201 (types), 203, 207, 230.

Range.—Templeton member.

Genus LEGUMEN Conrad, 1858

Type species: *Legumen ellipticum* Conrad (1858, p. 325), designated by Stoliczka (1871, p. xvi), from the Owl Creek formation (Upper Cretaceous), Tippah County, Miss.

Legumen ligula Stephenson, n. sp.

Plate 27, figures 9-11.

Shell of medium size, thin-walled, subovate-elongate in outline, depressed convex, strongly inequilateral, equivalve. There is some individual variation in outline. Beaks small, nonprominent, incurved, prosogyrate, approximate, situated one-fifth to one-fourth the length of the shell from the anterior extremity. Lunule and escutcheon wanting. Anterodorsal margin relatively short, steeply descending, nearly straight; anterior margin sharply rounded below the midheight; ventral margin nearly straight centrally, rounding broadly upward at each end; posterior margin less narrowly rounded than the anterior, more narrowly rounded than a semicircle; posterodorsal margin long, very broadly arched. The surface markings consist of fine to medium coarse growth ridges and gentle undulations; in detail the ridges are of irregular strength, and they tend to become a little coarser toward the margins and toward the extremities.

Dimensions of the holotype, a left valve: Length 43 mm, height 21.5 mm, convexity about 4 mm.

Ligament external, long-lanceolate, rather thick, and about three-tenths as long as the shell. The hinge was not seen uncovered but an experimental X-ray negative of the figured paratype, made by Ruth A. M. Schmidt of the Geological Survey, using Bureau of Standards equipment, shows rather dimly the short, nearly direct medial and anterior cardinal teeth, and the long oblique posterior cardinal, of the right valve. These teeth appear to be essentially normal for the genus. Pallial sinus subtrigonal, straight on the sides, subpointed at inner terminus, of medium depth, terminating several millimeters short of the midlength. Inner margin smooth.

Compared with the genotype, *Legumen ellipticum* Conrad, this species is proportionately shorter and higher, and is less compressed laterally. The generic assignment is made on the basis of outline, form, and surface features.

Shumard's description of *Tapes hilgardii* (1860b, p. 601) indicates that that species differs from the present one in that the posterior end is said to be narrower than the anterior, the posterior end approaches subtruncation, and the inflation is greater; in *L. ligula* the anterior end is the narrower. In the absence of illustrations and type material, it seems inadvisable to refer the present material to Shumard's species.

Types.—Holotype, U.S.N.M. 105417; 2 unfigured paratypes, U.S.N.M. 105418; all from gully 250 feet north of road, 0.65 mile south, 1 mile west of Star School, Grayson County. One figured paratype, U.S.N.M. 105415; 1 unfigured paratype, U.S.N.M. 105416; 3 unfigured paratypes, U.S.N.M. 105419.

Occurrence.—Grayson County: Locs. 160, 163-165, 170 (holotype and 2 unfigured paratypes), 171; Lamar County: locs. 201 (4 paratypes, 1 figured), 203 (3 selected unfigured paratypes).

Range.—Templeton member.

Genus *SINONIA* Stephenson, n. gen.Type species: *Sinonia levis* StephensonEtymology: *Sinonia*, an island in the Tyrrhenian Sea. Gender, feminine.

This shell is similar in form to the one from North Carolina described by Conrad under the name *Baroda carolinensis* (1875, p. 8), and later transferred by me to the genus *Legumen* Conrad (Stephenson, 1923, p. 321), except that the beaks are proportionately farther removed from the anterior extremity. The dentition is also similar in the two species, with small but important differences in the weight and spacing of the teeth. Another difference pertains to the pallial sinus, which in this species is relatively small, is subtrigonal, and is directed rather steeply upward, whereas in *Legumen carolinense* it is rather broad, directed more nearly in a horizontal direction, and is rounded at the anterior end.

In the right valve of this species there are three cardinal teeth, the posterior one long, narrow, strongly oblique, and sharply bifid, the medial one of moderate strength, nearly direct, with its posterior flank sloping to the rear, and the anterior one of moderate length and strength and directed somewhat obliquely forward. The socket separating the anterior from the medial cardinal is trigonal, deep, and of moderate width; the socket between the medial and posterior teeth is trigonal, of medium width, and deepest at its inner end; there is a long, narrow, oblique socket back of the posterior cardinal; in an adult a channel extends forward for about 8 mm from the anterior cardinal. In the left valve the anterior cardinal is short, thin, bifid, and nearly direct; the medial cardinal is longer, of medium thickness, and moderately oblique; and the posterior cardinal is weak, long, thin, and lies close to the nymph, with which it is nearly parallel. The posterior cardinal is separated from the medial one by a long, trigonal, oblique socket, which is divided on its bottom by a low longitudinal ridge; the medial cardinal is separated from the anterior one by a short trigonal socket of moderate width; in front of the anterior cardinal is a short socket which opens freely into a channel that extends forward parallel to the margin.

Compared with *Legumen ellipticum* Conrad, the genotype of *Legumen*, the cardinal teeth of this genus are more evenly distributed. In *L. ellipticum* the posterior cardinal of the right valve is very narrow, very narrowly bifid, and is so oblique as to be nearly parallel with the nymph; there is a wide space between the posterior and medial cardinal and a very narrow space between the medial and anterior cardinal; in the left valve there is a wide space between the anterior and medial cardinal and a very narrow space between the very oblique medial and posterior cardinals; *L. ellipticum* lacks a channel extending forward from the anterior cardinal tooth.

The present species is nearer to *Legumen carolinense* (Conrad) in outline, form, and dentition than it is to *L. ellipticum*, but the more distant position of the beak from the anterior extremity, the somewhat thicker right posterior cardinal, and the more sharply pointed, more ascending pallial sinus seem to justify its generic separation from *L. carolinense*.

Sinonia levis Stephenson, n. sp.

Plate 28, figures 19-25; plate 54, figures 1-5

Shell of medium size, thin, smooth, subovate-elongate in outline, compressed, inequilateral, equivalve. Beaks nonprominent, incurved, prosogyrate, situated about one-third the length of the shell from the anterior extremity. Lunule and escutcheon wanting. Anterodorsal margin nearly straight or gently arched, descending; anterior margin regularly and rather narrowly rounded; ventral margin very broadly and regularly rounded; posterior margin regularly rounded, fullest below the midheight; posterodorsal margin broadly arched, gently descending. Incremental lines very fine.

Dimensions of the holotype: Length 32.2 mm, height 20 mm, thickness about 14 mm.

Ligament external, opisthodontic, about 7 mm long in the holotype. Three cardinal teeth in each valve. Laterals wanting. In right valve, anterior cardinal thin, of moderate length, oblique forward; medial cardinal of about the same size as the anterior one, nearly direct, with the posterior flank sloping gently into the medial socket; posterior cardinal long, oblique, narrow, bifid. The socket between the anterior and medial teeth is trigonal and deep; the medial socket is deep at its posterior side; the posterior socket is long, very oblique, and closely parallels the nymph. In the left valve the anterior cardinal is bifid on the crest and of moderate thickness; medial cardinal moderately thick, and a little longer than the anterior cardinal; the posterior cardinal is weak, long, narrow, and closely parallels the nymph, to the lower side of which it is partly fused; in front of the anterior tooth is a socket into which fits the anterior cardinal of the right valve, and this socket opens freely into a shallow lateral channel that extends forward about 5 mm in the holotype; this lateral channel is not a tooth socket, for opposed to it on the right valve is a corresponding channel. Adductor scars are obscure but apparently of medium size and subequal. Pallial line weakly punctate; pallial sinus subtrigonal, of medium size, narrowly rounded at the anterior end, directed upward and forward. Inner margin of shell smooth.

The holotype, a medium-sized specimen, is nearly complete. One large paratype (47 mm long) has been broken and distorted by several of the calcite veins cutting the septarian concretion in which the shell was found. All other paratypes are much smaller but ap-

pear to possess the essential characters of the holotype; they are interpreted to be juvenile examples.

Paratypes from Hill, Grayson, and Lamar Counties are internal and external molds in ferruginous sandstone. One paratype from Hill County is figured.

The shell has a general resemblance to *Legumen carolinense* (Conrad) (Stephenson, 1923, p. 321, pl. 81, figs. 5-8), but has the beaks farther removed from the front, has a shorter, trigonal, more elevated, and more pointed pallial sinus, and differs in hinge details. The species appears to be more closely related to *L. carolinense* than it is to *L. ellipticum* Conrad.

Types.—Holotype (both valves), U.S.N.M. 105420; 1 paratype, figured, U.S.N.M. 105421; 3 paratypes, unfigured, U.S.N.M. 105422; all from the Templeton member on a branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County. Two paratypes, figured, U.S.N.M. 105423a-b; 3 paratypes, unfigured, U.S.N.M. 105424; 2 paratypes, figured, U.S.N.M. 105425a-b.

Occurrence.—Hill County: Locs. 3, 5 (2 paratypes, figured), 7; Grayson County: locs. 107, 164 (holotype, and 4 paratypes, 1 figured), 165 (5 paratypes, 2 figured), 171; Lamar County: loc. 207.

Range.—Lewisville member to Templeton member.

Genus FLAVENTIA Jukes-Browne, 1909

Type species: *Clementia (Flaventia) ovalis* (Sowerby), from the Upper Greensand (zone of *Schloenbachia rostrata*) of Blackdown, England. (Jukes-Browne, 1909, p. 167; see also Woods, 1908, vol. 2, pt. 5, p. 189.) Described as a subgenus of *Clementia* Gray.

The one species, *Flaventia ludana*, here referred to *Flaventia* Jukes-Browne appears to possess essentially the same shell characters as the genotype. There are, however, some differences. In the left valve of *Flaventia ovalis*, as figured by Woods, the anterior cardinal tooth is longer and more oblique forward, the medial cardinal is heavier and more oblique rearward, and the posterior cardinal is weaker and more slender. Both species possess a lunule and an escutcheon, and both lack lateral dentition. In the right valve of *F. ovalis* both the posterior and medial cardinal teeth are thinner and the anterior socket narrower, than the corresponding features of *F. ludana*.

Cyclorisma Dall from the Snow Hill marl member of the Black Creek formation (Upper Cretaceous), North Carolina, is a related genus, but it lacks both lunule and escutcheon.

Flaventia ludana Stephenson, n. sp.

Plate 28, figures 14-18

Shell of medium size, subovate in outline, longer than high, low convex, inequilateral, equivalve. Beaks small, incurved, strongly prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity. Lunule rather long and narrow, excavated, outlined by an obscure groove on the crest of a broad, obtuse subangulation. Escutcheon elongate,

obscurely outlined by a broadly obtuse subangulation. Anterodorsal margin broadly concave, descending; anterior margin narrowly rounded; ventral margin broadly and regularly rounded; posterior margin rather narrowly rounded, curving sharply upward into the long, broadly arched posterodorsal margin. Surface bearing distinct incremental lines and widely spaced grooves marking resting stages.

Dimensions of the holotype, a left valve: Length 39.2 mm, height 30 mm, convexity 10 mm. One paratype measures: Length 57 mm, height 43.5 mm, convexity 15 mm.

Ligament external, opisthodontic, long, seated on a long, narrow nymph bordered by a deep groove. Hinge of left valve with three cardinal teeth. The anterior cardinal is strong and nearly vertical; the medial one is oblique rearward, is about equally prominent, with its posterior face abrupt and its anterior face sloping strongly forward; the posterior one is long, narrow, strongly oblique, gently arched upward in trend. The anterior and medial cardinals are separated by a rather short, wide, trigonal socket and the medial and posterior cardinals by a long, narrow, trigonal, slightly curved socket. Hinge of right valve with three cardinals; the anterior one narrow and slightly oblique forward; the medial one thick, slightly oblique toward the rear, with anterior face abrupt and posterior face sloping to the rear; the posterior one long, thick, oblique, bifid. A narrow channel separates the anterior cardinal from the margin; a wide, deep trigonal socket separates the medial cardinal from the anterior one; a shallower trigonal socket separates the posterior cardinal from the medial one; and a long, narrow, deep socket parallels the rear side of the posterior cardinal. Lateral dentition is wanting. As shown on an internal mold the adductor scars are subequal and situated slightly above the midheight. Pallial sinus of medium depth, ascending, narrowly rounded at the inner end.

The species is similar in form and outline to *Aphrodina tippiana* Conrad, the type species of *Aphrodina* Conrad (1869a, p. 246). It is, however, more elongated, the beak is farther forward, and it lacks anterior lateral dentition, a conspicuous feature of Conrad's genus.

The species is more elongated than any of the species of *Callistina* Jukes-Browne in the Woodbine formation and differs from all of them in the absence of anterior lateral dentition.

Types.—Holotype, U.S.N.M. 105426; 1 paratype, an internal mold, figured, U.S.N.M. 105427; 1 paratype, an incomplete left valve, unfigured, U.S.N.M. 105428; all from a gully 0.5 mile south, 0.75 mile west of Star School, 5 miles south-southeast of the center of Denison, Grayson County. One figured paratype, U.S.N.M. 105429; 7 unfigured paratypes, U.S.N.M. 105430.

Occurrence.—Grayson County: Locs. 171 (holotype and 2 paratypes 1 figured), 173 (8 paratypes, 1 figured); Fannin County: loc. 198.

Range.—Templeton member.

Superfamily TELLINACEA

Family TELLINIDAE

Genus NELLTIA Stephenson, n. gen.

Type species: *Nelltia stenzeli* Stephenson.

Etymology: By anagram from *Tellina*. Gender, feminine.

Shell broadly subelliptical in outline, compressed. Beaks small, nonprominent, prosogyrate, situated in advance of the midlength. Radiating sculpture apparently wanting. Ligament opisthodontic, external, extending nearly halfway to the rear; groove deep, nymph thick and prominent. Hinge of left valve with two cardinal teeth, the anterior one prominent, trigonal, bifid, forming a thick-limbed inverted V, the posterior one simple, of medium thickness, oblique, partly fused against the anterior end of the nymph; the anterior cardinal is bounded on either side by a narrow, deep socket, the two sockets connected above the crest of the inverted V. A thin, prominent lateral tooth extends from near the top of the anterior cardinal, forward for 5 or 6 mm in adults, and is separated from the sharp outer margin of the shell by a deep, narrow channel; posterior lateral short, weak, situated just below the posterior end of the ligamental groove. Hinge of right valve, as seen on the holotype only, with two cardinal teeth. The anterior one is rather poorly preserved, is elevated, oblique toward the front and short, but may be partly broken away; posterior cardinal oblique to the rear, of medium length and thickness, apparently simple; the separating socket is trigonal and deep. A deep anterior lateral socket separates a pair of claspers, the inner element of which is strong and prominent and the outer weak and fused against the inner margin of the shell; the posterior lateral dentition consists of a short, strong tooth separated from the lower end of the ligamental groove by a channel of medium width and depth. The pallial sinus is of medium width, is rounded on the inner terminus, lies in a nearly horizontal position, and extends a little short of the midlength.

Compared with the Recent *Tellina radiata* Linné, the genotype of *Tellina* Linné, the type species of this genus is much less elongated, has the beak in front of midlength, lacks a posterior plication and external radial lining, is not flexed at the rear, and is markedly different in its dentition. The anterior cardinal in the left valve of *T. radiata*, though bifid, is less isolated and less sharply V-shaped; the posterior cardinal is much weaker; and the anterior lateral dentition is distant, short, and weak; the beak is back of the midlength. Another striking difference is the exaggerated attenuation of the pallial sinus in *T. radiata*, the terminus of which almost reaches the anterior adductor scar.

Nelltia stenzeli Stephenson, n. sp.

Plate 28, figures 9-13

Shell of medium size, depressed convex, subelliptical in outline, slightly inequilateral, nearly equivalve; the

species exhibits marked individual variation in outline in shells from the same piece of rock; some shells are proportionately higher with respect to length and some are much lower than the holotype. Beaks small, nonprominent, incurved, prosogyrate, situated about two-fifths the length of the shell from the anterior extremity. Anterodorsal margin gently descending, gently arched; anterior margin rounded less than a semicircle; ventral margin very broadly rounded, rising steeply at the front and rear; posterior margin rather sharply rounded; posterodorsal margin very broadly arched. Surface with fine, more or less irregular growth ridges and gentle undulations, with an increase in coarseness toward the margins and especially along the posterodorsal margin.

Dimensions of the holotype, a right valve: Length 38.2 mm, height 27.3 mm, convexity about 6 mm. An internal mold proportionately higher and shorter than the holotype measures, length 36 mm, height 28 mm; an internal mold proportionately lower and more elongated than the holotype measures, length 33 mm, height 20 mm.

Ligament external, 8 or 9 mm long in the holotype; groove narrow, deeply impressed; nymph rather thick and prominent. Hinge of right valve with two diverging cardinal teeth, not seen perfectly preserved, separated by a deep trigonal socket. The anterior cardinal appears to be short, rather prominent, and oblique forward, but may be partly broken away; the posterior cardinal is not complete but is rather thin, about twice as long as the anterior cardinal, is oblique backward, and is bordered behind by a narrow, shallow socket. Immediately in front of the anterior cardinal is a well-developed lateral tooth about 5 mm long in the holotype, paralleled above by a deep, narrow socket, which in turn is paralleled by a very weak lateral tooth fused against the inner margin of the shell, the two laterals forming a pair of claspers. Just below the posterior end of the ligamental groove is a short well-developed lateral, which is also bordered above by a narrow channel. The hinge of the left valve, as seen in two shells, neither of which is complete, presents one large, short, trigonal, bifid, inverted V-shaped anterior cardinal tooth and an oblique, narrow, posterior cardinal, the two separated by a narrow, deep socket; in front of the anterior cardinal is a deep, narrow socket that connects above the tooth with the other cardinal socket. A well-developed anterior lateral is present opposite the claspers of the right valve; the posterior lateral is quite weakly developed as seen on one of the specimens. Inner margin smooth. Pallial sinus of moderate depth, punctate, rounded on the inner end, with axis nearly horizontal.

Types.—Holotype, a right valve, U.S.N.M. 105431; 2 unfigured paratypes, U.S.N.M. 105432; all from near Chicago, Rock Island and Pacific Railroad, 0.9 mile to 1 mile west of the Dallas County

line, in Tarrant County, Tex. One figured paratype, U.S.N.M. 105433; 1 unfigured paratype, U.S.N.M. 105434; 2 figured paratypes, U.S.N.M. 105435a-b; 1 unfigured paratype, U.S.N.M. 105436; 35 or more unfigured paratypes, 2 measured, in hard, calcareous sandstone matrix, U.S.N.M. 105438; 1 unfigured paratype, U.S.N.M. 105437. Honoring H. B. Stenzel.

Occurrence.—Tarrant County: Locs. 37, 38 (holotype and 2 unfigured paratypes), 41 (36+ unfigured paratypes), 44 (5 paratypes, 3 figured); Denton County: loc. 90.

Range.—Lewisville member.

Genus TELLINA Linné, 1758

Type species: *Tellina radiata* Linné, by subsequent designation (Children, 1823, pp. 305-306; reprint, pp. 32-33). Recent, in West Indian waters.

In the absence of hinge features it is impossible to determine the generic affiliations of many Cretaceous specimens which, from their form, appear to belong to the Tellinidae. Most of them probably belong to genera other than the Recent *Tellina* Linné, s. s.

"Tellina" stabulana Stephenson, n. sp.

Plate 28, figures 6-8

Shell small, thin, elongate-subovate in outline, compressed, inequilateral, subequivalve, bent slightly to the left at the rear. Posterodorsal surface delimited from the main surface by a very obtuse subangulation. Beaks small, nonprominent, nearly direct, situated about 0.55 the length of the shell from the anterior extremity. The dorsal margins diverge from the beaks at an angle of about 150°. Anterodorsal margin long, broadly arched; anterior margin sharply rounded below midheight; ventral margin very broadly rounded, curving sharply upward toward the front; posterior margin subangulated well below midheight, with a short subtruncation above, rounding into the nearly straight, descending posterodorsal margin. The main surface is smooth with the exception of fine growth lines, and the posterodorsal surface is covered with fine radial striations crossed by growth lines, thus producing a fine reticulation.

Dimensions of the holotype: Length 15 mm, height 7.8 mm, thickness 2.7 mm. A larger internal mold measures: Length 19.2 mm, height 10.1 mm, thickness 3.7 mm.

Ligament and hinge features not uncovered. Pallial sinus profound, extending forward slightly past midlength.

This species is smaller than "*Tellina*" *rivana*, is longer in proportion to the height, and is bent to the left at the rear instead of to the right.

Types.—Holotype, U.S.N.M. 105439, from the Templeton member in a gully south of a barn or stable, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson County. One figured paratype, U.S.N.M. 105440; 1 unfigured paratype, U.S.N.M. 105441.

Occurrence.—Tarrant County: Locs. 41, 44, (paratype, figured); Denton County: loc. 90 (paratype, unfigured); Grayson County: loc. 171 (holotype).

Range.—Lewisville member to Templeton member.

"Tellina" rivana Stephenson, n. sp.

Plate 29, figures 17-21

Shell of medium size, thin, subelliptical in outline, compressed, inequilateral, subequivalve, bent slightly to the right at the rear. Beaks small, nonprominent, nearly direct, situated about 0.55 the length of the shell from the anterior extremity. Hinge not uncovered. The dorsal margins diverge from the beaks at an angle of about 140°. Anterodorsal margin broadly arched; anterior margin sharply rounded near the midheight; ventral margin very broadly rounded, curving up more steeply at the front than at the rear; posterior margin subtruncated a little below midheight, rounding into the broadly arched posterodorsal margin above. Surface smooth with the exception of fine incremental lines and several very fine radiating lines bordering the anterodorsal margin.

Dimensions of the holotype: Length 29 mm, height 17.7 mm, thickness 6 mm.

The ligament, which is partly preserved, is opisthodontic and about 8 mm long. The shell is partly peeled off, but the hinge and other internal features cannot be clearly seen.

The paratype, a young shell more completely preserved than the holotype, shows a group of 7 or 8 closely spaced fine radial lines bordering the anterodorsal margin of each valve; several obscure radiating lines of the same kind border the posterodorsal margin adjacent to the ligament.

Compared with "*Tellina*" *stabulana* this species is proportionately less elongated, a little plumper, possesses fine radial lines along the anterodorsal margin, and lacks distinct radial lining on the posterodorsal slope.

Type.—Holotype, U.S.N.M. 105442, from a branch of Big Bear Creek at crossing of north-south road, 1.2 miles northeast of Euless, Tarrant County; 1 paratype, figured, U.S.N.M. 105443.

Occurrence.—Tarrant County: Locs. 44 (paratype, figured), 53 (holotype); Cooke County; loc. 99.

Range.—Lewisville member.

"Tellina" parkerana Stephenson, n. sp.

Plate 28, figures 1-5

This species is based on external and internal molds. Shell small, compressed, subovate in outline, inequilateral, subequivalve, bent very slightly to left at rear. Beaks small, compressed, nonprominent, nearly direct, situated about three-fifths the length of the shell from the anterior extremity. Angle of divergence of dorsal margins at beak about 125°. Anterodorsal margin very gently arched; anterior margin rather sharply rounded at midheight; ventral margin broadly rounded; posterior margin sharply rounded a little below midheight; posterodorsal margin gently arched, steeply descending. Surface marked only by fine growth lines.

Dimensions of the holotype: Length 19 mm, height 13.3 mm, convexity about 2 mm.

Hinge narrow. Ligament external, short. Two small diverging teeth in the right valve are separated by a deep triangular socket. In the left valve a central, nearly direct, triangular cardinal tooth lies between two deep triangular sockets of medium width. Lateral dentition slender and about equally distant from the beaks. In the right valve inner laterals are separated from the margin by narrow sockets; in the left valve single lateral teeth fit into the sockets of the right valve. Posterior adductor scar apparently a little larger than the anterior one. Pallial sinus wide, rounded in front, extending slightly past midlength.

Compared with "*Tellina*" *rivana*, the most nearly related of the Woodbine species, "*T.*" *parkerana* is proportionately shorter and higher and has a more steeply descending posterodorsal margin.

Types.—Holotype, U.S.N.M. 105444; 1 figured paratype, U.S.N.M. 105445; 5 unfigured paratypes, U.S.N.M. 105446; all from the Hillsboro road, 2.5 miles northwest of Parker, Johnson County.

Occurrence.—Johnson County: Loc. 9.

Range.—Lewisville member.

"*Tellina*" *dugansensis* Stephenson, n. sp.

Plate 29, figures 13–16.

Shell of adult large and thick for the genus, subelliptical in outline, elongate, depressed convex, slightly inequilateral, slightly inequivalve. Beaks small, non-prominent, compressed, nearly direct, situated about 0.55 the length of the shell from the anterior extremity. Anterodorsal margin long, gently descending, broadly arched; anterior margin narrowly rounded; ventral margin very broadly rounded; posterior margin with a short subtruncation; posterodorsal margin descending, gently arched. Surface marked with subdued but distinct growth lines and an occasional faint resting stage.

Dimensions of the holotype, a medium-sized right valve: Length 40 mm, height 23.2 mm, convexity about 6 mm.

Ligament external, about 9 mm long in the holotype. Nymph moderately thick and prominent. Cardinal teeth two, in the right valve, the posterior one of medium thickness, bifid, directed slightly rearward, and the anterior one thick, prominent, bifid, directed obliquely forward. Lateral dentition consisting of rather distant, short, well-developed claspers, with the inner element relatively thick and the outer element formed by the shell margin. Impressions on the internal mold show the adductor scars to be rather deeply sunken, the anterior one being the larger and the more elongated; each scar is bordered by a shallow radial depression marking a low, broad-crested swell on the inner surface of the shell. The pallial sinus is wide and deep, reaching nearly to midlength. Inner margin of shell smooth. The type material includes incomplete

individuals of several sizes ranging in length from 17 mm to about 55 mm. The shell is present but shatters easily, and well-preserved specimens are not easily obtained.

The species is similar to "*Tellina*" *rivana* but is more convex, the beak is more prominent, the shell is thicker, and the adults are much larger.

Types.—Holotype, U.S.N.M. 105447; 4 unfigured paratypes, U.S.N.M. 105451; 1 figured paratype, U.S.N.M. 105448; 6 unfigured paratypes, U.S.N.M. 105449; 3 unfigured paratypes, U.S.N.M. 105450: all from the Lewisville member near a branch, 1.05 miles east and 0.2 mile south of Penland (Terrace station), 0.3 mile southeast of Dugans Chapel, Grayson County.

Occurrence.—Hill County: Loc. 76; Tarrant County: loc. 41; Grayson County: locs. 122 (holotype and 14 paratypes, 1 figured), 123, 160; Cooke County: loc. 99.

Range.—Lewisville member to Templeton member.

Unidentified specimens of "*Tellina*"

One incomplete elongate trigonal, compressed internal mold of a left valve of "*Tellina*", with a rather sharp beak, from the Lewisville member in a road exposure 3 miles northeast of Whitney, Hill County (loc. 7), is specifically indeterminate. Its length is 30+ mm, U.S.N.M. 105452. A similar right valve is from Timber Creek, Denton County (loc. 74), U.S.N.M. 105453.

A large internal mold of "*Tellina*" in ferruginous sandstone, similar in form to "*T.*" *dugansensis*, but having a shorter posterior extension, was found in the Lewisville member on Copper Creek, 4.6 miles south 25° west of Gordonville, 0.8 mile east-northeast of Dixie triangulation station, Grayson County (loc. 131). It measures: Length 44 mm, height 28.5 mm, convexity about 6 mm. U.S.N.M. 105454.

Two fragments of internal molds of a small "*Tellina*" in ferruginous sandstone of the Templeton member in a public road 3.8 miles west of Ravenna, Fannin County (loc. 197), are too incomplete for specific identification. The beak is somewhat back of the midlength. U.S.N.M. 105455.

Genus *LINEARIA* Conrad, 1860

Type species: *Linearia metastriata* Conrad, from the Ripley formation (Upper Cretaceous) near Eufaula, Ala. (Conrad, 1860, p. 279).

Subgenus *LIOTHYRIS* Conrad

Type species: *Linearia (Liothyris) carolinensis* Conrad (by monotypy), from the Snow Hill marl member of the Black Creek formation, Snow Hill, N. C.

This subgenus is represented by specimens from two localities. They possess the hinge features of *Linearia* Conrad, but they lack radiating costae. If species lacking this feature are to be separated from the ribbed species either as a subgenus or a distinct genus, Conrad's name *Liothyris* (1875, p. 9) is applicable to these specimens. Species showing all degrees of radial sculpture, from that covering the whole shell to that consist-

ing of a few fine radial lines bordering the dorsal margin, are known. The smooth forms seem therefore to form the end members of the series.

Linearia (*Liothyris*) *concentrica* Stephenson, n. sp.

Plate 29, figures 7-11

Shell small, elongate-subovate in outline, depressed convex, inequilateral, equivalve. Beaks nonprominent, approximate, situated a little back of midlength. Umbonal ridge weak, rounded on the crest, curving downward toward the ventral margin. Posterodorsal slope flattish to gently concave. Lunule long, narrow, sunken. Escutcheon wanting. Surface ornamented with distinct concentric ribs of irregular width; some are proportionately broad and flat, probably indicating rapid growth; others may be narrow and closely spaced, probably indicating less favorable growing conditions. Radiating sculpture is wanting.

Dimensions of the holotype: Length about 16 mm, height 11.6 mm, convexity about 6 mm.

The hinge is incompletely preserved. It is narrow and the right valve presents two narrow cardinal teeth, strongly oblique toward the front, as in *Linearia*; these teeth are separated by a narrow socket. There is a distant, short, weak pair of posterior lateral claspers in the right valve. Adductor scars slightly unequal, the posterior one the larger. Pallial sinus wide, profound, ascending, rounded on the inner end, extending forward a little past midlength. Inner margin smooth.

The external mold of a right valve and the internal mold of a left valve, in ferruginous sandstone from Hill County (loc. 3, coll. 11836) appear to belong to this species. The concentric ribs in the umbonal region are wide and flat, but over the main surface below they are of irregular width, mostly narrow. These irregularities in spacing are believed to be due to alternations in environmental conditions, the narrow spacing reflecting unfavorable conditions of growth, and the wide spacing favorable conditions.

Types.—Holotype, U.S.N.M. 105456; 9 unfigured paratypes, U.S.N.M. 105457; all from the Templeton member in a branch of Iron Ore Creek, 0.4 mile south, 0.8 mile west of Star School in Grayson County. One paratype, figured, U.S.N.M. 105458; 1 paratype, unfigured, U.S.N.M. 105459.

Occurrence.—Hill County: Loc. 3 (2 paratypes, 1 figured); Grayson County: locs. 165 172 (holotype and 9 unfigured paratypes).

Range.—Lewisville member to Templeton member.

Unidentified specimens of *Linearia*

One incomplete right valve showing the interior and most of the hinge, from the Lewisville member in a branch north of the Chicago, Rock Island and Pacific Railroad, in Tarrant County, 1 mile west of the Dallas County line (loc. 44), possesses the two strongly oblique cardinal teeth characteristic of *Linearia* (pl. 29, fig. 12). There is a distant, short, rather weak pair of lateral

claspers. The pallial sinus is only faintly visible and appears to extend about to midlength. The exterior is covered with hard, tightly adhering matrix. The approximate dimensions are: Length 33 mm, height 20.5 mm. U.S.N.M. 105460.

Two internal molds in ferruginous sandstone, from the Lewisville member in a branch of Walnut Creek, east of north-south road, 0.5 mile north of Gordonville, Grayson County (loc. 126), have the characteristic cardinal dentition of *Linearia*. They are elongate, compressed, and probably smooth. Dimensions of the larger mold: Length 36 mm, height 24.5 mm, convexity about 4.5 mm. U.S.N.M. 105461.

Genus *SOLYMA* Conrad, 1870

Type species: *Solyma lineolatum* Conrad,⁵ from the Woodbury clay, Haddonfield, N. J. (Conrad, 1870, p. 75, pl. 3, fig. 9.)

The reference of the Texas species *Solyma stewarti* to Conrad's genus is made with reservations. Conrad gives one figure only, which shows the two cardinal teeth of the right valve directed downward and curving slightly backward, whereas the two corresponding teeth of *S. stewarti* trend downward and forward; the latter also has a heavier and smoother hinge plate.

Three poorly preserved topotypes of *Solyma lineolatum* from Haddonfield, N. J., a left valve about an inch long, a right valve half an inch long, and an incomplete right valve probably three-fourths of an inch long, show certain features in addition to those seen by Conrad. The juvenile right valve, when first uncovered, showed the two cardinal teeth with a slight twist to the rear, essentially as represented in Conrad's figure, but these fragile teeth were accidentally broken off and lost. The other right valve shows these two teeth perfectly. The ligamental groove is narrow and deeply impressed, and the nymph is narrow and plain. The left valve shows one prominent, thin cardinal tooth that is rendered bifid by a shallow but sharply incised channel on its crest and tip. The one cardinal tooth of a left valve of *S. stewarti* is entire, but it represents a much older growth stage. In outline and form the Haddonfield shells are similar to the Texas species but are higher in the posterior part, the beaks are more nearly central, and the concentric markings are more strongly developed; these shells lack even a suggestion of lateral dentition.

In *Solyma levis* Stephenson, from the Snow Hill marl member of the Black Creek formation, Snow Hill, N. C. (1923, p. 331, pl. 82, figs. 1-3), the two cardinal teeth of the right valve are even more strongly oblique toward the front than are those of *S. stewarti*.

It seems doubtful that slight differences in the direction of the cardinal teeth and the absence of a groove on the crest of a tooth in the Texas shells is of sufficient importance to justify generic separation.

⁵ *Solyma*, an abbreviated form of the Greek name, Hierosolyma (Jerusalem), is neuter in gender.

Solyma stewarti Stephenson, n. sp.

Plate 29, figures 1-6

Shell of medium size and inflation, greatest inflation a little above midheight and well in advance of midlength, subelliptical in outline, inequilateral, subequivalve, there being a slight flexure to the left at the posterior extremity. Beaks small, slightly prominent, incurved, nearly direct, approximate, situated about 0.45 the length of the shell from the posterior extremity. Lunule long, narrow, lanceolate, outlined by a sharp, angular edge that separates it from the main shell surface. Escutcheon represented by a long, lanceolate, sub-V-shaped trough, the forward two-thirds of which is nearly filled by the thick ligament. There is a weak but easily recognizable umbonal ridge that forms a wide subobtuse angle in cross section. Fine but somewhat irregularly developed growth lines and gentle undulations cover all of the surface in front of the umbonal ridge; on the flattish posterodorsal slope, the growth lines become distinctly coarser and sharper. Very fine, very obscure radial lining may be seen in a favorable light in places on parts of the surface near the ventral and posterior margins.

Dimensions of the holotype, a shell with both valves intact but shifted slightly from normal position: Length 36.8 mm, height 24.8 mm, thickness about 13.5 mm.

Ligament external, rather thick, about 7 mm long in the holotype; groove narrow and deep; nymph narrow, prominent, somewhat roughened. Hinge with two cardinal teeth in right valve and one in left. In the right valve the cardinals are wedge-shaped, the anterior one rather thin and oblique forward, the posterior one thicker and nearly direct, the two separated by a deep, trigonal, rather narrow socket; there is a shallow, narrow channel on the hinge plate in front of the anterior cardinal and a narrow, deeper channel behind the posterior cardinal. A weak, elongated swelling on the hinge plate in front of the anterior cardinal may represent an anterior lateral, and a small, very short, very obscure swelling below the distal end of the ligament may represent a posterior lateral. In the left valve the one prominent cardinal tooth is wedge-shaped, rather thin, and is slightly oblique forward; it occupies a scoop-shaped depression in the hinge plate, the anterior and posterior parts of which serve as sockets for the reception of the cardinals of the right valve; there is a short, nonprominent protuberance on the hinge plate just back of the posterior socket and just below the forward end of the ligament, which suggest a vestigial tooth. The adductor scars are subequal in area, the anterior one somewhat elongated and the posterior one more broadly ovate. The pallial sinus, as seen on internal molds, is profound, extends to about midlength, rises noticeably, and is broadly

rounded on the forward end. The internal mold exhibits rather weak radial lining in a band paralleling the ventral margin. Inner margin of shell smooth.

Types.—Holotype, U.S.N.M. 105462; 2 paratypes, figured, U.S.N.M. 105463a-b; 6 paratypes, unfigured, U.S.N.M. 105464; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. Honoring R. B. Stewart.

Occurrence.—Johnson County; Loc. 9; Tarrant County: locs. ?11, 14-16, 25, 27, 28, 34, ?35, 38, 47; Grayson County: loc. 107; Fannin County: locs. 179, 180, 184 (types), 191, 195; Lamar County: loc. 2203.

Range.—Dexter member to Lewisville member. Templeton member(?).

Family DONACIDAE

Genus *PROTODONAX* Vokes, 1945

Type species: *Protodonax elongatus* Vokes, from the Colorado group (Upper Cretaceous, Carlile age), 20 miles west of Douglas, Converse County, Wyo. (Vokes, 1945a, pp. 295-308.)

Protodonax lingulatus Stephenson, n. sp.

Plate 30, figures 21-23

Shell of medium size, greatly elongated anteriorly, moderately inflated below the beak, abruptly steepened at the rear, the main surface curving broadly and gently downward to the anterior margin, excessively inequilateral, equivalve. The shell as a whole thins wedge-like toward the front. Beaks broad, slightly protruding, incurved, opisthogyrate at the tip, approximate, situated about four-fifths the length of the shell from the anterior extremity. Umbonal ridge well rounded, nonprominent. Posterodorsal slope divided midway by a weak radial ridge, broadly subobtuse in cross section. Anterodorsal margin long, nearly straight, gently inclined; anterior margin narrowly rounded; ventral margin long, nearly straight, curving gently upward near the extremities; posterior margin sharply rounded below, curving above into the steeply inclined posterodorsal margin. Surface marked with fine concentric growth lines and gentle growth undulations. Under a lens many fine radial lines may be seen on the anterodorsal slope and on the anterior surface of the shell of one of the paratypes; this may be internal shell structure revealed by a slight corrosion of the surface.

Dimensions of the holotype, a right valve: Length 43.5 mm, height 20 mm, convexity about 7 mm.

Ligament external, set in a narrow, deep groove bordered by a short, thick, prominent nymph; a shallow, elongated spoon-shaped depression just below the forward end of the nymph may have been occupied by a partly submerged portion of the ligament. The hinge of the right valve is narrow. Anterior cardinal tooth, as seen in a young shell, narrow, nonprominent, strongly oblique forward, fusing with the margin; in the adult this tooth is virtually crowded out and is represented only by a trace. Posterior cardinal short, of medium thickness, apparently bifid, a little oblique backward;

the two cardinals are separated by a wide, deep, triangular socket; back of the posterior cardinal is a narrow, triangular, moderately deep socket. Anterior pair of lateral claspers very long and narrow, with the posterior half of the inner element thick, strong, and much more prominent than the anterior half; the outer element is narrow and weak, and the two elements are separated by a deep, narrow socket. The anterodorsal margin is traversed by a narrow, shallow groove in which rests the sharp margin of the left valve. Posterior pair of claspers short, with a strong inner element and a weaker outer element, the two separated by a deep channel; this pair of claspers lies below the distal end of the ligamental groove. On both pairs of claspers the walls of the channels separating the inner and outer elements are transversely striated in the direction of movement. Hinge of the left valve not uncovered. Anterior adductor scar somewhat elongate and larger than the subovate posterior scar. Pallial sinus small, shallow, broadly rounded on the inner side. Inner margin smooth.

Types.—Holotype, a right valve, U.S.N.M. 105465; 1 paratype, figured, U.S.N.M. 105466; 6 unfigured paratypes, U.S.N.M. 105467; 4 unfigured paratypes, U.S.N.M. 105468; all the preceding are from near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County. One figured paratype, U.S.N.M. 105469.

Occurrence.—Denton County: Loc. 76 (includes 1 figured paratype); Cooke County: loc. 99; Grayson County: locs. 122 (holotype and 11 paratypes, 1 figured), 131.

Range.—Lewisville member.

Protodonax lingulatus tensus Stephenson, n. var.

Plate 30, figures 24–26

This variety resembles the typical *lingulatus* in form and in the rounded character of the umbonal ridge. It differs in that it is a little more slenderly elongated, the beaks are farther forward, being one-fourth to two-fifths the length of the shell from the posterior extremity, and the hinge is somewhat heavier. The holotype measures: Length 35.5 mm, height 14.5 mm, convexity 5.5 mm.

The species resembles *Protodonax elongatus* Vokes, from beds of upper Benton (Carlile) age, but differs in that the umbonal ridge is more rounded on the crest. (See Vokes, 1945a, p. 298, pl. 46, figs. 1–6.)

Types.—Holotype, a right valve, U.S.N.M. 105470; 2 figured paratypes, U.S.N.M. 105471a-b; 10 unfigured paratypes, U.S.N.M. 105472; 3 unfigured paratypes, U.S.N.M. 105473; all from near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County.

Occurrence.—Tarrant County: Loc. 38; Denton County: loc. 74; Grayson County: loc. 122 (holotype and 15 paratypes, 1 figured).

Range.—Lewisville member.

Protodonax robustus Stephenson, n. sp.

Plate 30, figures 18–20

Shell of medium size, greatly extended anteriorly, proportionately rather strongly inflated below the beak, very steep on the posterodorsal slope, rounding down very gently and broadly to the anterior extremity and to the venter below, strongly inequilateral, equivalve. Beaks broad, moderately prominent, incurved, opisthogyrate, approximate, situated about seven-tenths the length of the shell from the anterior extremity. Umbonal ridge subangular, slightly rounded on the crest, the angle in cross section being a little greater than a right angle. Posterodorsal slope rather conspicuously divided by a low radial ridge bordered on either side by a shallow radial depression. Anterodorsal margin long, very broadly arched; anterior margin sharply rounded, much narrower than a semicircle; ventral margin very broadly rounded; posterior margin subangular below at the end of the umbonal ridge, followed above by a short truncation; posterodorsal margin steeply inclined, nearly straight below the end of the ligamental groove. Surface marked by fine to rather pronounced growth lines; slight corrosion of the anterodorsal surface reveals fine radial structure lines.

Dimensions of the holotype: Length 42 mm, height 22.5 mm, convexity 7.5 mm. The largest paratype, an incomplete internal mold, is about 25 mm high.

Ligamental groove external, short, deeply incised; nymph thick and prominent, with a shallow internal ligamental depression at its forward end. Hinge heavy. Posterior cardinal tooth short, rather thick, oblique backward, bordered behind by a narrow socket and in front by a wide triangular socket. Anterior cardinal obscure. The anterior lateral dentition consists of a pair of greatly elongated claspers, the extremity extending a little past the anterior adductor scar; the inner element of the claspers is thick and prominent in the posterior half of its length but is reduced to a narrow ridge in its anterior half; the outer element is weaker and more uniform in size throughout its length; a narrow groove separates the outer element from the margin. The channel separating the claspers is proportionately wide and shallow, a little wider posteriorly than anteriorly, and in a good light fine striations can be seen on the sides. The posterior lateral dentition consists of a pair of short claspers beneath the end of the ligamental groove; in the holotype the pair is rather badly worn or corroded. As revealed by internal molds the adductor scars are deeply impressed, the pallial sinus is short and shallow, and the inner margin is smooth.

Compared with *Protodonax lingulatus* this species is proportionately more elongated, more inflated, has more

prominent beaks, and is particularly characterized by its angular umbonal ridge and its heavy hinge; as judged by the meager available material the species attains a somewhat greater size than *P. lingulatus*.

This species is similar to *Protodonax oblongus* (Stanton), but the beak is much less prominent and the shell is more elongated in relation to the height. (Stanton, 1894, p. 111.) Compared with *P. cuneatus* (Stanton) the umbonal ridge is not so sharply angular and is more extended posteriorly. The species resembles a group of species described by Vokes (1945a, pp. 295-308), from beds of the age of the Benton shale, the Niobrara formation, and associated formations of the Western Interior but differs from all of them in detail of outline, form, and the angulation of the umbonal ridge. Vokes' species include: *P. elongatus*, *P. stantoni*, *P. sphenicus*, *P. magnus*, *P. umbonianus*, *P. datilensis*, *P. coalvillensis*, *P. exaquilinus*, and *P. chloropagus*.

Types.—Holotype, a right valve, U.S.N.M. 105474; 1 figured paratype, U. S. N. M. 105475; 4 unfigured paratypes, U.S.N.M. 105476; 1 unfigured paratype, U.S.N.M. 105477; all from near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County.

Occurrence.—Grayson County: Loc. 122 (type locality).

Range.—Lewisville member.

Superfamily SOLENACEA

Family SOLENIDAE

Genus LEPTOSOLEN Conrad, 1865

Type species: *Siliquaria biplicata* Conrad (1858, p. 324), from the Owl Creek formation (Upper Cretaceous) on Owl Creek, 2.5 miles northeast of Ripley, Tippah County, Miss.

The name *Leptosolen* was introduced by Conrad (1865, p. 184) as a subgenus of *Solena* Mörch (1853, fasc. 2, p. 7). Later Conrad raised the subgenus to the rank of genus (1867, p. 15).

The oldest representative of *Leptosolen* in the United States is *L. otterensis* Cragin (1894, p. 8) from dark shale in the "Blue Cut" of the Atchison, Topeka, & Santa Fe Railroad, on Otter Creek, a few miles south-southwest of Belvidere, Kans. The containing bed is now considered to be of Kiamichi age. There is a difference of opinion as to whether the Kiamichi formation should be assigned to the upper part of the Fredericksburg group or to the lower part of the Washita group of the Comanche series.

Leptosolen angustus Stephenson, n. sp.

Plate 30, figures 14-17

Shell thin, greatly elongated, moderately convex, strongly inequilateral, equivalve, somewhat compressed anteriorly but warping out slightly and gaping moderately at the front, evenly convex above midheight from the longitude of the beak rearward to the extrem-

ity, with a wide open gape at the rear. Dorsal slope curving steeply over to the margin; ventral slope more gentle, curving broadly down to the margin. Beaks small, compressed, scarcely rising above the dorsal margin, situated about 0.25 the length of the shell from the anterior extremity. Anterodorsal margin relatively short, descending slightly; anterior margin sharply rounded, well above the midheight, curving down broadly into the ventral margin, which is long and straight centrally, curving up gently at the rear; posterior margin broadly rounded to subtruncated; posterodorsal margin long, straight. Shell material, preserved in a fragmentary manner over only parts of the type specimens, indicate fine growth lines over the anterior and lower parts of the surface and flatly compressed, overlapping concentric lamellae, ranging from 0.5 to one millimeter in width over the posterior and upper parts of the surface, each lamella marked with intermediate, faint concentric lines.

Dimensions of the incomplete holotype, a left valve: Length 37 mm, height 10.5 mm, convexity about 3.5 mm.

The ligament is not clearly preserved on the type material but is long and narrow as in the genotype, *Leptosolen biplicatus* (Conrad). Internal molds bear the impression of a narrow, prominent internal rib or buttress extending from below the beaks obliquely downward and a little rearward for about two-thirds the distance to the ventral margin.

In its surface features this species can scarcely be distinguished from *Leptosolen biplicatus* (Conrad), a common species in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain, recorded as ranging stratigraphically from beds as old as the upper part of the Austin Chalk upward to the top of the Cretaceous. However, the internal subumbonal rib of *L. angustus* appears to be consistently narrower and more sharply angular in cross section than the corresponding rib in *L. biplicatus*.

Compared with *Leptosolen otterensis* Cragin, as figured (1894, pp. 8, 9, pl. 1, fig. 2), the oldest representative of the genus in the United States, from the Kiowa shale of Kiamichi (Comanche) age of Kansas, this species is longer in proportion to the height.

Compared with *L. conradi* Meek (see Meek, 1876b, p. 253, pl. 2, figs. 12a-b), the internal radial rib in *L. angustus* is a little wider, longer, and more oblique in trend toward the rear.

Types.—Holotype, U.S.N.M. 105478; 1 figured paratype, U.S.N.M. 105479; both from the Lewisville member in a small branch, north of the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County. One figured paratype, U.S.N.M. 105480.

Occurrence.—Tarrant County: Locs. 11 (1 figured paratype), 41 (holotype and 1 figured paratype), 44; Grayson County: locs. 122, 160, 165, 170, 173; Fannin County: locs. 192, 197.

Range.—Dexter member to Templeton member.

Genus *SENIS* Stephenson, n. gen.

Type species: *Senis elongatus* Stephenson.

Etymology: By anagram from the Latin *ensis*, a sword.
Gender, masculine.

This new genus differs from other nearly related genera in the Solenidae in the absence of teeth in its long smooth hinge. The ligament is external, long, and narrow; the groove is a narrow slit, and the nymph is thin and prominent. The pallial line lies well above the ventral margin, and the pallial sinus is short, of medium width, and rounded on the inner end.

Siliqua huerfanensis Stanton from the so-called *Pugnellus* sandstone (late Eagle Ford age), in Huerfano Park, Colo. (1894, p. 114), is a member of this genus. *Pharella? dakotensis* Meek and Hayden (Meek, 1876b, p. 251) from the Dakota group of the Upper Cretaceous series, mouth of Vermilion River, Nebraska" (now southeastern South Dakota), should also be referred to *Senis*; it is closely similar to *S. elongatus* but appears to be more pointed at the anterior end; its stratigraphic position, low in the Upper Cretaceous series, is nearly the same as that of *S. elongatus*.

Siliqua Megerle, a related genus in American and Oriental Recent seas, is a shorter, higher shell with an internal buttress radiating from beneath the beak, and with two small cardinal teeth in the right valve and three in the left. The Recent *Pharus* Gray, inhabiting European seas, is a related genus, but it also is provided with two teeth in the right valve and three in the left. *Senis* appears to be related to the Recent genera *Noviculina* Benson and *Pharella* Gray, both of which are inhabitants of Oriental seas. They have 2 or 3 small cardinal teeth.

Senis elongatus Stephenson, n. sp.

Plate 30, figures 8-13

Shell of medium size, greatly elongated, moderately compressed, inequilateral, equivalve, narrowing a little in outline toward the front. Beaks very small and inconspicuous, situated about 0.4 the length of the shell from the anterior extremity. Shell thickest centrally, becoming gradually more compressed toward the front and rear, gaping a little at each end, most widely at the front. Lunule and escutcheon wanting. Dorsal margin nearly straight except toward the rear, where it descends gently; anterior margin rather sharply rounded; ventral margin nearly straight or very gently convex, descending slightly toward the rear, so that it is not quite parallel to the dorsal margin; posterior margin subtruncated. Surface with only fine concentric growth lines and gentle undulations.

Approximate dimensions of the holotype, an incomplete specimen in several broken parts: Length 70 mm, height 18 mm, thickness 9.5 mm. A young left valve measures: Length 30.3 mm, height 8 mm.

Ligament external, long (14 mm in the holotype);

groove narrow, deep; nymph thin, prominent. Hinge essentially edentulous. On the interior a low relatively broad swell extends from below and a short distance in front of the beak, obliquely forward and downward, fading out within a distance of 8 or 10 mm in adults. Below and a few millimeters back of the beak a similar narrower swell extends backward and obliquely downward, fading out within a distance of 16 or 18 mm. The anterior adductor scar is elongated, subtriangular in outline, moderately impressed, and is scored with weak radiating lines diverging toward the front. The posterior adductor scar is similar in outline and size to the anterior one but shows only the merest trace of radiating lines. Between the two adductor scars the inner surface is irregularly roughened. The pallial line, as obscurely seen on the internal mold of the holotype, is rather high above the ventral margin and is broadly concave downward in trend; pallial sinus relatively short and rounded on the inner end. Inner margin of shell smooth.

Types.—Holotype, U.S.N.M. 105481; 1 paratype, figured, U.S.N.M. 105482; 5 unfigured paratypes, U.S.N.M. 105483; all from the Lewisville member in a small branch north of the Chicago, Rock Island and Pacific Railroad, about 1 mile west of the Dallas County line, in Tarrant County. One figured paratype, U.S.N.M. 105484.

Occurrence.—Tarrant County: Locs. 725, 41, 44 (holotype and 7 paratypes, 1 figured), 49 (1 figured paratype); Denton County: locs. 74, 76, 79, 81, 90, 91; Cooke County: locs. 98, 99; Grayson County: locs. 107, 122, 132, 223; Red River County: loc. 209.

Range.—Euless member (?); Lewisville member.

Superfamily MACTRACEA

Family MACTRIDAE

Genus *CYMBOPHORA* Gabb, 1869

Type species: *Mactra ashburnerii* Gabb, from the Chico group of California (vol. 1, 1864, p. 153; vol. 2, 1869, p. 180).

Gabb's original description and figures of *Cymbophora* (1869, vol. 2, p. 180), supplemented by Popenoe's subsequent description and figures (1937, p. 397), afford reasonable justification for the assignment of *Cymbophora trigonalis* Stephenson, and other eastern Upper Cretaceous species, to that genus. The agreement, however, is not quite as complete as stated by Popenoe. In *C. trigonalis* the channel between the posterior lateral tooth and the margin in the left valve opens freely forward below the margin, whereas in *M. ashburnerii*, as shown in Popenoe's figure 1 (pl. 49), the lateral tooth appears to converge anteriorly with the margin. In the right valve of *C. gabbiana* (figured by Popenoe) the anterior cardinal tooth is more oblique than the same tooth in *C. trigonalis*, thus allowing freer communication below it from the cardinal socket to the channel separating the anterior claspers. These small differences seem to be of specific rather than of generic rank.

Cymbophora schucherti Stephenson, n. sp.

Plate 31, figures 22-28

Shell large, thick-walled, subtrigonal in outline, inflated, inequilateral, equivalve. Beaks of moderate prominence, prosogyrate, strongly incurved, separated by a space of about 2.5 mm in adults, situated a little in advance of midlength. Antero- and posterodorsal slopes steep, making wide obtuse angles with the main surface. Lunule wide and long, taking up nearly all the area of the anterodorsal slope, circumscribed by a weakly impressed line, and rising gently along the marginal contact to form a low keel. On the outer border of the posterodorsal slope on each valve, bordering its angulation (= umbonal ridge) with the main surface, is a shallow radial depression that increases from a width of less than a millimeter near the beak to a maximum of 6 mm toward the margin; the area inclosed between the depressions of the two valves may be interpreted to be an escutcheon. Anterodorsal margin descending steeply, gently arched; anterior extremity subangular well below midheight; ventral margin broadly rounded, rising a little more steeply at each end; posterior extremity sharply rounded below the midheight; posterodorsal margin steeply descending, broadly arched. The growth markings are very fine on about the umbonal half of the outer surface, beyond which, toward the margin the growth ridges and undulations become noticeably and increasingly coarser.

Dimensions of the holotype, a shell with both valves intact but with part of right valve broken away: Length 41.6 mm, height 41.5 mm, thickness about 33 mm.

Ligament partly external, deeply inset, short, the grooves forming an arrow-like opening pointing to the rear. Resilium internal, set in a large spoon-shaped chondrophore, the bottom of which rests on the hinge plate and the sides of which are formed of upturned laminae that rise prominently above the level of the hinge plate; this chondrophore reaches to the inner rounded margin of the hinge plate, the trend of which is slightly convex inward below the beak. On the left valve one large, prominent trigonal, bifid cardinal tooth is present below the beak; it is separated from the chondrophore behind and from the sharp margin of the shell above by deep narrow channels that unite with each other above the tooth. The lateral teeth are long and prominent, the posterior one being slightly the longer; the trend of both is slightly convex upward, and both are transversely and finely scored on the sides; they are separated from the sharp margin of the shell by narrow, deep channels. On the right valve the posterior cardinal tooth is merged with the upturned anterior edge of the chondrophore and the anterior one is represented by a slight, oblique swelling on the inner side of the shell margin. Anterior and posterior claspers, transversely scored on their inner sides, are present to receive the lateral teeth of the left valve; the

inner element of each pair is thick and strong, the outer one narrow and weak. Impressions on the internal mold show that the adductor scars are subequal in area, of moderate size, situated rather low, and the anterior one conspicuously inset. The pallial line is about 5 mm from the ventral margin in adults, and the pallial sinus is small, subtrigonal, and pointed directly forward. Inner margin smooth.

The hinge of this species appears to be essentially like that of the typical *Cymbophora ashburnerii* (Gabb), but the shell is heavier, more inflated, and shorter. Honoring the late Charles Schuchert.

Types.—Holotype, U.S.N.M. 105485; 1 figured paratype, U.S.N.M. 105486; 3 unfigured paratypes, U.S.N.M. 105487; 5 unfigured paratypes, U.S.N.M. 105488; these are from a branch, north of the Chicago, Rock Island and Pacific Railroad in Tarrant County, 1 mile west of the Dallas County line. One figured paratype, U.S.N.M. 105490; 1 unfigured paratype, U.S.N.M. 105491; 1 figured paratype, U.S.N.M. 105489.

Occurrence.—Hill County: Locs. 3, 7, 8; Tarrant County: locs. 37, 38 (includes 1 paratype, figured), 41, 44 (holotype and 9 paratypes, 1 figured); Denton County: locs. 72, 74, 76 (2 paratypes, 1 figured), 78, 79, 81, 83, 84, 90; Cooke County: loc. 99; Grayson County: locs. 116, 122, 126, 132; Fannin County: loc. 183.

Range.—Lewisville member.

Cymbophora spooneri Stephenson, n. sp.

Plate 30, figures 1-7

Shell relatively short for the genus, subtrigonal in outline, moderately inflated, with the maximum broadly inflated part near midlength and a little above midheight, slightly inequilateral, equivalve. Beaks prominent, strongly incurved, prosogyrate, separated by a space of 1 mm or less, situated a little in advance of midlength. Lunule large, outlined by a weak line. Escutcheon not sharply defined. Dorsal slopes steep. There is a weakly developed, obtusely subangular umbonal ridge extending to the lower posterior extremity; immediately back of the umbonal ridge is a narrow, flattened, radial band bordered behind by an obscure radial ridge. The main surface is ornamented with fine but not sharp-edged, somewhat irregular concentric growth lines. On the steeper part of the anterodorsal slope, within the lunule, and on the posterodorsal slope behind the obscure ridge mentioned above, the concentric ridges are markedly coarser, sharper, and more regular than on the main surface.

Dimensions of the holotype, an incomplete left valve: Length 19.5+ mm, height 17 mm, convexity 8 mm. Dimensions of a smaller specimen with the two valves intact: Length 12.2 mm, height 10 mm, thickness 7.2 mm.

The ligament appears to be essentially normal for the genus. It is in two parts, an outer, short, partly submerged part occupying the margin of a narrow, oblique marginal notch, and an inner part, or resilium, set, on the hinge plate in a spoon-shaped resilifer with

upcurved side walls. The bottom of the resilifer is about flush with, or depressed slightly below, the surface of the hinge plate. This resilifer is incompletely preserved, the upturned edges being broken away. The one cardinal tooth of the left valve as seen in one specimen is imperfect, but it appears to be prominent and trigonal, with a broad, shallow notch on the inner face; it is separated from the upturned edge of the resilifer by a narrow slit. The lateral teeth are normal, with sides transversely striated as in *C. trigonalis*. The anterior cardinal of the right valve is rather strong and is well separated from the marginal wall of the shell; it is in line with the inner element of the anterior lateral claspers. The posterior cardinal, as seen preserved in one young shell, is thin and is separated from the upturned margin of the resilifer by a narrow slit. The inner elements of the lateral claspers are strong and the outer weak and merged with the marginal wall. The pallial line as seen on an internal mold is punctate, and the pallial sinus is short, narrow, rises steeply, and is rounded on the inner end. Inner margin smooth.

This species is similar to *C. securis* but is shorter and plumper and differs in hinge details.

Types.—Holotype, an incomplete left valve, U.S.N.M. 105492; 2 figured paratypes, U.S.N.M. 105493a-b; 4 unfigured paratypes, U.S.N.M. 105494; all from the Lewisville member near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County. One paratype, figured, U.S.N.M. 105495; 1 paratype, figured, U.S.N.M. 105496; 1 paratype, figured, U.S.N.M. 105497; 1 unfigured paratype, U.S.N.M. 105498. Honoring W. C. Spooner.

Occurrence.—Hill County: Locs. 3, 4, 7; Johnson County: loc. 9; Tarrant County: locs. 37, 39 (1 figured paratype), 44, 53; Denton County: loc. 93; Cooke County: loc. 99; Grayson County: locs. 122 (holotype, and 6 paratypes, 2 figured), 126, 131, 132, 158 (1 paratype, figured), 160 (2 paratypes, 1 figured), 162, 170, 171, 173; Fannin County: loc. 193; Lamar County: loc. 201.

Range.—Lewisville member to Templeton member.

Cymbophora securis Stephenson, n. sp.

Plate 31, figures 18-21

Representatives of this species are present in great numbers at the type locality in Grayson County. Shell of medium size, subtrigonal in outline, moderately inflated, with maximum inflation near midlength and above midheight, subequilateral, equivalve. Beaks prominent, rather broad, strongly incurved, prosogyrate, situated about two-fifths the length of the shell from the anterior extremity. Lunule broad, long, limited by an impressed line of variable strength on different individuals. Escutcheon wide and long, outlined by a weak subangulation. Dorsal slopes steep to overhanging. Umbonal ridge nonprominent, obtusely subangular in cross section, sinuous in trend. Anterodorsal margin descending, slightly arched; anterior margin sharply rounded; ventral margin broadly rounded; posterior margin sharply rounded below,

rounding into the broadly arched posterodorsal margin above. Main surface marked with fine, somewhat irregular growth lines that become a little coarser ventrally. On the dorsal slopes within the limits of the lunule and escutcheon the growth markings are markedly coarser, sharp-crested, and more regular.

Dimensions of the holotype, a nearly complete shell: Length 18.5 mm, height 15.4 mm, thickness 11.5 mm. There is some individual variation in the proportion of length to height.

The details of the ligament and hinge are not clearly revealed in the numerous specimens available, most of which have the two valves tightly closed. Enough can be seen, however, to show that the features of both the ligament and hinge are essentially like those of *Cymbophora puteana*, the details of which are described on a following page. The pallial sinus is of moderate depth, narrow, and rounded on the inner end; it is like the pallial sinus of *C. spooneri*, except that it rises more steeply inward.

The species is similar to *C. puteana* in form and surface features except that it is shorter in proportion to the height, is a little less plumply inflated, and is consistently smaller.

Types.—Holotype, U.S.N.M. 105499; 1 figured paratype, U.S.N.M. 105500; 70 selected unfigured paratypes, U.S.N.M. 105501; all from the Templeton member in a bluff on a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County. One figured paratype, U.S.N.M. 105502.

Occurrence.—Grayson County: Locs. 152, 163, 164, 165 (holotype and 70+ selected unfigured paratypes), 167 (includes 1 figured paratype); Fannin County: loc. 192.

Range.—Lewisville member to Templeton member.

Cymbophora puteana Stephenson, n. sp.

Plate 31, figures 14-17

This species is similar in form, surface, and internal features to *Cymbophora securis* except that it is proportionately a little larger, longer, and more inflated.

Dimensions of the holotype: Length 23 mm, height 17 mm, thickness 12.4 mm.

The ligament is normal for the genus, being in two parts, an outer, partly submerged part occupying a narrow, short, oblique slit just back of the beak and an inner part occupying an oblique, spoon-shaped resilifer set on the hinge plate, with upcurved sides rising markedly above the level of the plate. The one cardinal tooth of the left valve is elongate-trigonal, rises prominently, and is rendered slightly bifid by a weak notch on the inner side. This tooth is in alignment with a rather strong anterior lateral tooth, from which it is incompletely separated by a wide V-shaped notch. The cardinal and lateral teeth are separated from the outer margin of the shell by a narrow, deep, continuous channel, which appears to be only partly occupied by the opposing weak outer lateral of the right valve; the lateral tooth is striated on the sides in the direction of

movement. The posterior left lateral dentition consists of a strong, striated tooth longer than the anterior lateral, separated from the margin of the shell by a sharply incised channel; both tooth and channel are broadly arched in trend parallel to the margin. The right valve bears two subequal cardinal teeth, the anterior one short, prominent, oblique, situated about halfway up the inner marginal slope. The posterior cardinal is prominent and is directed downward and slightly backward; it is separated from the anterior cardinal by a deep triangular socket; the upraised anterior margin of the resilifer is cemented above against the side of the posterior cardinal but is separated from it below by a narrow fissure. The anterior and posterior cardinals are distinctly separated from each other at their upper ends. The anterior lateral dentition of the right valve consists of a pair of claspers, the inner element of which is long and strong and the outer element short, weak, and partly merged with the margin of the shell; the separating socket is striated on the sides. The posterior dentition is similar to that of the anterior but is longer and broadly arched in trend; the separating socket is striated. Pallial sinus narrow, of medium length, rounded on the inner end. Inner margin of shell smooth.

The hinge of the left valve of this species appears to agree in most essential features with that of *Cymbophora ashburnerii* (Gabb), the type species of the genus, as figured by Popenoe (1937, p. 397). In the latter, the posterior lateral appears in the figure (pl. 49, fig. 1) to extend obliquely forward and upward across the hinge plate, merging with the outer shell margin. The figure, however, may be misleading, due in part to breakage along the margin of the shell and perhaps in part to a slight error in retouching. In *C. puteana* this lateral is separated from the margin by a channel, and the same is true of *C. gabbiana* (Anderson), the hinge of which I have succeeded in uncovering in duplicate material in the National Museum. Popenoe states that the hinge of *C. gabbiana* "accords in all ways" with that of *C. ashburnerii*. With the exception of minor differences, the hinge of the right valve of *C. puteana* appears to be essentially like that of *C. gabbiana*, as determined by comparison with duplicate specimens in the National Museum.

Compared with *Cymbophora spooneri* this species is more sharply trigonal and is less plumply inflated, and there are some noticeable hinge differences. In *C. spooneri* the inner element of the anterior claspers of the right valve is in alignment with the anterior cardinal tooth, and the outer element appears to have merged almost completely with the shell margin, whereas in *C. puteana* the outer element, though smaller and shorter than the inner element, is distinctly developed and is in line with the anterior cardinal. In *C. puteana* the outer element of the posterior claspers,

though weaker and shorter than the inner element, is distinct, whereas in *C. spooneri* the outer element is represented by a mere trace on the inner slope of the shell margin. *C. schucherti* is a much larger, thicker, shorter, and more trigonal species than either *C. puteana* or *C. spooneri*.

Types.—Holotype, U.S.N.M. 105503; 2 figured paratypes, U.S.N.M. 105504; 20 unfigured paratypes, U.S.N.M. 105505; all from a borrow pit south of the Chicago, Rock Island and Pacific Railroad, about 0.9 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Loc. 50 (holotype and 2 figured paratypes); Denton County: loc. 89; Fannin County: loc. 183.

Range.—Lewisville member.

Cymbophora? saccellana Stephenson, n. sp.

Plate 31, figures 11, 12

Shell of medium size, relatively compressed, broadly subovate in outline, somewhat extended in the posteroventral direction, inequilateral. Beak broken away but obviously moderately prominent, incurved, prosogyrate, situated about three-tenths the length of the shell from the anterior extremity. Umbonal ridge broadly rounded. Anterodorsal slope short, moderately steep; posterodorsal slope less steep, broadly arched in profile in the radial direction. Anterior margin rounded less than a semicircle; ventral margin broadly rounded, rising more steeply toward the front; posterior margin sharply rounded below, truncated and inclined forward above, rounding into the short, gently arched posterodorsal margin. Surface marked concentrically with fine lines of slightly uneven strength, which become sharper and more distinct on the dorsal slopes.

Dimensions of the only available specimen, a left valve: Length 28.3 mm, height about 29.5 mm, convexity about 6.5 mm.

The cardinal and anterolateral dentitions are broken away; posterior lateral tooth distant, of moderate length and strength, and, though corroded, shows faintly the markings of transverse striations.

Compared with *Cymbophora schucherti* this species is laterally much more compressed, the dorsal slopes are much less steep, and there is no angulation of the surface where the dorsal slopes pass over into the main lateral surface of the shell.

Types.—Holotype, U.S.N.M. 105506; from near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County.

Occurrence.—Grayson County: Loc. 122.

Range.—Lewisville member.

Unidentified specimens of *Cymbophora*

Internal and external molds of a small, smooth bivalve having the form of *Cymbophora* are numerous in ferruginous sandstone of the Lewisville member on State Highway 22, 2 miles east of Whitney, Hill County

(loc. 3). The hinge appears to be that of *Cymbophora*. An internal mold measures: Length 12.5 mm, height 10 mm, convexity about 3.5 mm. U.S.N.M. 105507.

An incomplete, elongated, subtrigonal internal mold of a right valve, from the Lewisville member on Timber Creek, 2.5 miles south-southwest of Lewisville, Denton County (loc. 81), is referred doubtfully to *Cymbophora*. Some shell material adheres to the mold. The specimen is 28+ mm long, 20 mm high, and has a convexity of about 6.5 mm. The umbonal ridge is fairly distinct and is broadly subobtuse in cross section. The posterodorsal slope is steep but not excavated, and the posterior end is subtruncated. U.S.N.M. 105508.

Genus PRISCOMACTRA Stephenson, n. gen.

Type species: *Priscomactra cymba* Stephenson.

Etymology: Latin *priscus*, ancient; *Mactra*.

In outline, form, and surface features this genus resembles the genera *Cymbophora* Gabb, *Spisula* Gray, and *Mactra* Linné but differs from all of them in the character of its ligamental apparatus and in certain of its hinge features. The outer part of the ligament is completely external and is set in a deep narrow groove, which in *Priscomactra cymba* is about 4 mm long; the outer part is separated from the inner part, or resilium, by a thick, prominent ridge of shell material that stands even higher than the outer shell surface; the resilium differs from that of the other genera mentioned in that the resilifer on which it is seated, instead of being deep-seated in or on the hinge plate, is an elevated, slightly concave platform that slopes gently from the crest of the separating ridge forward to the posterior cardinal tooth. The proportionately heavy, trigonal anterior cardinal tooth of the left valve is less completely bifid than that of either *Mactra* or *Cymbophora*; in *Spisula* this tooth is small and nonbifid. The lateral dentition is well developed, and the sides of the teeth and claspers are finely and obscurely striated at right angles to the hinge plate.

The ligament and hinge of *Priscomactra* are similar to those of *Geltena*, except in minor details, but its subtrigonal outline and mactroid form serve to distinguish it from the broadly subovate to subcircular and more rotund species of *Geltena*.

***Priscomactra cymba* Stephenson, n. sp.**

Plate 31, figures 6-10

Shell small, subtrigonal in outline, moderately inflated, slightly inequilateral, equivalve. Anterodorsal slope steep to slightly overhanging toward the beak; posterodorsal slope less steep. Umbonal ridge of medium prominence, sinuous, forming a subobtuse angle in cross section, extending to the lower posterior extremity. Lunule rather wide, of moderate length, very obscurely outlined. Beaks prominent, incurved, very slightly opisthogyrate at the tip, situated about

two-fifths the length of the shell from the anterior extremity. Anterodorsal margin nearly straight, steeply descending; anterior margin sharply rounded below midheight; ventral margin broadly rounded; posterior margin subangular at end of umbonal ridge; posterodorsal margin broadly arched, steeply descending. Over the main surface the incremental lines are fine, becoming a little coarser near the ventral margin; on the anterodorsal slope the lines become a little stronger and sharper and on the posterodorsal slope much sharper, producing a decidedly roughened surface.

Dimensions of the holotype, a shell with both valves intact but with right valve incomplete in the umbonal region: Length 24.8 mm, height 20 mm, thickness 13.2 mm.

Outer layer of ligament completely external, short, thick; groove narrow, deeply impressed; internal layer of ligament (resilium) occupying a shallow resilifer on a platform which, at the rear, is elevated well above the hinge plate and slopes gently forward to the posterior cardinal tooth; this raised resilifer is in strong contrast to the deeply sunken resilifer of a typical *Mactra*. Cardinal teeth, two in each valve. In the left valve the anterior cardinal is heavy, prominent, trigonal, bifid, with the anterior element extending well forward; this tooth is separated from the sharp margin of the shell above by a narrow, deep channel; the posterior cardinal is short, thin, slightly oblique backward and is separated from the anterior cardinal by a narrow, deep socket; the laterals are short, prominent, about equally distant from the cardinal area and are finely and obscurely striate on the sides. The anterior cardinal of the right valve is thin, strongly oblique, and is fused against the margin of the shell, only the upper edge being separated from the margin by a narrow, shallow groove; the posterior cardinal is prominent, rather narrow, slightly oblique backward, and separated from the anterior cardinal by a wide, deep, trigonal socket; a narrow, moderately deep socket separates the posterior cardinal from the resilifer; the lateral pairs of claspers are each formed of a strong inner tooth and a weak outer tooth fused against the margin, and the two teeth in each pair are separated by a deep socket for the reception of the corresponding lateral of the left valve. Adductor scars distinctly impressed; anterior scar somewhat elongated; posterior scar larger and broadly subovate. Pallial sinus small, shallow, rounded on the inner end. Inner margin smooth.

Types.—Holotype, U.S.N.M. 105509; 3 figured paratypes, U.S.N.M. 105510a-c; 28+ selected unfigured paratypes, U.S.N.M. 105511; these are from the Lewisville member near the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County. Twenty-four selected unfigured paratypes, U.S.N.M. 105512; 2 unfigured paratypes, U.S.N.M. 105513.

Occurrence.—Tarrant County: Locs. 16, 37, 38 (holotype and 31+ selected paratypes, 3 figured), 39, 41, 44 (24 selected un-

figured paratypes), 49; Denton County: locs. 72, 74, 76, 77, 78, 79, 81, 84, 90; Cooke County: locs. 98, 99; Grayson County: loc. 122 (2 paratypes, unfigured); Fannin County: loc. 179.

Range.—Dexter member to Lewisville member.

Priscomactra munda Stephenson, n. sp.

Plate 31, figure 13

Shell small for the genus, thin-walled, somewhat elongated, not strongly inflated, inequilateral, equivalve. Beaks of moderate prominence, incurved, slightly progogyrate, situated about 0.45 the length of the shell from the anterior extremity. Umbonal ridge distinct but not prominent; posterodorsal slope rather steep. From the umbonal inflation the surface slopes broadly to the ventral and anterior margins. Anterodorsal margin nearly straight; anterior margin narrowly rounded; ventral margin broadly rounded; posterior margin sharply rounded below, subtruncated and inclined forward above, rounding into the broadly arched posterodorsal margin. Surface marked only with incremental lines that become sharp and distinct on the dorsal slopes.

Dimensions of the holotype, a right valve: Length 13.5 mm, height 9.5 mm, convexity about 2.5 mm.

The hinge and ligamental apparatus of this species, as seen poorly preserved in the holotype, though thin and delicate, appear to be essentially like those of *Priscomactra cymba*. The shell possesses a short, narrow, completely external ligamental groove, and the inner part of the ligament is seated on an elevated resilifer. The pallial sinus is small and shallow.

Compared with *P. cymba*, the species is smaller, more elongated in outline and less inflated.

Types.—Holotype, U.S.N.M. 105514; 9 unfigured paratypes, U.S.N.M. 105515; all from the Lewisville member in a small branch, north of the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. ?11, 41 (types), 44.

Range.—Dexter member (?); Lewisville member.

Priscomactra sp.

Seven internal molds, one with hinge features preserved, from the Lewisville member in a gully east of the Whitesboro road, 1.75 miles south of Sandusky, Grayson County (loc. 117), belong to *Priscomactra*, probably an undescribed species, but are inadequate for satisfactory specific assignment. The shell is subtrigonal in outline and resembles *P. cymba* but is more inflated and has a more prominent umbo and umbonal ridge. The largest mold measures: Length about 22 mm, height 19 mm, convexity about 6 mm. U.S.N.M. 105516.

Genus *ALIOMACTRA* Stephenson, n. gen.

Type species: *Aliomactra compressa* Stephenson.

Etymology: Latin *alius*, another; *Mactra*.

In surface features, outline, and form this genus resembles *Mactra* Linné, *Cymbophora* Gabb, and *Priscomactra* Stephenson, except that it is more compressed.

Its ligamental apparatus and dentition differ from all of those genera. As in *Priscomactra*, there is a short, external ligament seated in a narrow groove, but the internal part of the ligament, instead of occupying a spoon-shaped resilifer resting on the hinge plate, is seated on a surface that slopes from the nymph steeply downward and forward, the lower edge cutting a little into the hinge plate; the great length of the anterior lateral dentition is in contrast to that of the corresponding laterals of *Priscomactra*. On *Cymbophora* the lack of an external ligamental groove, the absence of an elevated, thickened calcareous plate separating the external and internal ligamental elements, the short anterior lateral dentition, and the presence of strong transverse striations on the sides of the lateral teeth and sockets serve to separate it from *Aliomactra*. The true *Mactra* has the resilifer inset into the hinge plate instead of resting on it or being elevated above it and has the inner ligamental element separated from the partly immersed outer element by a narrow, nonprominent, calcareous ridge; it has short, smooth laterals. In *Aliomactra* the pallial sinus is considerably wider and deeper than in any of the other mactroid genera here described. Other minor differences separate the four genera here compared.

Aliomactra compressa Stephenson, n. sp.

Plate 31, figures 1-5

Shell of medium size, compressed, shell wall thin, subtrigonal in outline, subequilateral, equivalve; there is some individual variation in the proportion of length to height. Beaks small, slightly prominent, incurved, nearly direct, with the tips about 1 mm apart, situated a little in advance of midlength. Lunule and escutcheon obscure or wanting. Dorsal slopes steep on either side of the beak, broadening out away from the beak in both directions. Anterodorsal margin descending, nearly straight; anterior margin rounded less than a semicircle near midheight; ventral margin broadly rounded; posterior margin obtusely subangular near midheight; posterodorsal margin very broadly arched, descending. The surface of the main shell presents fine growth lines and gentle undulations, and on the dorsal slopes the growth markings become a little stronger and coarser.

Dimensions of the holotype, an incomplete right valve: Length 37+ mm, height 28+ mm, convexity about 7.5 mm. A more elongated internal mold measures: Length 35 mm, height 25 mm, convexity about 6 mm.

The outer part of the ligament is completely external, and in each valve, is set in a narrow groove that extends obliquely backward about 3 mm to the inner margin. The internal part of the ligament, or resilium, rests on a resilifer that is proportionately large and deep and forms a steep, forward-tilted, broadly concave depres-

sion on the side of a prominent, thickened mass of shell substance that slopes upward and forms a pronounced nymph separating the external ligamental element from the resilium. In the left valve a prominent, deeply bifid cardinal tooth having the form of an inverted V rises above the deep resilifer. In front of this cardinal a long, thin, smooth lateral tooth extends more than halfway to the anterior end and is separated from the margin of the shell by a narrow, moderately deep channel. The posterior lateral is only about half as long as the anterior one and is also separated from the margin by a channel. In the right valve a thin cardinal tooth, somewhat oblique backward, rises prominently in front of the resilifer; in front of this tooth is a wide, deep trigonal socket that receives the bifid cardinal of the left valve, and in front of this socket is an obscurely developed anterior cardinal not sharply separated from the inner side of the marginal wall of the shell. The anterior lateral pair of claspers of the right valve consists of an inner tooth, as long as the corresponding lateral tooth of the left valve, and the margin of the shell, which serves as an outer clasper element; the posterior pair of claspers includes a relatively long inner element and a short outer element, which is separated from the margin of the shell by a channel. The pallial line as seen on one internal mold is punctate, and the pallial sinus is of moderate width and depth and well rounded on the inner end. The adductor scars are small and lie slightly above midheight; the anterior one is elongated and the posterior one subcircular. Inner margin of shell smooth.

Types.—Holotype, a right valve, U.S.N.M. 105517; 2 figured paratypes, U.S.N.M. 105518a-b; 2 unfigured paratypes, U.S.N.M. 105519; all from the Templeton member on an east-west road near head of a small branch, 3 miles northeast of Sherman Junction, Grayson County. One figured paratype, U.S.N.M. 105520.

Occurrence.—Tarrant County: Locs. 228, 34 (1 paratype, figured), 38, 41; Cooke County: loc. 99; Grayson County: locs. 160 (holotype and 4 paratypes, 2 figured), 170, 171.

Range.—Eules member (?); Templeton member.

Aliomacra? sp.

One poorly preserved internal mold of a left valve in ferruginous sandstone of the Dexter member in the bed of Rush Creek, 3 miles east by south of Handley, Tarrant County (loc. 14), has the outline and form of *Aliomacra compressa* except that it is proportionately shorter and higher. It measures: Length 23 mm, height 19.3 mm, convexity about 6 mm. U.S.N.M. 105521.

Genus *GELTENA* Stephenson, 1946

Type species: *Geltena subequilatera* Stephenson. (In Vokes, 1946, pp. 201-204.)

Etymology: By anagram from "elegant"; gender, feminine.

This genus is characterized by its broadly subovate to subcircular outline; its moderate to strong inflation;

its nearly direct beaks; its smooth surface, which on the main part presents only fine concentric lining; a long and broad lunule bounded by a weakly impressed line and having fine sharp concentric surface markings; a weak umbonal ridge; a posterodorsal slope somewhat roughened by stronger concentric lining; the presence of two cardinal teeth in each valve, of which the anterior one in the left valve is bifid; well-developed lateral teeth; shallow pallial sinus; and smooth inner margin.

In the features of its ligament and hinge *Geltena* agrees with *Priscomacra* except in minor details. In the latter genus the nymph stands out more prominently at its posterior end, the resilifer appears to be a little more deeply sunken, the anterior cardinal tooth of the left valve is more distinctly bifid, and there is a slightly more open connection between the anterior cardinal sockets of the valves and the anterior lateral sockets. The lateral teeth are less distinctly striated in the direction of movement. The two genera differ from each other mainly in outline and form. *Priscomacra* is distinctly subtrigonal in outline and mactroid in form, and its beaks are prosogyrate; it is represented in the Woodbine fauna by two species, *P. cymba* and *P. munda*. *Geltena* is subcircular to broadly subovate in outline; its beaks are nearly direct; and the genus tends toward a plumper form, some species being more rotund than others, the species *G. subcompressa* being the least rotund and *G. obesa* the most rotund of the five species referred to the genus.

Geltena subequilatera Stephenson

Plate 32, figures 25-29

1946. *Geltena subequilatera* Stephenson. (In Vokes, 1946, pp. 201-204, pl. 10, figs. 1-6.)

Shell of medium size for the genus, broadly subovate in outline, subequilateral, equivalve, rather strongly inflated, greatest inflation about midway of the length at two-thirds the height. Umbonal ridge weakly developed, making a very broad subobtuse angle in cross section. Antero- and posterodorsal slopes of nearly equal steepness. Beaks moderately prominent, nearly direct, incurved, about half a millimeter apart on the holotype, situated slightly in advance of midlength. Anterior margin rather narrowly rounded; ventral margin broadly rounded; posterior margin somewhat variable, ranging from equal in curvature to the anterior margin to somewhat more fully rounded, with a slight tendency to subtruncation. Lunule long, rather wide, outlined by a weakly impressed line. Main surface smooth and polished, marked only by very fine growth lines and gentle undulations; on the lunule and on the posterodorsal slope the growth lines become sharper and coarser.

Dimensions of the holotype: Length 20 mm, height 17.8 mm, thickness 11.8 mm. Dimensions of a smaller paratype: Length 17.4 mm, height 15.5 mm, thickness

10.3 mm. The largest individuals attain a length of about 24 mm.

External part of ligament short, set in a narrow, deep groove. Below the anterior end of the groove is a shallow, spoon-shaped resilifer dipping forward toward the posterior cardinal tooth. Hinge narrow but dentition sharply developed. Left valve with two cardinal teeth separated by a deep, triangular socket of medium width; anterior cardinal thick, triangular, weakly bifid, directed downward and slightly forward; posterior cardinal narrow, nonprominent, oblique. Anterior and posterior laterals about equally distant from the beaks, strong, short, finely and obscurely striated in the direction of movement, each separated from the margin by a wide, moderately deep channel. Hinge of right valve with two cardinal teeth separated by a wide, deep, triangular socket; anterior cardinal long, narrow, strongly oblique, fused against the margin of the shell; posterior cardinal rather thick, directed downward and a little backward, with a deep, very narrow socket behind it. Well-developed claspers receive the laterals of the left valve; the inner element of each pair is the stronger. Pallial line not seen well preserved throughout, but on the right side of the holotype, the pallial sinus is exposed and forms a shallow, gently arched indentation. Inner margin entire.

Compared with the species *G. prunoides* and *G. nitida*, this species is noticeably less plumply inflated, more triangular in outline, and more nearly equilateral.

Types.—Holotype U.S.N.M. 103761; 3 figured paratypes, U.S.N.M. 103762; 15 selected unfigured paratypes, U.S.N.M. 105522; all from the Lewisville member on Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 11, 28, 34, 35 (type locality); Grayson County: loc. 123.

Range.—Dexter member to Lewisville member.

Geltena obesa Stephenson, n. sp.

Plate 32, figures 30–33

The holotype and four paratypes consist of poorly preserved shell substance adhering to internal molds. The other paratypes are molds in ferruginous sandstone. Shell large for the genus, very broadly subovate in outline, strongly and plumply convex, slightly inequilateral, equivalve. Umbonal ridge very weakly developed, represented by a broad swell, with a suggestion of broad subobtuse angularity in some specimens. Greatest inflation about midway of the length a little above midheight, from which point the surface in adults rounds down steeply to the anterior, ventral, and posterior margins. Anterodorsal slope steep, overhanging; posterodorsal slope steep, slightly overhanging toward the beak. Beaks prominent, strongly incurved, prosogyrate, situated slightly in advance of midlength. Anterior margin regularly rounded, narrower than a semicircle; ventral margin regularly rounded, more open

than a semicircle; posterior margin subequal in outline to the anterior. Lunule broad and long but very obscurely outlined in the available material. Growth lines on main surface fine; growth undulations weak and narrow. Obscure; fine radiating lines present on some specimens with shell material preserved. Growth markings sharper and more pronounced on both the antero- and posterodorsal slopes.

Dimensions of the incomplete holotype: Length 42+ mm, height 38.5 mm, convexity about 15 mm. Dimensions of an internal mold of both valves: Length 39 mm, height 37 mm, thickness 29 mm.

The hinge is not well preserved in the available material, but squeezes made from imprints in the ferruginous matrix indicate a hinge essentially like that of the genotype, *Geltena subequilatera*. There is a short, narrow, external ligamental groove. The nymph is strong and flattish on the surface of attachment.

Compared with the other species of *Geltena*, this one is much larger and more plumply inflated; it is more nearly circular in outline than the genotype, *subequilatera*.

Types.—Holotype, an incomplete right valve, U.S.N.M. 105523; 1 paratype, figured, U.S.N.M. 105524; 3 unfigured paratypes, U.S.N.M. 105525; all from a headwater branch of Walnut Creek, about 0.7 mile north of Gordonville, Grayson County. One figured paratype, U.S.N.M. 105526; 13 unfigured paratypes, U.S.N.M. 105527.

Occurrence.—Cooke County: Loc. 99; Grayson County: locs. 114 (holotype, 4 paratypes, 1 figured), 117, 121, 123, 126 (14 selected paratypes, 1 figured), ?127, 130, 132, 223, 227.

Range.—Lewisville member.

Geltena nitida Stephenson, n. sp.

Plate 32, figures 21–24

This species is represented chiefly by molds; some shell material adheres to questionably identified internal molds from several localities. The species is very similar to *Geltena prunoides* in most of its characters, but its length is greater in proportion to its height, the beaks appear to be slightly farther forward, and the average size is greater. The shell is plump and nearly smooth, the growth lines being very fine. The posterodorsal area back of the umbonal ridge is a flattish to slightly excavated band, and this band is separated from the margin by a narrower flattened escutcheon-like band, with which it makes a wide obtuse angle in cross section; on this narrower band are sharply developed, fine growth ridges. An external mold shows a rather wide lunule bounded by a faintly impressed line; the lunule is covered with fine, sharp, concentric ridges.

An internal mold, which appears to be nearly perfect as to form, is selected as holotype. It measures: Length 25.4 mm, height 21.7 mm, thickness 14.9 mm. Internal molds referred to this species reach a maximum measured length of 36 mm.

The hinge dentition is like that in *Geltena prunoides*. The anterior adductor scar is a little more elongated than the posterior one. The pallial line, as clearly shown on one internal mold, is punctate as far back as the beginning of the shallow, gently arched pallial sinus. Obscure radial lines and ridges appear on some internal molds. Inner margin entire.

Types.—Holotype, an internal mold, U.S.N.M. 105528; 2 figured paratypes, U.S.N.M. 105529a-b; 14 paratypes, unfigured, U.S.N.M. 105530; all from the Lewisville member on Johnson Creek, 1.5 miles northeast of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 20, 22, 34, 37, 38, 41, 47 (types); Grayson County: locs. 107, 123.

Range.—Euless member to Lewisville member.

Geltena prunoides Stephenson, n. sp.

Plate 32, figures 34, 35

This species is based on molds in fine ferruginous sandstone. Shell of medium size, thin-walled, subcircular to broadly subovate in outline, plumply inflated, subequilateral, equivalve. There is a weak umbonal ridge that is broadly subobtuse in cross section; back of this ridge the posterodorsal slope forms a flattened band that is radially a little sinuous. Beaks nearly central, moderately prominent, incurved, nearly direct, apparently a little separated. Anterior margin rather narrowly rounded; ventral margin a little more broadly rounded than a semicircle; posterior margin subtruncated; dorsal margins broadly arched. The surface, as shown by fragments of external molds, is smooth with the exception of fine growth lines, which become noticeably sharper and more closely crowded on the anterodorsal slope.

Approximate dimensions of the holotype, an internal mold with the two valves partly separated: Length 19 mm, height 18 mm, thickness about 14 mm. Individuals may attain a length of 25 mm.

Ligamental groove not seen. Hinge of left valve with two cardinal teeth, the posterior one narrow, short, oblique, the anterior one large, triangular, bifid, the two separated by a deep, triangular socket; back of the posterior tooth is a narrow, shallow, oblique socket. Hinge of right valve with two narrow cardinal teeth separated by a profound, wide, triangular socket; back of the posterior tooth is a narrow, deep, oblique socket; the anterior cardinal is nearly parallel to the margin of the shell. Lateral teeth are present on the left valve, and these fit into claspers on the right valve; the laterals are narrow, rather long, and are at moderate distances from the cardinal area, the posterior one being a little the farther removed. The adductor scars and pallial line are obscure on the internal molds; the pallial line appears to be slightly indented near the posterior adductor. Fine, obscure radiating lines are present on the internal molds. Inner margin entire.

This species is similar to *Geltena nitida* in most of its

features but is more nearly circular in outline and its beaks are more nearly central.

Types.—Holotype, U.S.N.M. 105531; 10 unfigured paratypes, all molds, U.S.N.M. 105532; all "from Johnson Creek, 2 miles [sic; probably 1.5 miles] northeast of Arlington, Tarrant County."

Occurrence.—Tarrant County. Locs. 34 (types), 47.

Range.—Lewisville member.

Geltena subcompressa Stephenson, n. sp.

Plate 32, figure 20

The available material consists of molds only. Shell of medium size, subovate in outline, moderately inflated, subequilateral, equivalve. Umbonal ridge present but obscure. Beaks nearly direct, incurved, situated very slightly in advance of midlength. Anterodorsal margin gently descending, broadly arched; anterior margin narrowly rounded; ventral margin fullest centrally, becoming less curved away from the center, and rising noticeably both to the front and rear; posterior margin sharply rounded; posterodorsal margin broadly arched, descending. Lunule, as seen on an external mold, long, wide, and outlined by a very weak line. Main surface marked only with fine concentric growth lines and gentle undulations; the concentric markings become coarser and sharper on the lunule and on the posterodorsal slope.

Dimension of the holotype, a left valve: Length 23.5 mm, height 18.4 mm, convexity about 5.5 mm. A larger specimen measures: Length 29 mm, height 23.5 mm, convexity about 7 mm.

Impressions on the molds indicate a ligament and dentition like those on *Geltena subequilatera*. Pallial sinus very shallow.

The species appears to be most nearly related to *G. subequilatera* but is relatively more compressed, more elongated, and more sharply rounded on the anterior and posterior margins. The molds indicate that some of the shells are less elongated and some are more compressed than the holotype.

Types.—Holotype, an internal mold of a left valve, U.S.N.M. 105533; paratypes, about 20 internal molds, and 4 incomplete external molds, U.S.N.M. 105534; all from the Lewisville member on the Hillsboro road, 7.8 miles southeast of Cleburne, Johnson County.

Occurrence.—Johnson County: Loc. 9 (types); Tarrant County: locs. 14, 16, 20; Denton County: loc. 81.

Range.—Dexter member to Lewisville member.

Superfamily MYACEA

Family CORBULIDAE

In a paper published in 1945, H. E. Vokes (1945b, pp. 8-10) shows that *Corbula sulcata* Lamarck, the genotype of *Corbula* Lamarck s.s., Recent, off the coast of Senegal, Africa, possesses ligamental features that fully justify classifying it as generically distinct from many of the so-called Corbulas of both the Tertiary

and the Cretaceous. Among the Cretaceous Corbulidae that have come to my attention, I have not seen a species having the hinge and ligamental features of *Corbula sulcata*. Some generic names are available for the shells thus excluded from Lamarck's genus, but the state of preservation of many of the fossil Corbulidae is such that it is difficult to determine their generic affinities, and some of them doubtless belong to generic groups that have not as yet been defined. In our present incomplete state of knowledge, and in lieu of a monographic treatment of the Corbulidae, it is convenient to designate the unassigned shells as "*Corbula*." This amounts to giving them a family rather than a generic status.

The names *Caryocorbula* Gardner, *Parmicorbula* Vokes, and *Ursirivus* Vokes are applied to three of the generic groups in the Woodbine formation. Of these, *Caryocorbula*, an Eocene genus, is questionably used.

Genus CARYOCORBULA Gardner, 1926

Type species: *Corbula alabamiensis* Lea, from the Claiborne group, Eocene of Alabama. (Gardner, 1926, p. 46.)

Caryocorbula? ovisana Stephenson, n. sp.

Plate 32, figures 9-15

Shell small, thick-walled, subtrigonal in outline, strongly inflated, inequilateral, slightly inequivalve, the right valve a little more convex than the left. Beaks prominent, strongly incurved, prosogyrate at the tip, approximate, situated about one-third the length of the shell from the anterior extremity; right beak slightly higher than the left. Lunule and escutcheon wanting. Umbonal ridge nonprominent, subobtuse in cross section. Just back of the umbonal ridge on the right valve is a slightly excavated radial band with a maximum width of 2 mm on the holotype; this band is bounded on the inner (upper) side by a low ridge broadly subobtuse in cross section. Dorsal slopes steep to slightly overhanging. Anterodorsal margin short, steep; anterior margin regularly rounded less than a semicircle; ventral margin broadly rounded; posterior margin subangular at the extremity well below midheight, with a short truncation inclined forward above; posterodorsal margin long, steeply descending, nearly straight. The margin of the right valve laps slightly over that of the left valve all the way around. The surface of the right valve of the holotype is regularly ornamented with pronounced concentric ridges which, toward the ventral margin, number about eight in a radial distance of 5 mm. The ribs end abruptly about a millimeter in front of the umbonal ridge, beyond which on the umbonal ridge and the posterodorsal slope, only fine growth lines are present. The surface of the left valve lacks regular concentric ribs and is marked only by fine growth lines and gentle undulations. The shells of this species are abundant at the type locality and at some other locali-

ties, and many of the individuals exhibit resting stages in their surface ornamentation; these stages are manifested by grooves that range in depth from one or two faint ones, to four or five deep rugged ones, the latter markedly changing the appearance of the shell as compared with that of the holotype. The extremes in surface features are shown in the illustrations. The individuals exhibit considerable variation in form as well as in ornamentation.

Dimensions of the holotype, a shell with the two valves together: Length 12.2 mm, height 9.7 mm, thickness 7.6 mm. The largest shells scarcely exceed 14 mm in length.

On the left valve the resilium is seated in an elongated resilifer on a resiliary plate or chondrophore, which is partly submerged and projects somewhat inward from the plane of contact of the two valves. This plate is bounded on its outer side near the margin by a pronounced narrow groove, and a weaker groove parallels the resilifer on the inner side of the plate. On the right valve the outer end of the resilium is attached just back of the beak on the under side of the slightly overhanging margin of the shell. The right valve exhibits one prominent, trigonal, upcurved, dull-pointed cardinal tooth that fits into a corresponding profound socket on the left valve; a deep depression back of this tooth receives the chondrophore of the left valve. The left valve is edentulous. The adductor scars are subovate in outline, the anterior one being slightly the larger; they are not raised above the inner shell surface. Pallial line distinct; pallial sinus small and shallow.

In its ligamental and hinge features the species is essentially like the genotype, *Caryocorbula alabamiensis* Lea, except that the latter has a ridge instead of a groove bordering the outer side of the chondrophore, and its chondrophore is divided by a low narrow ridge. The genotype differs also in that it possesses a posterodorsal keel, a sharply angular umbonal ridge, and the posterior adductor muscle is seated on a platform that is more prominently raised on the left than on the right valve.

Types.—Holotype, a nearly complete shell, U.S.N.M. 105535; 4 figured paratypes, U.S.N.M. 105536a-d; 147 unfigured paratypes, U.S.N.M. 105537; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Tarrant County: locs. 15, 16, 19, 22, 24, 25, 26, 27, 28, 34, 35; Denton County: locs. 58, 59, 75, 79, 93; Cooke County: loc. 98; Grayson County: locs. 107, 132, 135, 136, 154; Fannin County: locs. 179, 180, 184 (types), 186, 191, 195, 197; Red River County: loc. 209.

Range.—Dexter member to Templeton member.

Caryocorbula? varia Stephenson, n. sp.

Plate 32, figures 16-19

In size, outline, form, and multitude of individuals, this species is similar to *Caryocorbula? ovisana* but differs in features which appear to be constant among the myriad individuals that largely compose certain

layers and lenses of the Woodbine formation. The shells are more elongated than those of *C. ? ovisana*, the beaks are less prominent, the inflation is less pronounced, and the primary or normal concentric sculpture is much finer. Pronounced resting stages of the same character as those on *C. ? ovisana* are present on most medium-sized to mature specimens, and number from one to five on different individuals; this gives to many of the mature shells a rough, rugged appearance that is in contrast to the relatively smooth younger stages. The differences mentioned seem to hold good among the many individuals available for comparison. The individuals exhibit minor variations in form.

Dimensions of the holotype, a shell with both valves intact: Length 10.7 mm, height 8.3 mm, thickness 6 mm.

Types.—Holotype, U.S.N.M. 105538; 1 figured paratype, U.S.N.M. 105539; 145 selected paratypes, U.S.N.M. 105540; all from the Lewisville member on Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 11, 20, 21, 34, 35 (types), 36, 47, 54; Grayson County: locs. 112, 117.

Range.—Dexter member (?); Lewisville member.

Caryocorbula ? tradingensis Stephenson, n. sp.

Plate 32, figures 1-3

Shell small, subtrigonal in outline, strongly inflated, inequilateral, inequivalve, the right valve somewhat larger than the left, which it overlaps slightly around the margins. Umbonal region rather narrow. Beaks prominent, incurved, prosogyrate, approximate, situated about one-third the length of the shell from the anterior extremity. Umbonal ridges angular, sinuous, about equally strong on each valve; the ridge on the left valve forms a somewhat wider obtuse angle in cross section than that on the right. The posterodorsal slope on the right valve forms a broadly excavated, sinuous band having a maximum width of about 1 mm on the holotype; the corresponding slope on the left valve is nearly 1.5 mm wide and is more broadly excavated than that on the right valve; the upturned inner margins of these bands unite to produce a keel-like rostrum. A posterior twist of the shell to the left produces a slight sinuosity in the contact of the two valves at the extremity. A broad, faint, radial excavation produces a slight constriction of the left valve just in front of the umbonal ridge. Anterodorsal margin descending, broadly arched; anterior margin rounded, narrower than a semicircle; ventral margin broadly rounded, faintly excavated at the rear; posterior margin subangular below the midheight, with a short truncation above the end of the umbonal ridge; posterodorsal slope descending, gently arched. Surface polished in well-preserved shells and smooth except for fine incremental lines, which coarsen a little toward the margins.

Dimensions of the holotype, a nearly complete shell:

Length 6 mm, height 5 mm, thickness 3.7 mm. The largest specimen measured is 7.3 mm long.

Though not well-preserved in the available material there is an oblique, slightly submerged resiliary platform in the left valve, in front of which is a deep pit for the reception of the cardinal tooth of the right valve. The latter tooth is typical of the genus except that proportionately it is not quite so robust as that on most Cretaceous species in the Corbulidae. The pallial sinus is small and very shallow.

As seen in a well-preserved shell, this species is smaller, shorter, smoother, more polished, thinner-shelled, and more trigonal than *Caryocorbula ? varia*; however, the young, shorter variants of *C. ? varia* may not be easily separated from poorly preserved, corroded shells of *C. ? tradingensis*. The individuals are present in considerable numbers at the type locality.

Types.—Holotype, U.S.N.M. 105541; 54 selected paratypes, U.S.N.M. 105542; all from the Lewisville member on Johnson Creek, (Trading House Creek), 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. ?28, 35 (types).

Range.—Eulless member?; Lewisville member.

Caryocorbula ? sp.

The internal and external molds of one right valve of *Caryocorbula ?* in fine ferruginous sandstone of the Lewisville member exposed in a public road 7.5 miles north of Sherman, Grayson County (loc. 107), represent a species that is similar in form to *Caryocorbula ? varia* except that the beak is located near the midlength. The specimen measures: Length 8.4 mm, height 5.4 mm. U.S.N.M. 105543.

Genus **PARMICORBULA** Vokes, 1944

Type species: *Corbula neaeroides* Blackenhorn, from the Aptian Cretaceous, at Abeih, Lebanon Mountains, Republic of Lebanon.

Vokes (1944, pp. 614-623) shows that among the species of Corbulidae of the Cretaceous and Tertiary are some that possess an accessory siphonal plate posterior to the terminus of the left valve; this plate is complimentary to a posterior extension (rostrum) of the right valve and serves as a protecting shield to the left sides of the siphons. He also shows that the species possessing this plate are separable into two groups, one in which the plate has the form of an oblique trapezium and the other in which the plate is rectangular. The former group was recognized and named by Vincent (1909, p. 141), who proposed for it the generic name *Coestocorbula*⁶ (type species, *Corbula henckeliusiana* Nyst), but the reality of the plate on which the new genus was based was questioned by Gardner (1926, p. 44; 1928, p. 227). The latter group was differentiated

⁶ Vincent's original spelling of this name was *Coestocorbula* (1909) and he repeated this spelling in a paper published twelve years later; the spelling cannot therefore be regarded as an error on the author's part.

and named *Parmicorbula* by Vokes in the paper cited above.

The genus *Parmicorbula* is represented in the Woodbine fauna by *P. vokesi*, *P. sinuosa*, *P. numerosa*, *P. corneliana*, and *P. rupana*.

Parmicorbula vokesi Stephenson, n. sp.

Plate 33, figures 26-32

1944. *Parmicorbula*, n. sp. Vokes, Am. Jour. Sci., vol. 242, pp. 614-623, pl. 1, figs. 17, 18. (Holotype figured.)

Shell of medium size, thick-walled, subtrigonal in outline; strongly inflated in the middle and anterior parts, the right valve more so than the left; inequilateral, inequivalve, sharply constricted and narrowly extended posteriorly. The posterior extension, which pertains to the right valve only, is weakly divided exteriorly by a shallow sulcus and is bent slightly to the left; its inner surface is covered by a supplemental rectangular siphonal plate, the anterior end of which fits against the main part of the left valve, from which it is separated by a narrow seam. The right valve overlaps the left one around the margin. Umbonal region broad laterally. Beaks moderately prominent, incurved, prosogyrate, approximate, situated near or a little in advance of midlength. Umbonal ridges weak, sinuous, broadly subangular in cross section. Posterodorsal slopes narrow, sinuous, slightly excavated. Anterodorsal margin descending, broadly arched; anterior margin sharply rounded; ventral margin broadly rounded, becoming broadly excavated toward the rear; the posterior margin forms a short truncation, inclined a little forward; posterodorsal margin descending and broadly arched above, becoming broadly and deeply concave below. Surface of a well-preserved shell covered with small, nonprominent, rather sharp concentric ridges, which, near the ventral margin, number 3 or 4 in a vertical distance of 1 mm; these merge rearward into fine growth lines as they near the umbonal ridges. Fine, obscure radial lines appear on the posterior half of the main lateral surface of the right valve of the holotype and are present on some other individuals. Both the concentric and radial features of many of the shells appear to have been more or less completely removed by wear or corrosion. Nearly all the larger shells have reached and passed the initial stage of senility, as shown by the abrupt constriction or steepening of their surfaces bordering their ventral and anterior margins.

Dimensions of the holotype, a nearly complete specimen: Length 11.9 mm, height 7.3 mm, thickness 7.5 mm. A larger right valve is 14 mm long and 9 mm high.

The hinge of the right valve exhibits a strong up-hooked cardinal tooth in front of a deep resiliary socket; the left valve presents an oblique, elevated, resiliary platform behind a deep trigonal depression into which the cardinal tooth of the right valve fits. The adductor scars are subequal in size, and each forms a

broadly concave depression on an upraised platform, the posterior scar being more elevated than the anterior one; these scars make deep indentations on the internal mold. The pallial line is distinct and lies well back from the margin, and the pallial sinus is small and very shallow. An impressed line on the inner surface of the right valve about 1 mm or less from, and paralleling, the ventral and anterior margins marks the contact of the margin of the overlapped left valve. The interior surface of the posterior extension of the right valve is divided by a longitudinal ridge that separates the siphons; a slight gape between the terminus of the right valve and the terminus of the siphonal plate is obscurely figure-8-shaped, reflecting the tubular shape of the separated siphons. The inner surface of the siphonal plate bears a longitudinal ridge that separates the siphons, and a complimentary obscure longitudinal groove is present on the outer surface of the plate. The species exhibits considerable individual variation in form.

The adult of this species is not likely to be confused with other species of the Corbulidae in the Woodbine formation. The species is characterized by its broad, inflated, bulbous form, its sharply constricted posterior portion, and the presence of a rugose siphonal plate covering the inner surface of the narrow, posterior extension of the right valve; the siphonal plate is a clearly marked feature of the holotype but on other available specimens was worn or broken away before fossilization.

Type.—Holotype, U.S.N.M. 103713; 2 figured paratypes, U.S.N.M. 105544a-b; 14 unfigured paratypes, U.S.N.M. 105545; these are from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. One figured paratype, U.S.N.M. 105546; 25 unfigured paratypes, U.S.N.M. 105547.

Occurrence.—Hill County: Loc. 3; Tarrant County: locs. ?11, 41, ?47; Denton County: locs. 75, 81; Grayson County: locs. 114, 122, ?129, 131, 135, 160, 164, 165, 170, 171, ?173; Fannin County: locs. 183 (26 paratypes, 1 figured), 184 (holotype and 16 paratypes, 2 figured), 191, 192, 195, 197.

Range.—Dexter member (?); Lewisville member to Templeton member.

Parmicorbula sinuosa Stephenson, n. sp.

Plate 33, figures 22-25

Shell small, with wall of medium thickness, strongly and broadly inflated at the front and middle, sharply constricted and sharply narrowed at the rear, inequilateral, inequivalve. The ventral part of the shell of adults bends strongly to the left. Right valve more inflated than the left. Beaks very prominent, strongly incurved, prosogyrate, situated about two-fifths the length of the shell from the anterior extremity; right beak more prominent than the left. Dorsal slopes steep and overhanging near the beak. Umbonal ridge small and narrow, nonprominent, distinct on the right valve in the younger stages, extending in sinuous trend from the beak to the lower posterior extremity. A broad,

shallow, pronounced radial constriction intervenes between the umbonal ridge and the inflated part of the shell. Back of the umbonal ridge the posterodorsal slope forms a twisted, flattish to slightly excavated radial band, which ends posteriorly in a short marginal truncation. The surface of the right valve is ornamented with sharply developed concentric ridges that are equal in width to, or narrower than, the interspaces; they exhibit a noticeable sinuosity in trend about midway of the inflated part of the shell; near the ventral margin these ridges number about three in a radial distance of 1 mm. On the younger stages of the shell the concentric ridges fade out posteriorly to a nearly smooth surface that forms a somewhat irregular band 1 to 2 mm wide in front of the umbonal ridge; on later stages the concentric ridges extend farther toward the rear, reaching nearly to the umbonal ridge on larger individuals. There is some irregularity in the development of the concentric ridges, and some shells exhibit one or more resting stages. The ridges on the left valve are similar to those on the right but are more weakly developed; they too, fade out toward the rear to form a smooth area.

Dimensions of the incomplete holotype, a large right valve: Length 8.4+ mm, height 7.1 mm, convexity about 3.8 mm. A small incomplete shell with the two valves in place measures: Length 4.8+ mm, height 4 mm, thickness 3 mm.

The hinge of the right valve, though not very clearly preserved in the available material, appears to be essentially like that of *P. vokesi*. The hinge of the left valve and other internal features were not observed.

The species is referred to *Parmicorbula* on the evidence of its form, particularly its posterior construction, which resembles the characteristic constriction of that genus. The siphonal plate is not preserved on the available material.

Types.—Holotype, a right valve, U.S.N.M. 105548; 2 figured paratypes, U.S.N.M. 105549a-b; 15 selected unfigured paratypes, U.S.N.M. 105550; all from the Lewisville member on Timber Creek, a few hundred yards below the upper or first bridge (road to Shiloh Church), 3 miles west by south of Lewisville, Denton County.

Occurrence.—Tarrant County: Loc. 11; Denton County: loc. 75 (types); Fannin County: locs. 183, 192.

Range.—Dexter member to Lewisville member.

Parmicorbula numerosa Stephenson, n. sp.

Plate 33, figures 16-18

The individuals of this species are present in great numbers in certain concretions at the type locality. The shells are distributed rather uniformly through the rock with, as a rule, more or less matrix separating them. An occasional specimen of any one of several other species of mollusk may be seen among the shells of this species. One of them is *Parmicorbula corneliana*, a species of about the same size as *P. numerosa*,

but having coarser concentric ornamentation on the right valve. Shell small, plump, thick-walled, sub-trigonal in outline, plumply inflated in the middle and anterior parts, sharply constricted posteriorly, inequilateral, inequivalve. The right valve is slightly more inflated than the left, whose ventral and anterior margins it slightly overlaps. A radial depression extends from the beak to the posterior extremity. The posterior extension of the right valve is small, narrow and bent slightly to the left; its lower and upper margins bend sharply inward overlapping the edges of the siphonal plate, which lies immediately posterior to the terminus of the left valve. Beaks small, incurved, prosogyrate, approximate, the right one rising a little higher than the left. Surface ornamented only with fine, low concentric growth markings which appear to be a little sharper and more regular on the left than on the right valve. Fresh surfaces are polished.

Dimensions of the holotype: Length 6.4 mm, height 4.6 mm, thickness 3.8 mm.

All the shells observed have both valves present and tightly closed so that the ligament and hinge features are not exposed. The siphonal plate is small and on most shells is poorly preserved or, if well preserved, is difficult to uncover without damage. It is quadrangular, with edges of unequal length, the anterior one the longest. The interior surface of the right valve where it opposes the siphonal plate is divided by a low longitudinal ridge that marks the separation between the two siphons.

Types.—Holotype, U.S.N.M. 105551; unfigured paratypes (numerous), U.S.N.M. 105552; all from a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Locs. 164, 165 (types), 171.

Range.—Templeton member.

Parmicorbula corneliana Stephenson, n. sp.

Plate 33, figures 19-21

Shell small, subtrigonal in outline, plumply inflated centrally, strongly constricted posteriorly, inequilateral, inequivalve, the right valve more inflated than the left, whose margins it slightly overlaps. Beaks prominent, strongly incurved, slightly prosogyrate, situated slightly in advance of midlength. The posterodorsal slope of the right valve forms a slightly excavated band extending from the beak to the truncated posterior extremity; this band is crossed by coarse growth ridges and is separated from the main surface by an obtusely subangular umbonal ridge. The main surface bears strong concentric ribs numbering two to four to the millimeter in the radial direction, separated by relatively deep narrow interspaces; these ribs die out a little before reaching the umbonal ridge and are weakly developed or wanting in the high umbonal region. The left valve differs from the right in that it is shorter and smaller, lacks coarse ribs, and bears only fine to moderately coarse growth markings; the postero-

dorsal slope is narrower and the umbonal ridge weaker. The accessory siphonal plate lying back of the posterior extremity of the left valve proper is quadrangular, thick, and coarsely sculptured by growth lines; it is clasped above and below by the overturned margins of the right valve.

Dimensions of the holotype: Length 6.7 mm, height 4.8 mm, thickness 4.6 mm.

The features of the ligament and hinge were not seen well exposed. As shown by impressions on the internal mold, the adductor scars stand out prominently on the interior of the shell.

Compared with *Parmicorbula numerosa* this species averages a little larger and plumper, is proportionately longer, possesses a better developed umbonal ridge, and is much more strongly sculptured on the right valve.

In form and type of sculpture this species is similar to *Parmicorbula crassiplica* (Gabb) which, however, bears much coarser concentric ribbing on the right valve and has a much greater inequality in the size of the right and left valves.

Types.—Holotype, U.S.N.M. 105553; 15 unfigured paratypes, U.S.N.M. 105554; all from a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Loc. 165.

Range.—Templeton member.

Parmicorbula rupana Stephenson, n. sp.

Plate 33, figures 9-12

Shell small, with thick walls, subtrigonal in outline, strongly inflated, with greatest inflation toward the anterior end, inequilateral, inequivalve, the right valve larger than the left and overlapping strongly at the margins; the shell is strongly constricted at the rear, right valve more extended than the left. Beaks moderately prominent, incurved, prosogyrate, approximate, situated about 0.45 the length of the shell from the anterior extremity. Umbonal ridge sinuous, distinct on each valve but not prominent, forming a rather sharp obtuse angle in cross section. The posterodorsal slope on each valve forms a narrow, sinuous, excavated band extending to the extremity of the shell. Anterodorsal margin steeply descending, gently arched; anterior margin narrowly rounded; ventral margin broadly rounded, rising gently and straightening out a little toward the rear. Posterior extremity forming an approximate right angle below, followed above by a short truncation; posterodorsal margin descending, nearly straight or gently arched. Surface presenting low but sharp concentric ridges numbering about three to the millimeter; these fade out a little before reaching the umbonal ridge, and only fine growth lines appear on the dorsal slopes; a mere trace of fine radial lines may be seen in places on the main surface. As shown by a steepening of the surface toward the ventral margin, the holotype is in a senile stage.

Dimensions of the holotype, an incomplete shell with both valves together: Length 7.6+ mm, height 5.9 mm, thickness 5.4 mm.

The sharply upturned cardinal tooth of the right valve, with a deeply excavated resiliary pit back of it, is well shown on one of the paratypes. The adductor scars are subequal and produce deep impressions on the internal mold. The internal mold of the right valve shows a short, very shallow pallial sinus, and its posterior extension shows the impression of a low ridge that divided the siphons.

This shell is similar in form, outline, and in the character of its ornamentation to "*Corbula*" *ponsana*, but it is proportionately shorter and more inflated, the concentric ridging is noticeably coarser, the posterodorsal slopes are more deeply excavated, and the radial lining is much fainter.

Types.—Holotype, U.S.N.M. 105620; 2 figured paratypes, U.S.N.M. 105621a-b; 4 unfigured paratypes, U.S.N.M. 105622; 1 unfigured paratype, U.S.N.M. 105623; all from the Templeton member, bed of the Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar County. Three unfigured paratypes, U.S.N.M. 105624.

Occurrence.—Tarrant County: Locs. ?11, ?28; Lamar County: locs. 201 (holotype and 7 paratypes, 2 figured), 207 (3 paratypes, unfigured).

Range.—Dexter member(?); Eules member(?); Templeton member.

Parmicorbula? *hillensis* Stephenson, n. sp.

Plate 33, figures 13-15

This species is based on external and internal molds in reddish-brown ferruginous sandstone. Shell of medium size for the genus, subtrigonal in outline, strongly inflated in the middle and anterior parts, narrow and strongly constricted in the posterior part, inequilateral, inequivalve. Left valve less inflated than the right. Umbonal region broad in the direction of the length. Beaks prominent, strongly incurved, prosogyrate, situated a little in advance of the midlength; right beak more prominent than the left. Dorsal slopes steep, overhanging adjacent to the beaks. Anterodorsal margin broadly arched; anterior margin sharply rounded; ventral margin very broadly rounded; posterior margin subangular below, subtruncated, short, and inclined a little forward above; posterodorsal margin nearly straight, descending. Surface covered with rather pronounced concentric ribs that increase in coarseness ventrally; interspaces narrower than the ribs.

Dimensions of the holotype, a right valve: Length 13 mm, height 8.2 mm, convexity about 3.5 mm.

Anterior adductor scar small, not deeply impressed, posterior adductor seated on a raised platform, somewhat elongated, bounded by a radial buttress.

In outline and form this species resembles *Parmicorbula vokesi* but is not so narrowly constricted at the rear and possesses stronger and coarser concentric sculp-

ture. The ribbing is similar to that of *P. sinuosa*, but the ribs are less sinuous in trend. The evidence for the presence of a supplemental siphonal plate back of the terminus of the left valve is not conclusive.

Types.—Holotype, U.S.N.M. 105555; 1 figured paratype, U.S.N.M. 105556; 15+ unfigured paratypes, U.S.N.M. 105557; all from a northeast-southwest road, 3 miles northeast of Whitney, Hill County.

Occurrence.—Hill County: Locs. 5, 7 (types).

Range.—Lewisville member.

Unidentified specimens of *Parmicorbula*? sp.

Poorly preserved specimens mostly external and internal molds in sandstone, questionably referred to *Parmicorbula*, are recorded from the following localities:

Loc. 2. Lewisville member, in a ravine 2.8 miles east of Gholson, McLennan County. Specimens numerous. U.S.N.M. 105558.

Loc. 3. Lewisville member, on Hillsboro road, 2 miles east of Whitney, Hill County. Resembles *Parmicorbula*? *hillensis* but has finer concentric sculpture. U.S.N.M. 105559.

Loc. 9. Lewisville member, on Hillsboro road, 7.8 miles southeast of Cleburne, Johnson County. U.S.N.M. 105560.

Loc. 16. Dexter member, in field north of east-west road 3.2 miles east-southeast of Handley, Tarrant County. U.S.N.M. 105561.

Loc. 57. Dexter member, in a roadside exposure 5.5 miles east-northeast of Roanoke railroad station, 3.5 miles south by west of Bartonville, Denton County. U.S.N.M. 105562.

Loc. 141. Lewisville member, along a stream tributary to Mustang Creek, 0.15 mile south, 0.4 mile east of road bend at south edge of Sadler, Grayson County. Three poorly preserved shells of a small, elongated species similar to *Parmicorbula sinuosa*, except that they are smaller and have finer concentric markings that are less sinuous in trend. Approximate dimensions of one of the shells: Length 7 mm, height 4.7 mm. U.S.N.M. 105563.

Genus *URSIRIVUS* Vokes, 1945

Type species: *Corbula* (*Potamomya*?) *pyiformis* Meek, from the Bear River formation (Upper Cretaceous), Wyoming. (Vokes, 1945b, p. 15.)

Ursirivus fanninensis Stephenson, n. sp.

Plate 33, figures 38–42

Shell large for the family, thick-walled, subtrigonal in outline, strongly inflated, inequilateral, subequivalve; the right valve is slightly more inflated than the left, which it slightly overlaps around the margins. More than the anterior half of the shell is broadly and prominently inflated; the posterior third is narrow and strongly compressed, most strongly so in the left valve, becoming subpointed at the extremity, which is slightly gaping. There is a faintly outlined lunule, rather wide and long. The posterodorsal surface of each valve is sharply outlined by a narrow, low carina (or umbonal ridge), and this is bordered behind by a slightly excavated radial band, which is divided centrally by a faint radial ridge; enclosed between these radial bands of the two valves is a weakly defined, smooth, escutcheon-like area. Just in front of the umbonal ridge

of the left valve is a broad, shallow radial depression, the strength of which varies on different individuals. Beaks prominent, strongly incurved, very slightly prosogyrate at the tips, approximate, situated a little in advance of midlength. Anterodorsal margin steeply descending, broadly arched; anterior margin sharply rounded; ventral margin broadly rounded, becoming a little concave toward the rear; posterior extremity subpointed; posterodorsal margin nearly straight, descending. Rather strongly developed, somewhat irregular, concentric ridges cover the main surface of the shell, numbering six to eight in a radial distance of 5 mm; they exhibit a broad, slight downward convexity in trend about midway of the length. The ridges end rearward at or near the umbonal ridge; very fine growth lines are present on and between the ridges; these lines are not everywhere exactly parallel to the larger ridges but in places cross them at a slight angle, especially on the left valve. The slightly depressed radial band back of the umbonal ridge is covered with closely spaced, sharp-edged growth lamellae, but the nearly smooth escutcheon shows only very fine growth lines.

Dimensions of the holotype, a nearly complete, medium-sized individual: Length 26.3 mm, height 19.5 mm, thickness 14.8 mm. The largest shell in the available material is nearly 40 mm long and 30 mm high.

In the left valve the ligament or resilium, which is mainly though not completely internal, is seated on a grooved, broadly concave platform that projects inward and a little backward below the beak; in front of the platform is a profound socket, curved beakward, for the reception of the hooked tooth of the right valve. The hinge of the right valve includes a prominent, trigonal, upcurved cardinal tooth, behind which is a deep, rather broad, resiliary pit. Laterals are wanting. As seen on internal molds the anterior adductor scar is not quite as large as the posterior one, which is broadly subovate. The pallial line is distinct and the pallial sinus very small and very shallow. The inner margin is smooth.

The larger shells of this species are about equal in size to the large fresh- or brackish-water species *Ursirivus pyiformis* (Meek), from the Bear River formation (early Upper Cretaceous) of southern Wyoming. That species appears to be congeneric with *U. fanninensis* but is more inflated, more elongated posteriorly, more coarsely sculptured, and differs in other details.

Types.—Holotype, U.S.N.M. 105564; 2 figured paratypes, U.S.N.M. 105565; 10 unfigured paratypes, U.S.N.M. 105566; 2 unfigured paratypes, U.S.N.M. 105567; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Johnson County: Loc. ?9; Tarrant County: locs. 19, 25, 27, 34, 47; Denton County: locs. 76, 79; Cooke County: locs. 98, 99; Grayson County: locs. 116, 117, 132–136; Fannin

County: locs. 179, 180, 184 (holotype and 14 paratypes, 2 figured); 186, 191; Red River County: loc. 209.

Range.—Eulless member to Lewisville member.

Ursirivus? arlingtonanus Stephenson, n. sp.

Plate 33, figures 33-37

Shell large for the group, subtrigonal in outline, moderately inflated, the left valve a little more strongly inflated than the right, inequilateral, slightly inequivalve, slightly gaping at the posterior extremity. The greatest inflation is below the beak above midheight, from which point the surface rounds down steeply to the front margin and more gradually to the posterior extremity. The dorsal slopes round steeply down to the margin. Beaks prominent, incurved, very slightly prosogyrate at the tip, the right beak rising a little higher than the left, situated about two-fifths the length of the shell from the anterior extremity. Anterodorsal margin short, steeply inclined, nearly straight; anterior margin regularly rounded less than a semicircle; ventral margin broadly rounded; posterior margin sharply rounded well below midheight, with a short subtruncation inclined a little forward above the extremity; posterodorsal margin broadly arched. Surface of right valve strongly marked with concentric ridges; these number eight or nine to the half centimeter at midheight but become noticeably coarser toward the ventral margin; the ridges pass into fine lines as they approach and pass down over the posterodorsal slope. Surface of left valve much smoother than that of the right, the concentric markings being fine but becoming a little coarser toward the margin.

Dimensions of the holotype, a right valve corroded in the umbonal region: Length 22.3 mm, height about 16.5 mm, convexity 7 mm. The holotype is nearly as large as the largest individual available for comparison; corrosion has reduced the prominence of the beak.

As seen in the available material, the hinge of this species is not as well preserved as it is in *Ursirivus fanninensis*, but it does not appear to differ in any essential features. As revealed by internal molds the adductor scars are situated low in the shell and appear to be about equal in size. The pallial line is distinct, and the pallial sinus is very small and shallow.

Compared with *Ursirivus fanninensis*, this species averages a little smaller, is more distinctly subtrigonal, with the posterior extremity at a lower position, the beaks are farther forward, and the concentric ribbing is not so coarse and is more unequal on the two valves.

This species is similar in size and form to *Corbula hicksi* White (1894, p. 134), from beds recorded as of Dakota age in Jefferson County, Neb., where it is associated with a small fresh-water fauna. The right valve of White's species, as judged from a plastotype in the U. S. National Museum, appears to be much less coarsely sculptured.

Types.—Holotype, a right valve, corroded in the umbonal and hinge regions, slightly compressed mechanically on the most inflated part, U.S.N.M. 105568; 2 figured paratypes, U.S.N.M. 105569a-b; 4 unfigured paratypes, U.S.N.M. 105570; all from the Lewisville member on Johnson Creek, 1 mile east of Arlington, Tarrant County. One figured paratype, U.S.N.M. 105571.

Occurrence.—Tarrant County: Locs. 14, 15, 24, 25, 27, 31, 34, 35 (types), 47; Denton County: locs. 56, 58, 59; Grayson County: locs. ?107, 116, 117, 135, 140; Fannin County: loc. ?179.

Range.—Dexter member to Lewisville member.

Genus *CORBULA* Lamarck, 1799

Type species: *Corbula sulcata* Lamarck, Recent, off Senegal, west coast of Africa.

The status of *Corbula* Lamarck is discussed by Vokes (1945b, p. 7), who concludes that the name was validly proposed. The legality of the name has not, however, been acted upon by the International Commission on Zoological Nomenclature.

The six species here referred to "*Corbula*," and the unidentified specimens of "*Corbula*," are all too incompletely preserved to justify assigning them positively to Lamarck's genus. They probably all fall within the family Corbulidae.

"*Corbula*" *senecta* Stephenson, n. sp.

Plate 33, figures 5-8

The available material includes five right valves and one left valve. Shell small, with thick wall, very strongly and broadly inflated, inequilateral. Beaks prominent, very strongly incurved, prosogyrate, situated about one-third the length of the shell from the anterior extremity. Dorsal slopes overhanging in the umbonal region. Umbonal ridge sinuous, strongly curved below, obtusely subangular in cross section. On the right valve a slight, broad, shallow radial depression lies just in front of the umbonal ridge from about midway of the shell to the margin below; this depression is wanting or very weak in shells less than half-grown. Back of and paralleling the umbonal ridge on each valve is a slightly excavated, sinuous band, attaining about 1 mm in width in the adult stage; this band is separated from the posterodorsal slope by a low angular ridge that is broadly subobtuse in cross section. The outer, steepened profile of adult shells indicates that they enter a senile stage at a height of about 5 mm and continue this stage until a maximum observed marginal width of 4 mm has been added to the shell. Anterodorsal margin short, steep, gently arched; anterior margin narrowly rounded; ventral margin with a broad downward swell centrally; posterior margin subangular below, followed above by a short truncation inclined a little forward; posterodorsal margin steeply descending, broadly arched, sinuous. The surface is marked by fine concentric growth ridges that become somewhat coarser toward the margins; on the right valve the ridges exhibit a broad

downward swell in their trend across the main shell surface.

Dimensions of the holotype, a right valve: Length 7.5 mm, height 5.8 mm, convexity about 3 mm.

The hinge and other internal features are not exposed in the available material, except that the cardinal tooth below the beak is partly uncovered on the holotype.

Types.—Holotype, a right valve, U.S.N.M. 105572; 1 paratype, a young right valve, figured, U.S.N.M. 105573; from Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County. One paratype, a right valve, unfigured, U.S.N.M. 105574; one paratype, a left valve, figured, U.S.N.M. 105575; 2 unfigured paratypes, U.S.N.M. 105576.

Occurrence.—Tarrant County: Locs. 38 (holotype, and 1 paratype, figured), 39 (1 paratype, unfigured), 44 (3 paratypes, 1 figured).

Range.—Lewisville member.

"Corbula" ponsana Stephenson, n. sp.

Plate 33, figures 3, 4

Shell small, with wall of medium thickness, subtrigonal in outline, moderately inflated, inequilateral, inequivalve. Beaks moderately prominent, incurved, prosogyrate, approximate, situated about 0.45 the length of the shell from the anterior extremity. Umbonal ridge weak but distinct, sinuous, broadly subobtuse in cross section. The posterodorsal slope forms a sinuous, slightly excavated radial band extending from the beak to the posterior extremity and having a maximum width of about 1 mm. Anterodorsal margin descending, broadly arched; anterior margin rather narrowly rounded; ventral margin very broadly rounded; posterior margin subangular below, followed by a short subtruncation, rounding into the broadly arched, descending posterodorsal margin above. Surface ornamented with nonprominent but sharp concentric ridges numbering about four to the millimeter; they pass into sharp growth lines on the posterodorsal slope. Fine, closely spaced, weak radial lining may be seen on most well-preserved left valves, but these lines appear to differ in strength on different individuals and can scarcely be detected on some shells.

Dimensions of the holotype, a left valve: Length 8.4 mm, height 5.8 mm, convexity about 3 mm.

The hinge is not uncovered on the available material. The chondrophore on which the ligament was seated in the left valve is seen poorly preserved in the holotype; it is partly sunken and is oblique backward and inward. The adductor scars are subequal and are distinctly impressed on internal molds. The pallial sinus is small and very shallow.

The radial lining serves to distinguish this species from the species described on preceding pages.

Types.—Holotype, U.S.N.M. 105577; from the Lewisville member near mouth of a small branch of Timber Creek, 800 feet upstream from the second or middle bridge, 2.5 miles southwest of Lewisville, Denton County.

Occurrence.—Hill County: Loc. ?6; Tarrant County: locs. 41, 44; Denton County: locs. 75, 79 (holotype); Lamar County: loc. ?201.

Range.—Lewisville member to Templeton member.

"Corbula" amniculana Stephenson, n. sp.

Plate 33, figures 1, 2

The species is obviously closely related to *"Corbula" ponsana*, but is more compressed in the umbonal region, more extended in the posteroventral direction, possesses somewhat coarser and more variable concentric sculpture, and shows a definite tendency to take on senile characteristics of a kind that appear to be wanting in most examples of *"C." ponsana*. The two species are of similar size and both exhibit fine, obscure radiating lines on well-preserved shells. On the holotype of *"C." amniculana*, a left valve, the ligament is seated on a partly submerged oblique resilifer that lies just back of a deep socket for the reception of the cardinal tooth of the right valve.

Dimensions of the holotype: Length 8.7 mm, height 6.3 mm, convexity about 3 mm.

Types.—Holotype, U.S.N.M. 105579; 1 unfigured paratype, U.S.N.M. 105578, both from the Lewisville member in a small branch, north of the Chicago, Rock Island and Pacific Railroad, 1 mile west of the Dallas County line, in Tarrant County. Two unfigured paratypes, U.S.N.M. 105580.

Occurrence.—Hill County: Locs. ?3, ?6; Tarrant County: loc. 44 (types); Denton County: locs. 73, 75, 79 (2 paratypes, unfigured); Grayson County: loc. ?162; Lamar County: loc. 201

Range.—Lewisville member to Templeton member.

"Corbula" dentonensis Stephenson, n. sp.

Plate 32, figures 7, 8

This species is based on one right valve, which, however, is well preserved and nearly complete. Two ferruginous molds are referred questionably to the species. Shell small, moderately depressed, subtrigonal in outline, inequilateral. Greatest inflation about midway of the length, above midheight. Beak of moderate prominence, incurved, prosogyrate, situated about two-fifths the length of the shell from the anterior extremity. Umbonal ridge weak but distinct, sinuous, broadly subobtuse in cross section. The posterodorsal slope presents a sinuous, rather broadly excavated radial band, which attains a maximum width of about 1.5 mm and ends posteriorly in a short terminal truncation; between this band and the margin is a very narrow band (escutcheon) sloping steeply inward. Anterodorsal margin descending, gently arched; anterior margin regularly rounded, less than a semicircle; ventral margin broadly rounded, straightening out a little toward the rear; the lower posterior extremity forms an angle that is a little more open than a right angle, above which is a short truncation; posterodorsal margin long, descending, very gently arched. Umbonal half of surface covered with fine, closely spaced concentric ridges

numbering about 7 in a radial distance of 1 mm; toward the umbonal ridge these ridges pass into very fine growth lines; on the ventral half of the shell the concentric ridges become much coarser, numbering only three to the millimeter at the crest of a steepened, narrow ventral slope, which marks a senile stage; only fine growth lines cover the posterodorsal slope.

Dimensions of the holotype: Length 12 mm, height 8.4 mm, convexity about 3 mm.

The hinge is thin and shows a relatively small, up-hooked cardinal tooth in front of a deep resiliary socket.

In general form and outline this shell is similar to that of "*Corbula*" *amniculana*, but it is larger, is less strongly inflated, has a wider and more deeply excavated band on the posterodorsal slope, and has a proportionately thinner and frailer hinge.

Type.—Holotype, U.S.N.M. 105581; from the Lewisville member on Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Tarrant County: Loc. 228; Denton County: loc. 76 (type).

Range.—Eules member (?); Lewisville member.

"*Corbula*" *starana* Stephenson, n. sp.

Plate 32, figure 6

Three specimens only, from two different localities, are available for study. Shell very small and thin-walled, elongate, subelliptical in outline, broadly and only moderately inflated, inequilateral, apparently more nearly equivalve than is usual in this genus. Beaks nonprominent, incurved, prosogyrate, situated about 0.45 the length of the shell from the anterior extremity. Umbonal ridge sinuous, rather weak, forming a broad obtuse subangle in cross section. The posterodorsal slope forms a sinuous, distinctly excavated, narrow radial band extending to the extremity. Anterodorsal margin descending, evenly rounded; anterior margin rounded less than a semicircle; ventral margin broadly rounded, ascending at the rear; posterior extremity subangular below midheight, with a short truncation inclined forward above; posterodorsal margin long, gently arched. Surface covered with very fine growth lines; under sufficient magnification about 15 relatively widely spaced radiating lines may be seen on the posterior half of the surface.

Dimensions of the holotype, a specimen with both valves present: Length 4.1 mm, height 2.7 mm, thickness about 1.7 mm.

Hinge and internal features not uncovered.

This small, thin, elongated shell is not apt to be confused with any other species thus far found in the Lewisville unit.

Types.—Holotype, U.S.N.M. 105583; 1 unfigured paratype, U.S.N.M. 105584; from Johnson Creek, 1 mile east of Arlington, 0.3 mile east of Eastern Star Home, Tarrant County. One unfigured paratype, U.S.N.M. 105582.

Occurrence.—Tarrant County: Loc. 35 (holotype and 1 unfigured paratype); Denton County: loc. 75 (1 unfigured paratype).

Range.—Lewisville member.

"*Corbula*" *pulvinata* Stephenson, n. sp.

Plate 32, figures 4, 5

Shell small, thin-walled, broadly subovate in outline, broadly and moderately inflated, subequilateral, slightly inequivalve, slightly constricted at the posterior extremity. Beaks nonprominent, incurved, slightly prosogyrate, approximate, situated near midlength; the right beak rises slightly higher than the left. Dorsal margin broadly arched; anterior margin rounded less than a semicircle; ventral margin broadly rounded; posterior margin subangular below midheight, rounding into the dorsal margin above. Surface bearing rather fine, subdued, irregular growth lines.

Dimensions of the incomplete holotype: Length 9.4+ mm, height 8 mm, thickness 5.5 mm.

Hinge and internal features not uncovered.

This species is not closely similar to any of the other species known from the Woodbine formation.

Types.—Holotype, U.S.N.M. 105585; from the Templeton member in a bluff on a tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County. One unfigured paratype, U.S.N.M. 105586.

Occurrence.—Grayson County: Loc. 165 (holotype); Fannin County: loc. 180 (paratype, unfigured).

Range.—Lewisville member to Templeton member.

Unidentified specimens of "*Corbula*"

The external and internal molds of a right valve that appears to belong to the Corbulidae, from the Eules member, cut north of State Highway 183, a mile west by south of Eules, Tarrant County (loc. 25), records a rather large, relatively short, high species having an outline and form suggestive of the Veneridae. It is excluded from the latter family by the features of the hinge and dentition, which appear to be those of the Corbulidae. The beak is prosogyrate and is situated about two-fifths the length of the shell from the anterior end, and the surface is smooth. The dimensions are: Length 16 mm, height 13 mm, convexity about 4 mm. U.S.N.M. 105587.

Poor impressions of "*Corbula*" in ferruginous sandstone of the Dexter member were found in a roadside exposure 2.4 miles northeast of Keller, 0.5 mile north-northeast of a church, Tarrant County (loc. 17). The shell is elongated, rather depressed, and smooth. An internal mold measures: Length 13.5 mm, height 8 mm, convexity about 2.5 mm. U.S.N.M. 105588.

An internal mold of "*Corbula*" in ferruginous sandstone of the Lewisville member in a branch east of a north-south road, 1.5 miles north of Mineral Creek, 2.5 miles north of Sadler, Grayson County (loc. 132), is plump, short posteriorly, and rather long anteriorly.

It measures: Length 11 mm, height 8 mm, convexity about 2.5 mm. U.S.N.M. 105589.

An incomplete right valve of a small "*Corbula*," from the Lewisville member in a small stream gorge, 0.45 mile west of road, 1.9 miles S. 50° W. of center of Ambrose, Grayson County (loc. 135), is broken away around all but the dorsal margin. It is distinctly ribbed concentrically, the ribs ending before reaching the prominent, subangular umbonal ridge. Back of the ridge is a relatively broad, steep, slightly excavated posterodorsal slope, which is divided by a low, rounded radial ridge. The hinge bears one prominent, upcurved cardinal tooth. The shell is 4+ mm long and 3+ mm high. U.S.N.M. 105590.

Family PANOPEIDAE

Genus PANOPE Ménéard, 1807

Type species: *Panope aldrovandi* Ménéard, Recent in the Mediterranean Sea. (Ménéard, 1807, January, pp. 16, 30, 31; Dall, 1912, pp. 34, 35.)

Panope subparallela Shumard

Plate 34, figures 24, 25

1860. *Panopaea subparallela* B. F. Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 605.

1928. *Panope subparallela* B. F. Shumard. Adkins, Texas Univ. Bull. 2838, p. 171.

Shumard described this species as follows:

Shell subovate; length double the width; extremities of nearly equal width; buccal side short, strongly and regularly rounded; anal end widely gaping, obliquely truncate; pallial margin gently convex in the middle and abruptly rounded at the extremities; cardinal border subparallel with the base; beaks approximate, not much elevated, situated considerably in advance of the middle; surface marked with somewhat irregular, narrow, concentric folds, which are prominent on the anterior and upper portion of the shell.

Length 3.11 inches; width 1.58 [inches]; thickness 0.94 [inch].

Shumard had one partly crushed example of this shell, which is presumed to be lost. His description fits the one available specimen in the present collection reasonably well, considering its badly crushed condition. This specimen still has both valves intact, and presents the following characters: Shell elongate, thin-walled, equivalve, inequilateral, and apparently moderately inflated. Beaks broad, somewhat prominent, incurved, situated well in advance of midlength, perhaps about one-third the length of the shell from the anterior extremity. A broad, shallow radial depression extends from the beak directly downward across the side to the ventral margin. The dorsal margin appears to be long and nearly straight; anterior margin evenly and rather sharply rounded; ventral margin long and very broadly rounded; posterior margin subtruncated and inclined slightly forward. The surface is ornamented all over with small, narrow, somewhat irregular growth undulations, which are noticeably coarser on

the anterior part of the shell; in the umbonal region the coarser pattern of ornamentation appears to end rearward before reaching the radial depression just described. Back of this depression the concentric markings are weaker and somewhat finer.

The shell is 70+ mm long; its condition is such that the height and thickness cannot be measured accurately.

Types.—The holotype, the present whereabouts of which is not known, was collected by G. G. Shumard "in septaria of the marly clay, near the base of the Lower Cretaceous Group," on Red River in Fannin County, and was described by B. F. Shumard. The "Marly Clay or Red River group" formed the lower part of the division which the Shumards called Lower Cretaceous. The description of the strata given by G. G. Shumard suggests that they fall within the Woodbine formation, but they may have included the lower part of the Eagle Ford shale (B. F. Shumard, 1860a, pp. 582-590).

The plesiotype described and figured in the present paper bears the catalogue number U.S.N.M. 105625.

Occurrence.—Lamar County: Loc. 203.

Range.—Templeton member

Superfamily ADESMACEA

Family PHOLADIDAE

Genus PHOLAS Linné, 1758

Type species: *Pholas dactylus* Linné, Recent, in the Atlantic from England to Gibraltar, and in the Mediterranean.

Pholas? scaphoides Stephenson, n. sp.

Plate 34, figures 17-19

The type material includes three examples of a small *Pholas*-like bivalve, one a nearly complete internal mold of a right valve with the sculpture impressed upon it and with fragments of weathered shell material adhering along the dorsal and posterior margins; one is a similar, but incomplete, internal mold of a left valve with some weathered shell material adhering to it; and one is a much smaller but nearly complete external mold of a left valve partly lined with a thin film of weathered shell substance.

The shell is thin, elongate-subovate in outline, moderately inflated anteriorly, becoming regularly more compressed and narrower posteriorly, strongly inequilateral, equivalve, having a wide anteroventral gape and a narrow posterior gape. Beaks broad, low, incurved, prosogyrate, approximate, situated about one-fourth the length of the shell from the anterior extremity; the umbo is divided by a narrow, shallow radial groove that extends with a strong obliquity downward and backward for a distance of 5 or 6 mm from the tip. Anterodorsal slope rather deeply excavated in the radial direction, bearing a pair of unequal radial grooves at the bottom of the depression, the lower one deep and rather wide, the upper one narrow and shallow. The margin of the shell in front of the umbo is elevated and bent outward to form a short umbonal reflection. Anterodorsal margin short, descending, rostrate; anterior extremity subpointed above the gape; ventral margin

long, nearly straight centrally, curving upward at each end; posterior extremity sharply rounded; posterodorsal margin nearly straight, nearly horizontal. The anterior and central parts of the surface are ornamented with narrow radial costae that are rather weak and wide apart from below the beak forward, are numerous and closely spaced on a rather wide central area, and are few and more widely spaced in a narrow area back of the central area; costae are wanting on the posterior part of the surface. The whole surface is ornamented with regularly spaced, gentle concentric undulations that are noded at the intersections of the radial costae. These undulations form the dominant sculpture on the anterior part of the surface but become weak posteriorly; they are spaced 1 to 2 mm apart on the ventral slope of the large specimens; below the umbo, they bend upward to conform to the anterior gape of the shell. Fine irregular radiating striae are present on a fragment of shell adhering to the internal mold at the posterior extremity of the holotype. The internal features are not uncovered for observation.

The holotype measures: Length 37 mm, height 13 mm, convexity about 6 mm.

No species closely related to this one has been described from the American Upper Cretaceous.

Types.—Holotype, a right valve, U.S.N.M. 105591; 1 figured paratype, U.S.N.M. 105592; 1 paratype, unfigured, U.S.N.M. 105593; all from near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County.

Occurrence.—Cooke County: Loc. 99; Grayson County: loc. 122 (holotype, 2 paratypes, 1 figured).

Range.—Lewisville member.

Genus **OPERTOCHASMA** Stephenson, n. gen.

Type species: *Opertochasma venustum* Stephenson.

Etymology: Latin *opertus*, covered; Latin *chasma* (neuter gender), an opening.

This genus is related to *Martesia* Leach but has its closest affinities with *Martesiella* Verrill and Bush (1898, p. 777), which was classed by its originators as a subgenus of *Martesia*. *Martesiella* is based on *Martesia* (*Martesiella*) *fragilis* Verrill and Bush, Recent, off the Atlantic Coast of the United States. Bartsch and Rehder (1945, pp. 4, 5) treat *M. fragilis* as a stunted form of the genotype species *Martesia* (*Martesia*) *striata* (Linné).

The shell is of medium size, subcone-shaped, thin-walled, plump in front, with beaks well forward. In the type species two radial grooves extend from the beak down over the side to the ventral margin; one, the umbonal groove, is narrow, not deeply impressed, and reaches the margin about midway of the length of the shell; the other groove is wider and deeper, diverges slightly in its downward trend, and reaches the margin 2 or 3 mm in advance of the umbonal groove. In the other described species, *Opertochasma subconicum*, the anterior of these two grooves is well developed on some

shells but is weak or even wanting on others. The broad anterior hiatus with angular corners at upper right and left is largely bridged over in adults by a pair of thin plates (callum) that fail to meet in the median line, leaving a narrow lanceolate gape. A thick accessory plate (protoplax), very broadly ovate in outline, covers the front of the shell below the beaks and extends well back over the beaks; this plate is divided into right and left halves by a longitudinal slit. A rather pronounced posterodorsal gape is roofed over by a thin accessory plate (metaplax), which is long-lanceolate in outline and bulges upward somewhat canoe-shaped, with the highest bulge toward the front. On either side of this metaplax the posterodorsal slope takes the form of a narrow, sinuous band presenting a scaly or imbricated surface, roughly suggestive of a tiled roof; the scales form a superficial layer on the shell proper; this band is separated from the main lateral surface by a nonprominent, angular umbonal ridge. The surface of the shell from the umbonal ridge forward (not including the callum) is ornamented with very fine concentric ridges, which, in front of the umbonal fissure, are sharp and very finely crenulated on their crests. On the inner surface of the shell immediately under each of the radial grooves is a well-developed internal radial rib, and a broader and stronger internal ridge underlies the imbricated posterodorsal bands.

The typical *Opertochasma* differs from *Martesia* (*Martesia*) in having two radial grooves, instead of one, extending from the beak down over the side, in having a bipartite protoplax, in having well-defined imbricated posterodorsal slopes back of an angular umbonal ridge, in the apparent absence of a ventral accessory plate (hypoplax), in having the upper corners of the anterior hiatus angular instead of rounded, and in having relatively much finer surface sculpture.

The genus *Goniochasma* Meek is similar to *Opertochasma* in size, form, and in the character of its concentric ornamentation, but it apparently does not possess an additional radial groove in front of the umbonal groove; it seems to lack the imbricated bands on the posterodorsal slope, its concentric sculpture is much coarser, and no evidence of the presence of accessory plates is afforded by the type specimens. The two genera are, however, obviously closely related.

Martesia cuneata Meek and Hayden, from the Montana group at Longlake, S. Dak., is a more elongated, more slender representative of this genus. It possesses a well-developed, divided protoplax, which is not preserved on the holotype but is present on two shells of the species from the same group near Mingusville, Mont.

Opertochasma venustum Stephenson, n. sp.

Plate 34, figures 13-16

This neat, finely and elegantly sculptured woodborer is of medium size, thin-walled, elongate-subconical in

general form, fullest near the front, where, in the longitude of the beaks, the outline of a cross section is subcircular. The shell is rounded less than a hemisphere in its front profile, tapers to a narrow, blunt ending at the rear, is equivalve and very inequilateral. Beaks of medium prominence, very strongly incurved, curving outward away from each other at the tips, situated about 2 mm from the anterior extremity on the holotype. The anterodorsal slope of each valve forms an excavation on either side of a rostrum formed by the upturned edges of the shell. Umbonal ridge non-prominent, broadly subangular in cross section, sinuous, extending to the lower posterior extremity. Posterodorsal slopes narrow, sinuous, broadly excavated, each reaching a maximum width of about 2.5 mm in the holotype, the edges of the two slopes separated by a lanceolate gape, which is roofed over by a thin, bulging, canoe-shaped accessory shield of calcium carbonate (metaplast). A narrow, somewhat crenulate, slightly impressed umbonal groove extends from the beak obliquely down over the side to about the middle of the ventral margin. Another wider and more deeply impressed groove, forward from the umbonal groove, extends from the beak in a slightly diverging course to the ventral margin which, on the holotype, it intersects nearly 3 mm in advance of the distal end of the umbonal groove. The broad anterior hiatus is shield-shaped, the upper right- and left-hand corners forming approximate right angles; in adults the hiatus becomes nearly closed by a thin, slightly bulging callum of calcium carbonate, which grows forward from the edges of the hiatus on each valve but, in the available specimens, fails to join centrally, leaving a narrow, lanceolate anterior gape; the callum is thin and brittle and is partly peeled off and lost from most specimens.

A well-developed, shield-like accessory plate of calcium carbonate (protoplast) covers the front below the beaks and extends well back over the beaks; it is slightly longer than broad and is bipartite, being equally divided by a longitudinal slit. On the holotype only the anterior half of the protoplast is preserved, but it may be seen in nearly complete form on several of the paratypes; its length is about two-fifths the length of the shell, and the width is more than half the total thickness of the shell. From the umbonal ridge forward, the surface, exclusive of the smooth callum, is daintily and elegantly sculptured with exceedingly fine, concentric ridges that parallel the outer margins; these number 10 or more to the millimeter on the coarser parts of the surface and may more than double that number on the more crowded parts of the surface; from rear to front the ridges, after crossing the umbonal groove, bend gently upward to the second groove, thence bend sharply upward parallel to the margin of the anterior hiatus to its upper angle, thence turn at a right angle and trend parallel to the upper margin of the hiatus, and finally

curve upward to the posterodorsal margin of the shell; under a strong magnification the ridges, from the umbonal groove forward, are seen to be finely and delicately crenulated on their crests; crenulations are wanting back of the umbonal groove. Back of the umbonal ridge, the posterodorsal band lacks concentric ridges and presents a scaly or imbricated surface, roughly resembling the shingles on a roof; these imbrications form a superficial layer on the shell proper.

Dimensions of the holotype: Length 12.8 mm, height 7.7 mm, thickness 8 mm. A larger shell measures: Length 15 mm, height 9 mm, thickness 9 mm. The largest shells in the collection are about 18 mm long.

The internal mold bears the impression of a narrow, internal, radiating ridge corresponding to the umbonal groove and the impression of a stronger and wider radial ridge corresponding to the other external groove in front of the umbonal groove; on the posterodorsal slope of the mold just back of the umbonal ridge is a third broader and deeper radial groove, produced by a strong internal ridge, which extends in sinuous trend from the beak to the extremity, and between this groove and the shell margin above is a weaker radial groove. The hinge is not exposed on the available material. The posterior adductor scar is elongate-subelliptical in outline and is distinctly impressed on the inner surface of the shell; no positive indication of the presence of an anterior adductor could be detected.

Types.—Holotype, U.S.N.M. 105594; 1 figured paratype, U.S.N.M. 105595; 5 paratypes, unfigured, and pieces of wood containing a dozen or more paratypes, U.S.N.M. 105596; all from the Lewisville member on "Timber Creek, 4 miles [3 miles] west by south of Lewisville, Denton County."

Occurrence.—Tarrant County: Loc. ?44; Denton County: locs. 60, 72 (types).

Range.—Euleless member to Lewisville member.

Opertochasma subconicum Stephenson, n. sp.

Plate 34, figures 10-12

Shell of medium size, elongate-subtrigonal in outline, subconical in form, gaping a little both front and rear. The shell is fullest near the front in the longitude of the beak, where it is nearly circular in cross section; it tapers neatly to the posterior extremity, where it is slightly gaping. The front of the shell is plumply rounded, with a shield-shaped opening that becomes covered with a thin callum in adults. The umbonal groove is distinct though not deeply impressed. A second radial groove is present in advance of the umbonal groove on some specimens and is wanting on others; this is a variable feature on shells closely associated in the same piece of wood, some having the groove strongly developed and others having it weak or absent. The concentric sculpture is fine, the ribs numbering six or seven to the millimeter on the coarser parts of the surface. On most specimens there is little evidence of imbricated scaly bands on the posterodorsal slopes, but

this seems to be due to incomplete preservation, for some specimens show indications of the presence of such bands. The concentric ridges in front of the umbonal groove are finely crenulated; those back of it lack these crenulations. A divided protoplax is present on the holotype and on several of the paratypes; it varies in size on different individuals, possibly due to incomplete preservation on some shells. Broken fragments of a metaplax may be seen on the holotype. No indications of a hypoplax could be detected.

Dimensions of the holotype: Length 12 mm, height 6.5 mm, thickness 6.5 mm.

Compared with *Opertochasma venustum*, this species is more slender, is a little more coarsely sculptured, is more nearly circular in cross section, is less constant in the development of a second radial groove in advance of the umbonal groove, exhibits a less conspicuous development of scaly or imbricated bands on the posterodorsal slopes, and averages a little smaller. The two species appear to be closely related.

Types.—Holotype, U.S.N.M. 105597; 13+ unfigured paratypes, U.S.N.M. 105598; all from the Lewisville member in a small stream cut, 0.2 mile south, 0.5 mile west of Star School, about 5 miles southeast of Denison, Grayson County.

Occurrence.—Grayson County: Locs., 137 (types), 164, 165; Fannin County: loc. 196; Lamar County: locs. 201, 203, 230.

Range.—Lewisville member to Templeton member.

Family TEREDINIDAE

Genus TEREBRIMYA Stephenson, n. gen.

Type species: *Terebrimya lamarana* Stephenson.

Etymology: Latin *terebrā*, a boring instrument, Latin *mya*, a mussel shell.

In the past it was customary to refer to the genus *Teredo* Linné all wood-boring bivalve mollusks, both Recent and fossil, the shells of which have the general form of that Recent genus. These creatures are popularly known as shipworms because of their destructive operations on the bottoms of wooden ships and other wooden structures installed in sea water. As early as 1842 Gray (Synopsis Contents British Museum, ed. 44, p. 76) erected the genus *Bankia* (type, *Teredo bipalmulata* Lamarck) to include those *Teredo*-like species the pallets of which consist of a series of cone-in-cone structures resembling an ear of wheat, but whose shells present no characters to justify distinguishing them from *Teredo*; in *Teredo* proper the pallet, an apparatus designed to close the small distal end of the calcareous tube in which the animal is encased, is paddle- or spoon-shaped. Since the pallet belongs to the soft parts of the animal and has not been found preserved in fossil form, it is obvious that the genera *Teredo* and *Bankia* cannot be distinguished from each other among fossil shells. Bartsch (1930, pp. 460–461) has proposed that when the generic characters cannot be determined from the shell alone, and the soft parts are not available, a

provisional pseudogeneric term having no genotype be employed, with the understanding that if and when the true generic relationships become known the provisional name be dropped. In the case of *Teredo*-like shells, he proposed the pseudogeneric name *Teredolithus*. (For a parallel case see Bartsch, 1942, p. 137.)

The Cretaceous species here under consideration has a *Teredo*-like form and might perhaps be conveniently disposed of by dubbing it *Teredolithus*. Bartsch (1922, p. 6) points out that in the shipworm group (*Teredo* and *Bankia*) the outer surface of the shell is divisible into three parts or areas, which he designates anterior, median, and posterior parts. These parts are recognized in the Cretaceous species. However, a vast time interval separates the Cretaceous from the Recent shells, and it is possible, even probable, that if the soft parts of the former species were known it would fall into a generic group distinct from either *Teredo* or *Bankia*. The pallet of the Cretaceous species may have been a generalized form from which the two types of pallets that, respectively, characterize *Teredo* and *Bankia*, were later developed by branching from the parent stock. These considerations lead me to propose a new generic name, *Terebrimya*, for the Cretaceous species.

Terebrimya lamarana Stephenson, n. sp.

Plate 34, figures 20–23; plate 58, figures 4, 5

This Cretaceous species, like the modern shipworms, was an efficient borer in wood. A piece of brownish, rather soft fossil wood 1 foot long, 4 to 4.5 inches wide, and 2 to 3 inches thick, from the Slate Shoals locality in Lamar County, contains many of the calcareous tubes of this species. One group of tubes obviously grew as a colony of young individuals radiating out from a common hatchery. One shell in a fair state of preservation was uncovered in the large end of one tube, and less complete portions of shells were seen in other tubes. Doubtless a shell is present in each tube, the large end of which is preserved, for the gradual increase in the size of the tube as the shell grew larger made it impossible for the animal to escape from its self-constructed prison. Each tube, now largely crystallized, is made up of a closely fitting succession of truncated cone-shaped growth layers, which gradually increase in size as the animal grows and bores its way deeper into the wood.

Shell of medium size, thin-walled, plump centrally, height about equal to length, inequilateral, equivalve. Deep indentations in the anteroventral margins of the two valves produce a wide shield-shaped anterior opening, or hiatus, whose upper right and left corners form subangles a little greater than right angles; in the holotype this opening shows no indication of having been covered with a callum. Posterior widely gaping. Umbonal ridge broadly rounded. Beaks prominent,

strongly incurved, strongly prosogyrate, situated about one-fourth the length of the shell from the anterior extremity. The most inflated part of the shell is above midheight, a little in advance of midlength. Centrally a cross section of the shell is subcircular. Anterodorsal slope broadly concave, rising dorsally to the edge of a deep, wide lunulelike depression. From the high point of the inflation the surface rounds down in the posterodorsal direction to the round-crested umbonal ridge, thence descends steeply and rises again to form a moderately deep, broad, radial, sinuous depression whose dorsal edge forms the nearly straight hinge line. Hinge not uncovered but hinge line straight. The umbonal groove is very narrow and shallow and extends from the beak down over the exterior of the shell to a point on the ventral margin about midway of the length; it is closely paralleled on its two sides by narrow, weak to obscure ridges, each of which is delimited on its outer edge by a weak to obscure groove; a triangular patch of shell broken from the flank of the left valve shows that these ridges and grooves are reflected on the internal mold, which, in addition, shows a narrow, shallow groove in the mold paralleling the margin of the anterior hiatus. Two internal molds found in a fossil log from Sheep Creek, Fannin County (loc. 196), show the presence in each valve of a long, slender, curved myophore extending from under the beak into the interior of the shell; as preserved, this myophore stands free in a curved cavity in the mold, the upper end being attached to the shell. The growth lines are fine, sharp, and closely spaced; immediately in front of the umbonal groove, they rise sharply and extend parallel to the posterior margin of the hiatus, to the radiating trace of the angle previously noted, thence turn sharply forward, and parallel the upper margin of the hiatus to the anterodorsal margin. Back of the umbonal groove the growth lines curve strongly upward and extend parallel to the margin of the posterior gape of the shell to the posterodorsal margin, crossing the posterodorsal sulcus in a strongly sinuous trend.

Dimensions of the holotype: Length 10 mm, height 9.8 mm, thickness about 10 mm. The tubes may attain a thickness of 15 mm or more.

Types.—Holotype, U.S.N.M. 105600; numerous paratypes not uncovered from their tubes in a fossil log, U.S.N.M. 105599; from the Templeton member near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County. Two paratypes, Conlin's private collection. Eight paratypes, unfigured, U.S.N.M. 105601. (See plastotypes of two of Conlin's paratypes, U.S.N.M. 105602 a, b.)

Occurrence.—Tarrant County: James P. Conlin's private collection from his locality 1.5 miles east of Euless (T-10-Kwb), 2 paratypes, figured. Grayson County: Locs. 137, 165; Fannin County: loc. 196 (8 paratypes, unfigured); Lamar County: loc. 201 (holotype and paratypes in fossil log), 207.

Range.—Lewisville member to Templeton member.

Class SCAPHOPODA

Family DENTALIIDAE

Genus DENTALIUM Linné, 1758

Type species: *Dentalium elephantinum* Linné. Recent, in the Red Sea.

Dentalium alineatum Stephenson, n. sp.

Plate 34, figures 1, 2

Tube of medium size, circular in cross section, gently and uniformly tapering. The small end of the holotype is incomplete and the large end nearly complete. As preserved the tube measures: Length 39 mm, diameter at small end 2 mm, at large end 5 mm. One paratype, incomplete at the large end, appears to be about complete at the small end which measures 1 mm in diameter. No apical notch can be seen in this specimen. Outer surface of tube apparently without longitudinal striations. Growth lines slightly oblique around the tube.

Compared with *Dentalium sublineatum*, this species lacks longitudinal striations, and its tube tapers more gradually.

Types.—Holotype, U.S.N.M. 105603; 1 paratype, figured, U.S.N.M. 105604; 4 unfigured paratypes, U.S.N.M. 105605; 3 unfigured paratypes, U.S.N.M. 105606; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201 (holotype and 8 paratypes, 1 figured).

Range.—Templeton member.

Dentalium sublineatum Stephenson, n. sp.

Plate 34, figure 3

Shell, a gradually and uniformly tapering and gently curved tube of medium size, circular in cross section. The small end of the holotype is not complete, and the large end is mechanically somewhat compressed laterally and is partly broken on the rim. As preserved, the tube is 26.3 mm long, 2 mm in diameter at the small end, and approximately 4.7 mm in diameter at the large end. The shell wall is about 0.5 mm thick at the small end. The tube is faintly marked with fine longitudinal lines of irregular strength, numbering at least 50 centrally, where they are most clearly seen. These lines seem to fade out and practically disappear toward both the small and large ends, but this effect may be due in part to corrosion, in part to waterwear, or to both causes. The growth lines are slightly oblique around the tube.

Another tube in the type lot is not crushed and is therefore more perfect as to form, but its surface lining is more effectively damaged by corrosion, and it, too, is incomplete at the small end. It measures: Length 30 mm, diameter at small end 2.2 mm, diameter at large end 5.1 mm.

The longitudinal striations and the more rapid tapering of the tube serve to distinguish this species from *Dentalium alineatum*.

Types.—Holotype, U.S.N.M. 105607; 4 unfigured paratypes, U.S.N.M. 105608; 6 unfigured paratypes, U.S.N.M. 105609; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Grayson County: Loc. 154; Lamar County: locs. ?200, 201 (holotype and 10 paratypes, 1 figured), 207.

Range.—Templeton member.

***Dentalium minor* Stephenson, n. sp.**

Plate 34, figures 4, 5

Tube small, thin, nearly smooth, gently curved; one photograph shows a faint trace of fine longitudinal lines. Length of holotype 8.2 mm. diameter at small end 0.5 mm, maximum diameter at large end 1.7 mm, minimum diameter at large end 1.4 mm. The orifice at the small end is circular; as the tube increases in size it becomes slightly compressed in the dorsoventral direction, reaching a maximum in the lateral direction at the anterior orifice, as indicated by the foregoing measurements. Growth lines slightly oblique.

The typical *Dentalium*, *D. elephantinum* Linné, is a large longitudinally striated tube (about 65 mm long) having a circular cross section at all stages and no constriction at the anterior orifice. The present species is referred to *Dentalium* mainly because it shows no anterior constriction of the tube. In size, lack of surface ornamentation, and compression of the tube it departs markedly from the typical form.

Types.—Holotype, U.S.N.M. 105610; 1 unfigured paratype, U.S.N.M. 105611; 4 unfigured paratypes, U.S.N.M. 105612; all from the Lewisville member near the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. 34, 38 (holotype), 41 (1 unfigured paratype), 46 (1 unfigured paratype), 50; Denton County: loc. 76; Grayson County: locs. 114, 164, 165.

Range.—Lewisville member to Templeton member.

Unidentified specimens of *Dentalium*

Two incomplete specimens (pl. 34, fig. 6) from the Templeton member in gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson County (loc. 154), appear to belong to *Dentalium* Linné. The tube is small, long, slender, smooth, and apparently circular in cross section throughout its length. The taper is very gradual, and there is no constriction at the anterior orifice. The curvature is broad and even. The best-preserved specimen measures: Length 7.6 mm, diameter at small end about 0.4 mm, diameter at large end about 0.9 mm. The two specimens are about equal in size. U.S.N.M. 105613 and 105613a.

A badly corroded tube of *Dentalium* is present in one of the collections from the Lewisville member at Pine Bluff, Red River County (loc. 209). It is of medium size for the genus and is broken away at both ends. As preserved, it is about 15 mm long, 2 mm in diameter at the small end, and 3 mm in diameter at the large end. U.S.N.M. 105614.

Family SIPHONODONTALIIDAE

Genus CADULUS Philippi, 1844

Type species: *Cadulus ovulum* Philippi. From clay of Pliocene age at Crotonem, Sicily.

***Cadulus praetenuis* Stephenson, n. sp.**

Plate 34, figures 7-9

Shell, a small, thin, gently curved, partially transparent tube with polished surface. Length of holotype 6.9 mm, diameter at posterior or small end 0.6 mm, diameter at anterior end 1.3 mm. From the small end, the diameter increases gradually for about three-fourths the total length to a maximum of about 1.3 mm, thence decreases to the large end, thus producing a marked constriction of the anterior orifice. The more inflated part of the tube is slightly compressed in the dorsoventral direction—that is, transverse to the plane in which the curvature of the tube takes place. There are no slits or notches at the margin of either of the openings of the tube. Surface of tube smooth. The small posterior orifice is circular. The anterior orifice is a little oblique, sloping back toward the dorsal or convex side of the arched tube; this determines the slightly oblique trace of the growth lines around the tube. Some of the tubes exhibit a fine, closely spaced light- and dark-gray banding, the individual bands corresponding in direction to the growth lines; on some tubes the banding manifests itself in gray and reddish-orange colors, the latter probably being due to iron oxide staining; still other tubes are delicately mottled or spotted with light- and dark-gray; the holotype shows a very faint mottling but no banding. The individual variation in the color patterns and their near absence on some shells suggest that the patterns are due to secondary staining and are not original color patterns.

Types.—Holotype, U.S.N.M. 105615; 2 figured paratypes, U.S.N.M. 105616a-b; 20 or more unfigured paratypes, U.S.N.M. 105617; 15 or more unfigured paratypes, U.S.N.M. 105618; all from the Templeton member in gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson County.

Occurrence.—Grayson County: Locs. 154 (holotype and 37+ paratypes, 2 figured), 165, 170; Fannin County: loc. 183.

Range.—Lewisville member to Templeton member.

***Cadulus* sp.**

A specimen in a matrix of reddish, rather soft, oxidized sandstone of the Lewisville member, on a public road, 7.5 miles north of Sherman, 2.75 miles east by south of Pottsboro, Grayson County (loc. 107), consists of part of the external mold, in which rests most of the internal mold. The tube measures: Length 9.5 mm, diameter at small end 0.7 mm, diameter at large end 1.1 mm. The tube increases gradually in diameter to a point about two-thirds the length from the posterior orifice, thence decreases gradually to the anterior

orifice. The larger part of the tube appears to be slightly compressed in its dorsoventral dimension. Compared with *Cadulus praetenuis*, the maximum diameter is farther removed from the anterior orifice. U.S.N.M. 105619.

Class **GASTROPODA**

Subclass **STREPTONEURA**

Order **ASPIDOBANCHIA**

Suborder **DOCGLOSSA**

Family **ACMAEIDAE**

Genus **ACMAEA** Eschscholtz, 1830

Type species: *Acmaea mitra* Eschscholtz, Recent, on the Pacific Coast of North America from the Aleutian Islands to San Diego, Calif.

The family Acmaeidae is represented in the Woodbine fauna by a few specimens of one small species, *Acmaea pilleolus*, and by one small imprint questionably referred to *Acmaea*.

Acmaea pilleolus Stephenson, n. sp.

Plate 35, figures 24-26

Shell small, thin, subconical, elevated, polished, with apex eccentric, situated about one-third the length of the shell from the anterior margin; outline broadly subovate. Color brown. In profile from side view the anterior slope is short, steep, and nearly straight and the posterior slope long, more gently inclined, and broadly arched. Growth lines fine, distinct. Internal features not uncovered.

Dimensions of holotype: Length front to rear 9 mm, width 7.3 mm, height nearly 5 mm.

Types.—Holotype, U.S.N.M. 105626; 2 unfigured paratypes, U.S.N.M. 105627; a third young paratype is attached to the side of the holotype; all from the Templeton member on Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson County. One figured paratype, U.S.N.M. 105628.

Occurrence.—Tarrant County: Locs. 36 (on an ammonite), 38; Grayson County: locs. 152 (holotype and 2 unfigured paratypes), 162 (1 figured paratype), 164, 165.

Range.—Lewisville member to Templeton member.

Acmaea? sp.

A small imprint in ferruginous sandstone from the Red Branch member 3.3 miles north of Pilot Point, Cooke County (loc. 95), is questionably referred to *Acmaea*. It is compressed subcone-shaped and subtriangular in outline on the base, with the beak a little in advance of the center. Fine concentric growth lines conform to the outline of the base. It measures: Greatest diameter on base 5.5 mm, least diameter 4.8 mm, height of cone about 1 mm. U.S.N.M. 105629.

Family **TURBINIDAE**

Genus **TURBO** Linné, 1758, *sensu lato*

Type species: *Turbo petholatus* Linné, Recent, in the Indo-Pacific region.

Turbo? serratus Stephenson, n. sp.

Plate 35, figures 9-11

Shell of medium size, turbinate, imperforate. Spiral angle about 58°. Protoconch small and partly broken away. Whorls about 3.5, gently convex on the side, expanding rapidly. Suture closely appressed in a deep groove of moderate width. Ornamentation spiral. The periphery of the body whorl is marked by a narrow, weakly serrated spiral of medium strength; traced backward, this rib is partly concealed by the closely appressed, forward-growing body whorl. Above the periphery are three strong, nearly equal, serrated ribs, which occupy slightly more than the lower half of the side of the whorl; the serrations are very irregular in strength and length, the longest ones exceeding the shorter ones by two or three times. The upper part of the whorl bears three unequal, obscurely serrated spirals that range in size from below upward, as follows: The first is narrow and low; the second is about twice as wide and prominent as the first; and the third is thick and prominent and closely rims the sutural depression. The base bears eight or nine weakly noded, evenly spaced spiral ribs that become progressively smaller from the periphery inward; the outermost one is smaller than the spiral marking the periphery. Original color in dark-gray streaks trending in the direction of the growth lines is present on the base of the shell. The six spirals above the periphery continue back around the penultimate whorl without much change in proportional size but have been destroyed by corrosion on the two small whorls next to the apex. Aperture subcircular, flaring a little on the upper side. Outer lip and lower edge of aperture thick; inner lip forming a thin callus over the parietal wall. The growth lines curve broadly forward on the base and cross the side of the whorl above with a strong forward inclination.

Dimensions of the holotype: Height about 15.5 mm, diameter 13 mm.

The shells described by Stanton as *Turbo? revuelten-sis* (1947, p. 56) from the Purgatoire formation on Monte Revuelto, N. Mex., and *Amberleya mudgeana* (Meek) from the Kiowa shale near Belvidere, Kans. (Stanton, 1947, p. 57), are closely related species, differing from *Turbo? serratus* only in details of sculpture. Both are from beds of middle or early-late Comanche age. *Amberleya* Morris and Lycett (1851, p. 54) is based on the species *Terebra nodosa* Buckman, a high-spired, conspicuously noded shell, which is obviously not generically identical with Meek's species.

Types.—Holotype, U.S.N.M. 105630; 2 incomplete paratypes, U.S.N.M. 105631; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201 (holotype and paratypes).

Range.—Templeton member.

Turbo? sp.

Plate 35, figure 47

The incomplete internal and external molds of one specimen, questionably referred to *Turbo* Linné, was found in ferruginous sandstone of the Dexter member, 5.5 miles east-northeast of Roanoke, Denton County (loc. 57). The three rapidly expanding whorls are plumply rounded on the side. The largest whorl bears three strong, narrow, spiral costae on the side, separated by much wider interspaces, and two small, narrow spirals on the shoulder slope. Three spirals can be seen on the next whorl above, the lowest one barely showing above the suture. The growth lines are rather strong and sharp and slope conspicuously forward both on the side and shoulder. As preserved, the molds indicate a shell 10 mm in diameter and about 9+ mm high. U.S.N.M. 105632.

Adkins (1920a, p. 137) has described a closely related species, under the name *Amberleya graysonensis*, from the Weno limestone, Washita group (Comanche series).

This shell appears to be generically identical with one from the so-called Mentor beds of Kiamichi (Comanche) age in central Kansas, described by Meek (1876b, p. 300) under the name *Margarita mudgeana*, but differs specifically in the possession of two spiral ribs, instead of one, on the shoulder slope. The name *Margarita* Leach (1819) is preoccupied by the same author (1814) for a bivalve shell. Stanton (1947, p. 57) referred *M. mudgeana* Meek to the genus *Amberleya* Morris and Lycett, a strongly noded shell with a much higher spire.

Suborder RHIPIDOGLOSSA**Family FISSURELLIDAE****Genus DIADORA Gray, 1821**

Type species: *Patella apertura* Montagu, Recent, British Islands. (See Iredale, 1915a, p. 331.)

The family Fissurellidae is represented by the incomplete imprint of one individual that is generically indeterminate, but which is questionably referred to *Diadora* Gray.

***Diadora? bartonvillensis* Stephenson, n. sp.**

Plate 35, figure 48

This species is represented by the incomplete internal and external molds of one individual in ferruginous sandstone. The shell is conical, with an ovate basal outline. The apex stands moderately high and is situated a little in advance of midlength. The radiating sculpture is dominant and consists of closely spaced alternating large and small ribs that increase in strength toward the margin; on the holotype they are not preserved all the way around but are estimated to number 34 of each size. The concentric sculpture con-

sists of sharp, thin, threadlike ridges that override the radial ribs and number radially 3 or 4 to the millimeter. The presence or absence of a perforation at the apex is indeterminate.

The length of the long axis of the ovate base is estimated to be about 22 mm, and the short axis about 18 mm. The apex stands about 6 mm above the base.

Type.—Holotype, U.S.N.M. 105633; from a roadside exposure, 5.5 miles east-northeast of Roanoke, 3.5 miles south by west of Bartonville, Denton County.

Occurrence.—Denton County: Loc. 57.

Range.—A marine facies in the Dexter member.

Family NERITIDAE**Genus NERITA Linné, sensu lato.**

Type species: *Nerita peloronta* Linné, 1758, Recent, in the West Indies.

***Nerita ornata* Stephenson, n. sp.**

Plate 35, figures 1-4

Shell small, involute, with very low spire. Protoconch partly broken away by apparently very small and simple. Whorls about 2½, rapidly expanding. Shoulder broad, flattish to gently convex, limited outwardly by an obtuse subangulation. Body whorl below the agulation plumply rounded, broadening toward the aperture. The whole outer surface is ornamented with spiral costae, which are regularly noded and vary somewhat in number on different individuals. On the holotype the costae number 17; on one adult they number 23, and on another only 14; the largest costa follows the outside shoulder angulation and several costae on the flank below this ridge, and 4 or 5 low on the base, are larger than those on other parts of the shell; on the shoulder of the holotype between the outer angulation and the suture above are 3 to 6 spirals. Small obscure brown spots appear on one of the paratypes. New spirals may be introduced by intercalation. Aperture broadly subovate, with a wide obtuse subangulation at the intersection of the shoulder angle and with a narrow, shallow anal channel occupying an obtuse angulation at the rear. Outer lip broadly arched, with crenulations marking the termini of the ribs and interspaces. Inner lip forming a thin callus over a broad expanse of the parietal wall; inner edge of inner lip bearing a strong fold at the upper end just below the anal canal and 3 or 4 lesser nodes below.

Dimensions of the holotype, a half grown shell: Height 6 mm, diameter 7 mm. An adult shell may attain a height of 11 or 12 mm.

In form and in the character of the aperture this species is essentially like *Nerita semilevis*, but its strong, sharp ornamentation seems to justify its recognition as a distinct species.

Types.—Holotype, U.S.N.M. 105634; 9 unfigured paratypes, U.S.N.M. 105635; all from Timber Creek a few hundred yards below the first or upper bridge (road to Shiloh Church), 3 miles

west by south of Lewisville, Denton County. One unfigured paratype, U.S.N.M. 105636; 1 figured paratype, U.S.N.M. 105637; 6 unfigured paratypes, U.S.N.M. 105638.

Occurrence.—Denton County: Locs. 73 (7 paratypes, 1 figured), 75 (holotype and 10 paratypes), 79; Grayson County: loc. 135.

Range.—Lewisville member.

Nerita semilevis Stephenson, n. sp.

Plate 35, figures 6-8

Shell small, spire very low, involute. Protoconch missing on all specimens, apparently having been worn off. Whorls 2 or 2½, expanding rapidly. Shoulder broad, broadly concave, marked at its outer edge by a low ridge and traversed centrally by a narrow, weak sulcus. The bordering ridge is strongest on the penultimate whorl and on the early part of the body whorl, where it is rather weakly noded; toward the aperture it flattens out and forms an obtuse subangle at the edge of the shoulder. On the earlier stage of the body whorl are about a dozen weakly developed spiral ridges, the upper 3 or 4 of which are strongest and bear obscure nodes; these ridges become weaker toward the aperture and 5 or 6 of the central ones die out entirely. The periphery and base are broadly rounded. Aperture broadly subovate, with a widely obtuse subangulation at the intersection of the shoulder ridge and a stronger posterior angulation marking the position of the anal canal. Outer lip thin and in part weakly crenulated, the crenulations marking the termini of the ribs and interspaces. The inner lip forms a thin to thick callus over a broad area of the parietal wall; the inner edge of this area is marked at the upper end just below the anal canal by a moderately strong fold, which continues steeply into the interior, and below by 2 or 3 weak irregular nodes. The outer surface of the holotype is ornamented with 3 spiral rows of original brownish color patterns, 2 on the base and 1 bordering the outer edge of the shoulder, as shown in the illustration. Original color, as obscurely seen on several of the paratypes, indicates a striking difference in pattern on different individuals.

Types.—Holotype, U.S.N.M. 105639; 18 unfigured paratypes, U.S.N.M. 105640; all from Timber Creek, southwest of Lewisville, Denton County.

Occurrence.—Denton County: Locs. 72, 73 (types), 79.

Range.—Lewisville member.

Nerita sp.

Plate 35, figure 5

One juvenile shell, partly broken, from the Lewisville member on Timber Creek, Denton County (loc. 78), belongs to the family Neritidae and apparently to the genus *Nerita* Linné. On account of its youthful stage of growth and the resulting simplicity of the apertural features, it seems inadequate to serve as the type of a new species. The shell has the general form of *Nerita*,

exhibits 5 strong spiral ribs, and has a relatively wide, slightly excavated shoulder. The height of the shell is about 1.5 mm. U.S.N.M. 105641.

Genus *NERITINA* Lamarck, 1816

Type species: *Nerita pulligera* Linné, Recent, in rivers of India and Melanesia.

Neritina insolita Stephenson, n. sp.

Plate 54, figures 6-8

The species is represented by one medium-sized shell, which, though not entire, shows the form in essential completeness. Shell of medium thickness. Whorls 2, tightly and rather flatly coiled at and near the apex, very rapidly expanding. Surface ornamented with small, weak, irregular, round-crested, revolving costae, which number only 7 or 8 on the early part of the body whorl, but increase rapidly in number to 20 or more on the middle and upper parts of the expanded whorl; the costae become obscure and disappear forward on the base of the expanded whorl. The growth lines are fine and somewhat irregular on the earlier and middle stages, but become coarser and more irregular toward the aperture. The aperture is approximately half-moon-shaped; outer lip smooth, thin; inner lip straight, smooth on inner edge. Umbilicus as preserved wide open, deep; broken edges around the rim probably indicate that the umbilicus was bridged over with a thin callus forming a broad, inward sloping inner lip. Assuming that the umbilicus was indeed closed by a platform of callus the shell characters appear to be essentially like those of the genotype, *Neritina pulligera* (Linné). However, the possibility that the umbilicus was not completely closed, and in consideration of the vast lapse of time separating the Cretaceous from the Recent, the species should be referred to Lamarck's genus with caution.

Dimensions: Greatest dimension 24 mm, greatest width of aperture 17.3 mm.

Holotype.—U.S.N.M. 105642; from drainage bed, 100 feet south of old Pottsboro-Gordonville road, 0.2 mile east of road corner, 2.1 miles west and 0.6 mile north of the center of Pottsboro, Grayson County.

Occurrence.—Grayson County: Loc. 176.

Range.—Templeton member.

Subgenus *VELATELLA* Meek, 1873

Type species: *Neritina (Dostia?) carditoides* Meek, from Cretaceous beds in Carleton's coal mine, Coalville, Utah (here designated). (Meek, 1873, p. 499.)

Neritina (Velatella) ambrosana Stephenson, n. sp.

Plate 35, figures 20-23

The species is represented in Grayson County by one well-preserved example that is probably not full-grown. It is a convex, thick-walled, widely spiral, rapidly expanding shell, ornamented with 10 or 11 spiral costae,

which are round-crested, of medium strength on the most inflated part, becoming regularly weaker both above and below, those at the extreme upper and lower parts being faint to obscure. The interspaces at this stage are a little narrower than the costae. The costae are crossed by fine growth lines. The aperture is half-moon-shaped, with a thick outer lip crenulated on the inner margin, the crenulations marking the ends of the external costae; the inner lip is nearly straight, and is weakly denticulate, one tooth at each end being a little stronger than the intermediate ones. The callus of the inner lip spreads broadly forward, partly covering the beak and umbonal region.

Dimensions: Greatest dimension 6.5 mm, greatest width of aperture 5 mm.

An example from Tarrant County, consisting of an external and internal mold representing a more mature stage of growth, is closely similar to this species except that the spiral costae are more numerous. It is questionably referred to *Neritina (Velatella) ambrosana* on the possibility that the species is individually variable with respect to the number of costae. This specimen measures 13 mm in greatest length and 9 mm in greatest width.

The species is also closely related to *Neritina (Velatella) bellatula* (Meek, 1873, p. 497), from strata of early Late Cretaceous age exposed in Carleton's coal mine near Coalville, Utah. Meek's species is represented by three cotypes, two of which are small, incomplete, crushed shells and the third a larger incomplete shell also badly crushed. One of the two small shells possesses 10 or 11 low round-crested costae separated by wider interspaces and the other by 16 or 17 costae; as they both come from the same bed, have the same form, and are in the same state of preservation, it seems reasonable to assume that they are correctly assigned to the same species whose individuals vary in the number of their spiral costae. All three of the cotypes bear strong brown markings in the costal interspaces.

Neritina (Velatella) carditoides (Meek), from the same place as the preceding, is similar in form but is a larger shell with about 15 narrow, sharp, roughly crenulate costae separated by much wider interspaces.

Holotype.—U.S.N.M. 105643; from a stream in a gorge, 0.45 mile west of road, 1.9 miles S. 54° W. of center of Ambrose, Grayson County. One questionable example, U.S.N.M. 105644.

Occurrence.—Tarrant County: Loc. 754 (figured); Grayson County: loc. 135 (type).

Range.—Lewisville member.

Neritina (Velatella) sp.

Plate 35, figure 19

The internal mold of an incomplete body whorl, found in coarse ferruginous sandstone in the Dexter member, 1 mile southwest of Bartonville, Denton County (loc. 216), is referable to *Neritina (Velatella)*.

The mold indicates a strongly convex, rapidly expanding shell ornamented with more than 15 strong revolving costae. As indicated by impressions on the mold, the costae are weakly and irregularly tuberculated and are a little narrower than the interspaces. The costae are crossed by fine, rather sharp growth lines. The apical portion of the mold is broken away. The features of the aperture are not preserved. The mold measures 15 mm in its longest dimension and about 8.5 mm in the transverse direction.

The shell is similar in form to the genotype *Neritina (Velatella) carditoides* (Meek), and to *N. (V.) bellatula* (Meek), both from strata of early Late Cretaceous age exposed in Carleton's coal mine, Coalville, Utah. The shell differs from either of these species in the finer pattern of its revolving costae. U.S.N.M. 105645.

Order CTENOBRANCHIATA

Suborder PLATYPODA

Superfamily GYMNUGLOSSA

Family PYRAMIDELLIDAE

Genus PSEUDOMELANIA Pictet and Campiche, 1862

Type species: *Pseudomelania gresslyi* Pictet and Campiche (1862, pp. 266, 267), from the Valanginian (lower Neocomian) at Sainte-Croix, Switzerland.

The genotype of *Pseudomelania* is based on smooth internal molds that show neither the surface features nor the features of the aperture. It is a large shell having a total estimated height of 60 mm and a diameter of 22 mm.

Pseudomelania? roanokana Stephenson, n. sp.

Plate 35, figures 43-46

The species is based on molds in ferruginous sandstone. Shell small, high-turreted, with apical angle of about 32°, decreasing to about 20° on the spire below. Protoconch not preserved. Suture sharply but not deeply impressed. Whorls 7 or 8, flat to very gently convex on the side. Periphery of body whorl with a very faint obtuse subangle. Base descending rather steeply, very gently convex. Growth lines sinuous on body whorl, in trend broadly convex forward on the base, and concave forward above the periphery. Aperture broad-lanceolate, acutely angular at the rear and sharply rounded at the front. Outer lip broadly arched, with a broad notch above, as indicated by the growth lines. The available material indicates some individual variation in the spiral angle and in the convexity of the whorls.

Dimensions of the holotype, which is slightly incomplete at each end: Height 20.5+ mm, diameter 6.3 mm.

Pseudomelania gresslyi Pictet and Campiche, the type species of the genus, is much larger and less slender than this species; although *P. gresslyi* is probably a smooth shell, neither the presence nor the absence of

surface ornamentation, nor the trend of the growth lines, can be ascertained from the illustrations of the internal molds, on which the species is based. For this reason the generic assignment of *roanokana* is questioned.

Types.—Holotype, U.S.N.M. 105646; 12+ paratypes, unfigured, U.S.N.M. 105647; 2 paratypes, figured U.S.N.M. 105650a-b; 13+ paratypes, unfigured, U.S.N.M. 105651; 1 paratype, figured, U.S.N.M. 105648; 9+ paratypes, unfigured, U.S.N.M. 105649; all from near base of Dexter member at top of high bluff, 3.7 miles northeast of Roanoke, Denton County.

Occurrence.—Denton County: Loc. 56 (holotype and 37 paratypes, 3 figured); Grayson County: loc. 123.

Range.—Dexter member to Lewisville member.

Pseudomelania? *ferrata* Stephenson, n. sp.

Plate 35, figure 42

This species also is based on molds in ferruginous sandstone. Shell of medium size with smooth turreted spire. The spiral angle, which appears to be individually variable, is about 30° in the holotype; in one of the paratypes, this angle is about 40° as measured on a rubber cast. Protoconch not preserved. Suture narrow, moderately deep. Whorls 7 or 8, very gently convex in profile on the penultimate and earlier whorls and broadly concave on the body whorl of adults. Periphery faintly obtusely subangular. Base steep, very gently convex, becoming broadly excavated below. Growth lines rugged and strongly sinuous on the body whorl, the trend being strongly convex forward on the base, and concave forward above the periphery. Aperture broadly lanceolate, acutely angular at the rear and sharply rounded at the front. Outer lip broadly arched, the growth lines indicating a broad notch in the upper part.

Dimensions of the holotype: Height 31+ mm, diameter about 14 mm.

The species is associated with at least three species of *Unio*, indicating a fresh water habitat.

Compared with *Pseudomelania?* *roanokana* this species is larger, has a less slender spire, a deeper suture, and a more pronounced development of growth lines on the body whorl.

Types.—Holotype, U.S.N.M. 105652; 6 unfigured paratypes, U.S.N.M. 105653; all from a hillside north of Iron Ore Creek, 0.1 mile west of U. S. Highway 69, 0.85 mile N. 44° W. of Star School, in northeastern Grayson County.

Occurrence.—Grayson County: Loc. 102.

Range.—Red Branch member.

Genus **AMBROSEA** Stephenson, n. gen.

Type species: *Ambrosea nitida* Stephenson.

Etymology: Derived from the family name Ambrose.

The distinguishing features of this shell are its small size, moderately high spire, coarse but nonprominent axial and spiral ribbing, the three conspicuous folds on the columella, and the ribbing on the inner surface of the shell well back of the edge of the outer lip. The

columellar folds and the internal ribs appear to relate this genus to *Pyramidella dolabrata* (Linné), the genotype of *Pyramidella* Lamarek, the species of which are in contrast to *Ambrosea* in that they possess high-turreted, smooth spires.

Ambrosea nitida Stephenson, n. sp.

Plate 35, figures 12-15

Shell small, spire of moderate height; spiral angle about 28°. Protoconch small, smooth, rather high spired, dextral. Whorls 5 or 6, gently convex on the side. Suture closely appressed, moderately impressed. Body whorl relatively large and plump, broadly rounded on the periphery and base. Axial ribs low, thick, broadly rounded on the crests, separated by broad, shallow interspaces, the axials on the body whorl dying out at the periphery. The axials number 8 on the body whorl and 6 on the penultimate whorl of the holotype. The body whorl bears 10 low, broad spiral ribs separated by narrow grooves; both the spirals and the grooves are more pronounced on the base and upper part of the whorl than they are on the intermediate area. The spirals are weakly beaded. Four spirals and part of a fifth are exposed on the penultimate whorl of the holotype. Aperture lanceolate, of medium width, acutely angular at the rear, sharply rounded and slightly notched at the front. Outer lip thin at edge, thick, farther back, broadly arched; inner surface of shell well back of the outer lip bearing 8 or 9 short, narrow, weak spiral ribs that extend several millimeters back from the edge of the lip; these appear to be the internal expressions of the grooves separating the spiral ribs on the exterior. Inner lip forming a thin callus over the parietal wall. Columella bearing 3 distinct, oblique folds, the middle one of which is the most prominent.

Dimensions of the nearly complete holotype: Height 10.5 mm, diameter 4.3 mm.

Types.—Holotype, U.S.N.M. 105654; 1 figured paratype, U.S.N.M. 105655; about 60 unfigured paratypes, including young to adult stages, U.S.N.M. 105656; all from a stream gorge, 0.45 mile west of road, 1.9 miles S. 54° W. of Ambrose, Grayson County.

Occurrence.—Denton County: Loc. 78; Grayson County: loc. 135 (type lot).

Range.—Lewisville member.

Superfamily **PTENOGLOSSA**

Family **EPITONIIDAE**

Genus **CONFUSISCALA** Boury, 1909

Type species: *Scalaria dupiniana* D'Orbigny, from the Gault (Cretaceous, Albien), Department of Aube, France.

Confusiscala? sp.

Plate 35, figure 16

An incomplete shell that may belong to *Confusiscala* Boury was found in the Lewisville member 0.3 mile

southeast of Dugans Chapel, Grayson County (loc. 122). The three available whorls indicate a shell with a high spire and only moderately impressed suture. Spiral angle about 15°. The sides of the whorls are very low-convex. The largest is ornamented with 14 narrow, well-defined, direct axial ribs, narrower than the interspaces; 13 axials are present on the next to the largest whorl. Spirals appear to be wanting. The axials end at the periphery, which is subangulated, and the flattish base is broadly and slightly excavated. The incomplete shell measures: Height 13+ mm, diameter 6 mm. The form and axial ornamentation suggest Boury's *Confusiscalia* (classed by him as a subgenus of *Amaea* H. and A. Adams), from the Cretaceous (Gault) of France, but the Texas species is more slender and lacks spiral ornamentation. The protoconch and the features of the aperture are not preserved. U.S.N.M. 105657.

Genus EPITONIUM (Bolten) Roeding, 1798

Type species: *Turbo scalaris* Linné, Recent, in the western Pacific.

***Epitonium stellanum* Stephenson, n. sp.**

Plate 35, figures 17, 18

Shell of medium size, high-turreted. Spiral angle about 16°. Protoconch not preserved. Suture closely appressed, deeply impressed. Whorls 8, gradually and regularly increasing in size. Sides of whorls of spire moderately and regularly inflated. Periphery of body whorl obtusely subangular, with a suggestion of a rounded ridge. Axial ribs prominent, narrower than the interspaces, trending forward a little from below upward; they number 12 on the body whorl and 11 on the fourth whorl above the body whorl; the axials are not preserved on the 3 earliest whorls present on the holotype. On the body whorl the axials end at the periphery. Fine, obscure, closely spaced spiral ribs are present in the interspaces between the axials on the body whorl; spirals are scarcely discernible on any of the earlier whorls, possibly because of poor preservation. The base is steep, flattish, and crossed by distinct growth lines and lamellae; fine, closely spaced spirals can barely be detected under magnification. Aperture broadly subovate, modified by a small, shallow anterior notch.

Dimensions of the holotype, the only available specimen: Height 24.2 mm, diameter 7 mm.

This is the only representative of this genus thus far found in the Woodbine formation.

Holotype.—U.S.N.M. 105658; from a sandstone in a gully in the upper part of the Woodbine formation, 300 feet north of a road, 0.65 mile south and 1 mile west of Star School, 5 miles south-southeast of Denison, Grayson County.

Occurrence.—Grayson County: Loc. 173.

Range.—Templeton member.

Family MATHILDIIDAE

Genus DATHMILA Stephenson, n. gen.

Type species: *Dathmila lineola* Stephenson.

Etymology: By anagram from the generic name *Mathilda*. Gender, feminine.

The distinguishing features of this genus, as revealed by the one available species, are its turreted umbilicate spire, flattish whorls, subdued spiral ornamentation, sharp, microscopic, closely spaced growth lirae, and subcircular peristome attached on one side to the parietal wall. The protoconch is partly broken away but appears to be a small, high-turbinate shell.

***Dathmila lineola* Stephenson, n. sp.**

Plate 35, figures 39–41

Shell small, umbilicate, with high spire; spiral angle about 32°. Suture shallow, narrowly channeled. Protoconch small, partly broken away, apparently high-turbinate. Whorls 5 or 6, flattish in profile, with a shallow spiral constriction above the midheight on the sides of the larger whorls. Periphery of body whorl rounding down sharply to a steep, more gently rounded base. The body whorl above the periphery bears 5 narrow, subdued spirals, the uppermost one of which is strongest, and the next to the lowermost one of which is second in size. A group of 4 very small spiral lines are present on the base just below the periphery. The growth lines appear as microscopic, closely spaced, sharp lirae that bear strongly to the right as they pass up over the base and continue over the periphery and the upper part of the whorl in a gentle curve concave in trend toward the front; these lirae are well preserved on most of the body whorl and on the larger part of the penultimate whorl of the holotype, the only available specimen. On the remaining smaller whorls of the spire both the growth lines and the spiral lirae have been destroyed by attrition or corrosion. Peristome partly broken away but apparently subcircular, with about one-fourth of its circumference forming a thin layer of callus on the parietal wall. The umbilical opening is about 0.5 mm in diameter.

Dimensions of the holotype: Height 7.2 mm, diameter 4 mm.

Holotype.—U.S.N.M. 105659; from a bluff on a tributary of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Loc. 165.

Range.—Templeton member.

Superfamily TAENIOGLOSSA

Family NATICIDAE

Genus NATICA Scopoli, 1777, sensu lato

Type species: *Nerita vitellus* Linné, Recent, in the western Pacific. Scopoli, 1777, p. 392.)

Natica humilis Cragin

Plate 35, figures 29, 30

1893. *Natica humilis* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 224, pl. 46, fig. 2.
 1928. *Ampullina humilis* (Cragin). Adkins, Texas Univ. Bull. 2838, p. 177.

Shell small. Spiral angle about 70°. Protoconch small, turbinate, coiled about twice. Suture narrowly channeled, deeply impressed. Whorls 5 or 6, smooth, narrowly shouldered above, gently convex below. Body whorl regularly rounded at the periphery and on the base. Aperture subovate, widely acute at the rear, narrowly rounded at the front. Outer lip broadly and regularly arched. Inner lip forming a thin callus that spreads forward and upward over the upper part of the parietal wall and at the base, becomes more or less separated from the wall to form a shallow umbilical fissure. Umbilicus practically wanting except for this fissure.

Dimensions of the larger of the two cotypes: Height 11.5 mm, diameter 8.5 mm. This appears to be the cotype illustrated by Cragin.

Compared with *Natica dorothisiensis*, this species has a higher spire, a smaller spiral angle, a distinctly developed narrow shoulder at the upper edge of each whorl, and a less globose profile.

Types.—Two cotypes in the collection of the Department of Paleontology, University of Texas, Austin, Tex., bearing an original number 707, from the Lewisville member on Timber Creek, southwest of Lewisville, Denton County. (See plastotypes, U.S.N.M. 105660 a, b.)

Occurrence.—Hill County: Loc. 7; Tarrant County: locs. 11, 16, 47; Denton County: loc. 79; 2 cotypes from Timber Creek, southwest of Lewisville; Cooke County: loc. 99; Grayson County: locs. 114, 126; Fannin County: locs. 184, 191.

Range.—Dexter member to Lewisville member.

Natica striaticostata Cragin

Plate 35, figures 35, 36

1893. *Natica striaticostata* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 224.
 1928. *Natica? striaticostata* Cragin. Adkins, Texas Univ. Bull. 2838, p. 176.

The original label indicates that the type material should include more than one specimen. However, one specimen only is present in the tray; it fits fairly closely the measurements given in Cragin's description. This specimen is an internal mold with a considerable part of the shell substance worn or broken away from its surface. Part of the shell that remains, particularly on the base, is rather coarsely striated in the axial direction, a feature that suggested the specific name, but these striations are probably the result of corrosion along the growth lines and should not have been given the importance assigned to them.

The one available type specimen is poorly preserved; it resembles *Natica dorothisiensis* in form but appears to

have a higher spire, a more sharply constricted base, and a deeper and wider umbilical fissure. No topotype material is available for comparison.

Dimensions of the one available type: Height 12 mm, diameter 8.7 mm.

Types.—The type material, now represented by one specimen only, is in the collection of the Department of Paleontology, University of Texas, Austin, Tex. The label bears an original number 43. (See plastotypes, U.S.N.M. 105661.)

Occurrence.—Grayson County: The locality description on the original label reads: "4 miles east of Whitesboro and 1 mile south of Whitesboro-Sherman road."

Range.—Templeton member.

Natica dorothisiensis Stephenson, n. sp.

Plate 35, figures 31, 32

Shell of medium size and thickness, with low spire. Spiral angle about 95° on the larger whorls, increasing to 115° at the apex. Protoconch small, smooth, low turbinate, coiled about one and a half times. Suture closely appressed, not deeply impressed. Whorls four, rapidly expanding. Sides of whorls plump, regularly rounded, curving over to the suture above without a shoulder. Surface smooth with the exception of fine growth lines. Aperture subovate, somewhat elongate, acutely angular at the rear, with the angle curving over to the left against the body, narrowly rounded at the front. Outer lip thin at the edge, broadly arched. Inner lip forming a thick callus that laps over and thins to a feather edge against the upper part of the parietal wall; on the lower part of the wall the callus separates from the base to form a wide open, rather deep umbilical fissure, on the inner surface of which the growth lines are coarse.

Dimension of the holotype, which is not quite maximum size: Height 18.3 mm, diameter about 15 mm.

Compared with *Natica humilis* Cragin, the species attains greater size, has a lower spire, is plumper, lacks a well-defined shoulder, and has a much wider and deeper umbilical fissure.

Types.—Holotype, U.S.N.M. 105662; 25 unfigured paratypes, U.S.N.M. 105663; from the Lewisville member in a branch north of Chicago, Rock Island & Pacific Railroad near Dorothy Sid-ing, 1 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. 34, 37, 38, 39, 41, 44 (types), 46, 50; Denton County: locs. 72, 73, 76, 78, 81, 84; Grayson County: locs. 137, 152, 164, 170.

Range.—Lewisville member to Templeton member.

Natica dorothisiensis pendula Stephenson, n. var.

Plate 35, figures 33, 34

The shells referred to this new variety appear to differ from the typical form of the species only in the fact that the whorls expand a little less rapidly, thus reducing the plumpness somewhat and causing the sides of the whorls to droop more steeply from the suture. There is no suggestion of a shoulder below the suture. This difference holds good among many shells from localities in Grayson and Fannin Counties. The spiral

angle on the holotype is about 80°. The aperture and umbilical fissures are essentially like those on the typical form of the species.

Dimensions of the holotype: Height 14.3 mm, diameter 11.5 mm.

Types.—Holotype, U.S.N.M. 105664; 11 unfigured paratypes, U.S.N.M. 105665; all from the Lewisville member on an east tributary of Sheep Creek, 150 yards downstream from a small waterfall, 2.6 miles east and 3.4 miles north of Savoy, Fannin County.

Occurrence.—Grayson County: Locs. 122, 135, 160, 165, 170, 171, 173; Fannin County: locs. 183, 191, 192 (types), 193.

Range.—Lewisville member to Templeton member.

Natica dorothiensis alveata Stephenson, n. var.

Plate 35, figures 27, 28

This variety differs from the typical form of the species in several minor, though apparently consistent, features. The spire is higher, with an angle of about 72°, the suture is deeper and more troughlike, and the whorls are more convex in their lateral contour. There is a slight suggestion of a narrow, ill-defined shoulder below the suture.

Dimensions of the holotype: Height 13.4 mm, diameter 11 mm.

Types.—Holotype, U.S.N.M. 105666; 14 unfigured paratypes, U.S.N.M. 105667; all from the Templeton member in a bluff on a branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County.

Occurrence.—Hill County: Loc. 3; Tarrant County: loc. 35; Grayson County: locs. 126, 135, 164 (types), 165, 171.

Range.—Lewisville member to Templeton member.

Natica rivulana Stephenson, n. sp.

Plate 35, figures 37, 38

Shell of medium size, thick, with spiral angle of about 80°. Protoconch low, smooth, turbinata, coiled about one and a half times. Suture closely appressed, deeply impressed. Whorls 6 in the adult, rapidly expanding. Sides of whorls broadly and regularly rounded, with a narrow, fairly well-defined shoulder bordering the suture. Surface marked only by growth lines that may become rather coarse on the body whorl of adults. Aperture elongate-subovate, broadly and regularly rounded on the outer lip, acutely angular at the rear, sharply rounded in front. Inner lip forming a thin callus over the parietal wall; umbilical fissure small and narrow.

Dimensions of the type: Height 31.7 mm, diameter 24.4 mm.

This species attains a greater size, has a thicker shell, and is in general more rugged than any of the other species of *Natica* in this fauna. The spire is higher than that of *N. dorothiensis* and lower than that of *N. humilis*.

Types.—Holotype, U.S.N.M. 105668; 1 paratype, figured, U.S.N.M. 105669; 1 paratype, unfigured, U.S.N.M. 105670; all from the Lewisville member in a branch north of the Chicago,

Rock Island and Pacific Railroad, near Dorothy Siding, about 1 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. 27, 41, 44 (holotype, 2 paratypes, 1 figured); Denton County: locs. 72 (var. ?), 73, 75; Fannin County: locs. 180, 184; Lamar County: loc. ?206.

Range.—Euless member to Lewisville member; Templeton member (?).

Genus *GYRODES* Conrad, 1860

Type species: *Natica (Gyrodes) crenata* Conrad (1860, p. 289), now considered identical with the earlier described species *Rapa supraplicata* Conrad (1858, p. 332), from the Owl Creek formation, Tippah County, Miss. (See Stephenson 1923, p. 358.)

The species *Neritopsis tramitensis* Cragin, compared with *Neritopsis moniliformis* Grateloup, a Miocene species from France, which by monotypy is the genotype of *Neritopsis*, obviously does not belong to Grateloup's genus (Wenz, 1938, p. 412); it is clearly referable to the American genus *Gyrodes*. The same may be said of the species that Cragin called *Neritopsis biangulatus* Shumard; it belongs to *Gyrodes* and is believed to be assignable to *Gyrodes tramitensis* (Cragin). Shumard's species, based on an internal mold, was not illustrated, and the type material is lost; the specific name he used cannot be safely applied to the specimens here under consideration.

Gyrodes tramitensis (Cragin)

Plate 36, figures 24–29

1893. *Neritopsis tramitensis* Cragin, Texas Geol. Survey, 4th Ann. Rept. for 1892, p. 227.

1893. *Neritopsis biangulatus* Shumard. Cragin, Texas Geol. Survey, 4th Ann. Rept. for 1892, p. 227.

1951. *Gyrodes tramitensis* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, figs. 8, 9 (following p. 163).

This species was based on one internal mold, incomplete at the apex, with some badly corroded shell material adhering about the sutures and in the umbilicus.

Shell of medium size, with low spire and rapidly expanding, smooth, plump whorls. Protoconch small, turbinata, poorly preserved in the available specimens. Suture incised, deeply impressed. Whorls four, with a narrow weakly crenulated shoulder obtusely subangular on the outer border; on young shells referred to the species, this shoulder is seen to extend well back almost to the protoconch and is rather coarsely striated along the growth lines. Body whorl broadly rounded on the side and sharply rounded to subangular below at the border of the umbilicus. The growth lines extend from the border of the umbilicus upward and strongly forward across the body to the shoulder above, thence bend to the right and pass across the shoulder either directly or a little toward the rear. Aperture angular at the rear, with the angulation curving over strongly against the body, widening out below, and sharply rounded at the front. Outer lip forming almost a semi-

circle. Inner lip not well preserved. Umbilicus deep, widely flaring, probably extending nearly to the apex, limited outwardly by a sharply rounded ridge; inner surface rather coarsely striated in the direction of the growth lines. About halfway down the inner wall of the umbilicus is a rather weak, but sharp, revolving ridge seen only on well-preserved shells.

Dimensions of the incomplete holotype: Height about 34 mm, diameter 41 mm.

The available material indicates some individual variation in the height of the spire, the spire of the plesiotype being a little higher than that of the holotype.

The specimen that Cragin identified with *Neritopsis biangulatus* Shumard (1860b, p. 598) and that is preserved in the collection of the Department of Paleontology, University of Texas, appears to be a slightly distorted example of *Gyrodes tramitensis*; it, too, is an internal mold with a little shell material adhering to it.

Types.—Holotype (Leverett's specimen, orig. no. 52a) an internal mold with some shell material adhering, from the Lewisville member on Big Bear Creek, near Dallas-Tarrant County line, in Tarrant County, in the collection of the Department of Paleontology, University of Texas, Austin, Tex. (See plastotypes, U.S.N.M. 105672, 105673.) Two plesiotypes, U.S.N.M. 105671a-b.

Occurrence.—Tarrant County: Locs. 41, 44 (includes 2 plesiotypes), 46; also Cragin's type specimen (orig. no. 52a). Denton County: Loc. 79; Grayson County: locs. 126, 171; the specimen (University of Texas orig. no. 156) identified by Cragin as *Neritopsis biangulatus* Shumard (number in ink on specimen, K636), from 4 miles east of Whitesboro. Lamar County: Loc. 203.

Range.—Lewisville member to Templeton member.

Gyrodes fluvianus Stephenson, n. sp.

Plate 36, figures 20-23

1894. *Gyrodes depressa* Meek. Stanton, U. S. Geol. Survey, Bull. 106, p. 135, pl. 29, figs. 11-14.

Shell of medium size, low spire, and rapidly expanding whorls. Protoconch not completely preserved but apparently low turbinate and coiled not more than one and a half times. Suture sharply, but not deeply, impressed. Whorls four in adults; shoulder wanting or only weakly developed in the later stages of the body whorl of an adult. Body whorl plumply and regularly rounded from the suture above to the edge of the umbilicus below, where it rounds sharply into the umbilical depression. Growth lines rather pronounced over the entire surface; in the holotype the strength of the growth lines appears to have been considerably accentuated by differential corrosion. Aperture elongate-subovate, acutely angulated at the rear where the angulation curves over to the left against the body, sharply rounded at the front. Outer lip thin at edge, arched in an approximate semicircle. Inner lip moderately thick, overlapping and thinning to an edge high on the parietal wall and forming a prominent wall on the margin

of the umbilicus below. Umbilicus flaring, deep, probably extending to the apex, marked on its inner surface by conspicuous growth lines.

Dimensions of the holotype: Height about 25 mm, diameter 26 mm.

The species differs from *Gyrodes tramitensis* (Cragin) in the conspicuous development of the growth lines, but more particularly in the profile of the whorls, on which a shoulder is only weakly developed in the later stages of growth.

The shells figured by Stanton (1894, p. 135, pl. 29, figs. 11-14) under the name *Gyrodes depressa* Meek, from "Poison Canyon and Williams Creek, Huerfano Park, Colorado," appear to be essentially like this species. Meek's figured type (1877, p. 159, pl. 15, figs. 1, 1a) is a poorly preserved internal mold apparently having a narrow shoulder and a weak shoulder angle, and is probably not the species described and figured by Stanton.

Types.—Holotype, U.S.N.M. 105674; 1 incomplete young paratype, unfigured, U.S.N.M. 105675; 1 figured paratype, U.S.N.M. 105676; all from near old Slate Shoals, 8 miles east of Arthur City, Red River, Lamar County.

Occurrence.—Lamar County: Loc. 201 (holotype, 2 paratypes, 1 figured).

Range.—Templeton member.

Family XENOPHORIDAE

Genus XENOPHORA Fischer, 1807

Type species: *Trochus conchyliophorus* Born (= *Xenophora laevigata* Fischer), Recent, in the West Indies.

Xenophora? sp.

One poorly preserved low-trochiform gastropod, from the Templeton member about 5 miles south-southeast of Denison, Grayson County (loc. 171), bears the impressions of extraneous objects, probably shell fragments that were once attached to it by agglutination. This feature, together with the trochoid form of the shell, suggests close relationship with the long-ranging genus *Xenophora* Fischer. The protoconch is a low, smooth, trochiform shell coiled about one and a half times.

Dimensions: Height about 10 mm, diameter about 12 mm. U.S.N.M. 105677.

Family TRICHOTROPIDAE

Genus LIRPSA Stephenson, n. gen.

Type species: *Lirpsa cornuata* Stephenson.

Etymology: By anagram from *spiral*. Gender, feminine.

This genus is characterized by its relatively short spire, its rapidly expanding whorls, its single, sharp, prominent keel-like spiral rib, which becomes rounded in the adult shells of the species *teres*, its subquadrate aperture, and its widely flaring, sinuous umbilicus. The genus appears to be related to *Trichotropis* Broderip and Sowerby, genotype *T. tricarinata* (Sowerby), a

Recent species inhabiting the Arctic Sea off the northwest coast of Alaska, which is characterized by two sharp spiral ribs instead of one.

Trichotropis shumardi Cragin (1893, p. 229, pl. 42, fig. 13) is similar in form to *Lirpsa*, but compared with the plesiotype of the former, an internal mold, figured by Stanton (1947, p. 79, pl. 52, fig. 7), *Lirpsa* has a much more widely flaring umbilicus and a thick shell, and is probably generically distinct.

Lirpsa cornuata Stephenson, n. sp.

Plate 36, figures 4-7

Shell of medium size, and height, thick and rugged. Whorls three, rapidly expanding. Spiral angle about 82°, decreasing a little at the apex. Suture deeply impressed, loosely appressed. Protoconch not preserved. Body whorl with a broad, sloping shoulder, gently concave in cross section. Outer edge of shoulder bearing a sharply acute, serrated keel that passes back onto the smaller whorls as a sharp lateral spiral rib situated well below the middle of the exposed area. On the body whorl just below the sharp rib is a shallow, spiral depression that tends to die out toward the aperture. Below the depression, the base slopes moderately downward, bending up a little before reaching the sharply acute keel that bounds the umbilicus. Growth lines strong and irregular, inclining somewhat forward as they ascend toward the shoulder, which they cross with a still greater obliquity toward the front. Aperture large, subquadrate, with subangular anal and siphonal notches. Outer lip strongly arched, subangulated at the terminus of the shoulder keel. Inner lip rather thick, broadly concave, with a tendency in adults to separate from the parietal wall. Umbilicus wide open, twisted, and flaring in adults, becoming rapidly smaller rearward and apparently not extending to the apex; outer rim of umbilicus forming a sinuous, serrated keel, which is somewhat worn and broken in the holotype.

Dimensions of the holotype: Height 33+ mm, diameter about 31 mm.

Types.—Holotype, U.S.N.M. 105678; 2 figured paratypes, U.S.N.M. 105679a-b; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201 (holotype, 2 paratypes).

Range.—Templeton member.

Lirpsa teres Stephenson, n. sp.

Plate 36, figures 1-3

This species is similar in general form and in the features of the aperture and umbilicus to *Lirpsa cornuata*, but it has a more slender spire, with angle of about 65°, and the one spiral rib, though rather sharp on the younger stages, becomes progressively less prominent until, on the body whorl, it becomes a nonangular, rounded shoulder. The protoconch is broken or partly worn away on the available shells, but there is a sug-

gestion in its internal mold on one specimen, that its axis is strongly tilted in relation to the axis of the main shell.

Dimensions of the holotype: Height 31+ mm, diameter 22+ mm.

Types.—Holotype, U.S.N.M. 105681; 1 figured paratype, U.S.N.M. 105680; 2 unfigured paratypes, U.S.N.M. 105682; all from a point near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201 (types).

Range.—Templeton member.

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Type species: *Turbo terebra* Linné, Recent, in the western Pacific.

Turritella shuleri Stephenson, n. sp.

Plate 36, figures 14-19

Shell of medium size, high-turreted, with spiral angle of 18° or 19°. Protoconch small, not well-preserved in the available material. Suture closely appressed, not deeply impressed. Whorls 15 or more, flattish to only very slightly convex on the sides. Periphery of body whorl rounded, curving downward into a gently convex base. The periphery and base of the body whorl are ornamented with numerous narrow, nonprominent spiral ribs that tend to alternate in size, the series, however, becoming smaller to obscure downward. The sides of the whorls are ornamented with four primary beaded spirals; each of the upper two is wider than either of the lower two, and the uppermost spiral that closely borders the suture may or may not be wider than the one next below it; the width and arrangement of the spirals vary considerably on different individuals. Secondary ribs are present in the interspaces, and these vary from obscure to distinct. One, two, or three tertiary ribs appear as fine lines in the remaining interspaces, the number in each case depending on the available space; the tertiaries are often weak to obscure. Two secondaries may be present in the wider interspaces between primaries. The beads are coarsest on the two upper spirals, particularly on the uppermost one; the secondaries and tertiaries may or may not bear tiny beads. Traced backward toward the apex the secondary and tertiary spirals tend to fade out and disappear on the earlier whorls. Aperture not well preserved in the available material but apparently subcircular, with a thin outer lip, and the inner lip forming a thin callus on the parietal wall. Growth lines markedly sinuous, being deeply flexed backward a little above the middle of the exposed part of each whorl.

Dimensions of the holotype: Height 33+ mm, diameter about 10 mm. Large shells may attain a diameter of 18 mm or more.

This species is very similar to *Turritella thomsonina* Stephenson (1936, p. 400) both in form and sculpture,

differing mainly in the greater width and prominence of the primary spirals, leaving less room for tertiaries, and in the relatively greater coarseness of the beading. The species *thomsonina* was dredged from the ocean bottom on Banquereau Bank, off the east coast of Nova Scotia.

Several related, noded species of *Turritella*, notably *T. seriatim-granulata* Roemer and its varieties, are recorded from the Comanche series, Texas. (Ellisor, 1918, 29 pp.; Stanton, 1947, pp. 71-77.) Noded *Turritellas* of this kind appear to be wanting in the Gulf series (Upper Cretaceous) above the Woodbine formation.

Two species of *Turritella* from the Chico formation (Cenomanian or Turonian) of California, *T. tolenasensis* Merriam and *T. hearni* Anderson (C. W. Merriam, 1941, pp. 62-64), possess beaded spirals and are similar in form and in the profile of the base to *T. shuleri*.

Zekeli (1852, pp. 22-25, pl. 1) has recorded several species of beaded *Turritellas* from the Gosau beds of Austria, which may indicate an approach to synchronicity of the containing beds on the two sides of the Atlantic.

Types.—Holotype, U.S.N.M. 105683; 2 figured paratypes, U.S.N.M. 105684a-b; 11 unfigured paratypes, U.S.N.M. 105685; all from the Lewisville member in a small branch of Big Bear Creek at crossing of a north-south road, 1.2 miles northeast of Eules, Tarrant County. Two figured paratypes, U.S.N.M. 105686a-b; 17 unfigured paratypes, mostly fragmentary, U.S.N.M. 105687. Named in honor of Prof. Ellis W. Shuler, Southern Methodist University, Dallas, Tex.

Occurrence.—Tarrant County: Locs. 36, 38, 41, 44 (19 paratypes, 2 figured), 53 (holotype and 13 paratypes, 2 figured), 49; Denton County: locs. 72, 75-79, 81; Grayson County; loc. 153.

Range.—Lewisville member to Templeton member.

Unidentified specimens of *Turritella*

Imprints of a slender species of *Turritella* (pl. 36, fig. 12) are present in ferruginous sandstone of the Dexter member overlying Budalike limestone, 3.7 miles northeast of Roanoke, Denton County (loc. 56). The material is fragmentary and hardly adequate for specific assignment. A rubber cast of one specimen is illustrated. The suture is moderately impressed, the sides of the whorls are broadly and evenly rounded, and each whorl is ornamented with six evenly spaced, narrow, faintly tuberculated spiral ribs, which are separated by wider interspaces. The figured specimen indicates a shell 22+ mm. in height. U.S.N.M. 105688a.

The imprint of a small *Turritella* in ferruginous sandstone of the Dexter member, 3.5 miles south by west of Bartonville, Denton County (loc. 57), probably pertains to the same species as the preceding. U.S.N.M. 105689.

A small, very slender shell, probably a young *Turritella*, (pl. 36, fig. 13) was found in the Templeton

member, 2.2 miles west of Arthur City, Lamar County (loc. 207). Each whorl is slightly swollen below, with flattish side sloping in to the next suture above. The side of each whorl is ornamented with four evenly spaced spirals, which decrease in strength from below upward. The shell is 6+ mm high and 1.9 mm in diameter. U.S.N.M. 105690.

Genus *MESALIA* Gray, 1847

Type species: *Cerithium mesal* Adanson, Recent, off the coast of northwest Africa.

Mesalia? *shumardi* Stephenson, n. sp.

Plate 36, figures 8-11

Shell small, turreted, with spiral angle of about 27°. Protoconch not well preserved but on one small paratype appears to be high and loosely coiled. Suture deeply impressed in a wide V-shaped depression. Whorls about 9, moderately convex on the side, with greatest inflation about one-third the width of a whorl above the base. On the larger whorls the primary spiral ribs are 2 in number, the lower one, which follows the line of greatest inflation, being the larger; the upper one lies somewhat below the suture. The lower primary rib is obscurely beaded, the upper one distinctly beaded, the beads on both being relatively coarse. On the smaller whorls of the figured paratypes there is less differentiation in the size of the spirals than on the larger whorls of the holotype, and beading is distinctly developed on the three uppermost spirals. On the holotype a pair of secondary spirals is present between the primaries, and tertiaries appear in the remaining interspaces; still finer lining may be detected where the spaces are sufficiently wide. Below the lower primary adjoining the suture is a medium-sized spiral, which may be classed as a secondary. Below the latter on the body whorl the periphery is marked by a shallow spiral depression, below which is a weak spiral ridge. The periphery is rounded and the base strongly constricted, with spirals wanting on the lower part. The growth lines are sinuous and show a strong rearward inflection, with greatest depth slightly above the midheight of each whorl. Aperture subcircular; outer lip thin and strongly inflected in conformity with the trend of the growth lines. Inner lip forming a thin callus on the parietal wall above and lapping well over toward the front on the lower part of the base.

Dimensions of the incomplete holotype: Height 14+ mm, diameter about 7 mm.

The species is assigned tentatively to *Mesalia* Gray, chiefly on the basis of its lower spire and wider spiral angle as compared with *Turritella*.

Types.—Holotype, U.S.N.M. 105691; 2 figured paratypes, U.S.N.M. 105692 a-b; all from Timber Creek, 3 miles west by

south of Lewisville, Denton County. Named in honor of B. F. Shumard.

Occurrence.—Denton County: Loc. 75 (types); Grayson County: loc. ?122.

Range.—Lewisville member.

Genus *CRAGINIA* Stephenson, n. gen.

Type species: *Craginia turriiformis* Stephenson.

Etymology: Named in honor of F. W. Cragin, pioneer geologist and paleontologist of Texas.

Cragin (1893, p. 230) identified a specimen from Timber Creek, southwest of Lewisville, Denton County, with Meek's species *Turritella coalvillensis* from Coalville, Utah (1873, p. 502). Cragin's specimen is preserved in the collection of the Bureau of Economic Geology, Austin, Tex. Although resembling Meek's species, the specimen does not appear to agree closely enough with poorly preserved topotypes in the U. S. National Museum to justify Cragin's identification. Stanton later referred *coalvillensis* to the genus *Glauconia* Giebel (1852), a name that was preoccupied for a lizard (Gray, 1845). This would seem to free the name *Cassiope* Coquand (1865, pp. 247-254, pl. 3, figs. 1-6; pl. 4, figs. 1-8), heretofore regarded as a synonym by authors, to replace *Glauconia*. However, *Cassiope* is based on the species *Cerithium kefersteini* Münster (in Goldfuss, 1836, p. 36 (p. 34 in 1863 ed.), pl. 174, fig. 11), which appears to be generically distinct from *Craginia*. *C. kefersteini* is from the Gosau Cretaceous of Austria. *Cassiope*, although similar in a general way to *Craginia*, is a strongly noded species. The aperture is not shown in the original illustration. *Turritella coalvillensis* Meek is congeneric with *Craginia*.

Craginia is a large turreted shell with eight or more rather rapidly expanding whorls, a deep sutural depression, and spiral ornamentation that exhibits considerable individual and specific variation. One dominant ridge lies one-fourth to one-third the width of the whorl above the lower suture on all specimens; below this ridge is a short, steep slope to the suture below, and above it a longer, more gentle slope to the suture above; smaller spiral ribs may be present both above and below the dominant ridge. The growth lines are strongly sinuous, being broadly convex in trend forward on the base and deeply concave forward on the slope above the main ridge. The aperture is subcircular, but the periphery is discontinuous, the inner lip being plastered firmly against the parietal wall along nearly one-fourth the circumference. The outer lip is sinuous, in conformity with the trend of the growth lines, there being a deep notch in the lip between the terminus of the main spiral rib and the suture above. Individual shells vary in the closeness of coiling of the whorls, some being closely coiled, some showing an umbilical fissure, and an occasional one a small umbilical opening of considerable depth.

Craginia turriiformis Stephenson, n. sp.

Plate 36, figures 30-36

1893. *Turritella coalvillensis* Meek. Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 230. (Not *T. coalvillensis* Meek.)
1928. *Turritella coalvillensis* Meek. Adkins, Texas Univ. Bull. 2838, p. 181. (Not *T. coalvillensis* Meek.)

The species exhibits considerable individual variation among shells from the same locality, and shells from different localities do not agree closely with each other. The variations are manifested as differences in the number, prominence, thickness, and spacing of the spiral ribs and in the presence or absence of an umbilical opening, which is present only on certain more loosely coiled individuals. The present available material is too meager in the number of individuals, and most of it is too poorly preserved, to justify an attempt to subdivide the group into two or more species or varieties. The detailed description given below is based mainly on the holotype, a partly well preserved, though incomplete specimen.

Shell large, turreted, with apical angle of 30°. Suture deeply impressed, situated slightly above the middle of a wide depression. Protoconch not preserved. Whorls 7 or 8. Sides of penultimate and earlier whorls ornamented with 3 narrow spiral ribs, the lowest one prominent and round-crested, the middle one narrow, weak, and separated from the prominent spiral by a wide interspace, and the upper one moderately prominent and separated from the weak spiral below by a narrow interspace; a wide, broadly concave depression separates the upper spiral from a slightly tumid band that borders the suture above. Base of body whorl broadly convex, traversed on its upper half by 3 subequal, narrow spirals of medium strength. Several obscure spirals may be detected on the lower part of the base. Most of the surface is covered with fine, microscopic, closely packed spiral lines; these are wanting or very obscure on the crests of the larger ribs, possibly because of abrasion, and are weak to obscure on the lower part of the base. Growth lines sinuous, convex in trend toward the aperture low on the base, strongly concave in the same direction on the upper part of the whorl. Aperture subcircular except at the rear, where it is modified by a sharp anal angle. Outer lip thin, markedly sinuous, and conforming to the trend of the growth lines. Inner lip forming a thin callus over the parietal wall, becoming thicker on the free part below the base.

Dimensions of the incomplete holotype: Height 40+ mm, diameter about 23.5 mm. Large adults may attain a height of 60 mm or more.

Individual variations in the sculpture are shown in the illustrations. The type specimen has a narrow umbilical fissure; one shell in the collection has a narrow umbilical opening. On one specimen, which ap-

pears to be a varietal form, a spiral band of brownish color 2 to 4 mm wide traverses the upper slope of each whorl, ending at the deep notch in the outer lip of the aperture. This specimen was referred by Cragin to *Turritella coalvillensis* Meek.

This species is so closely related to *Turritella coalvillensis* Meek (1873, p. 502; also White, 1879, p. 315, pl. 9, fig. 4a) from Coalville, Utah, that I have hesitated to give it a separate specific name. However, a careful examination of the available material from both areas shows differences that seem to justify making the separation. Most of the Utah specimens, including the cotypes, are poorly preserved. Compared with *Craginia turriiformis*, the main inflation of the whorls in all the 20 cotypes of Meek's species is a little stronger and a little higher on the side of the whorls; the spire is slightly more slender; the two spiral ribs above the main inflation appear to be less sharply developed; fine spiral lining, such as that covering the spaces between the main spirals of *turriiformis*, appears to be wanting on *coalvillensis*, although its apparent absence may be due to poor preservation.

Stanton (1894, p. 132) referred Meek's species *T. coalvillensis* to *Glaucônia*, a name now known to be preoccupied. He placed *Cassiope whitfieldi* White (1874, p. 27; 1877, p. 196, pl. 18, fig. 1a) in the synonymy of *T. coalvillensis*; *C. whitfieldi* differs in details of ornamentation from *T. coalvillensis*, but in view of the known individual variation in the shells of this genus this disposition of Whitfield's species is probably correct.

The figured cotype of *Cassiope whitfieldi* White is an unusually large, incomplete specimen, the diameter measuring 43+mm; it possesses a narrow, deep umbilicus.

Types.—Holotype, U.S.N.M. 105694; from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. One paratype, figured, U.S.N.M. 105693; 1 example, figured, Bureau of Economic Geology no. R17600 (see plaster cast, U.S.N.M. 105695); 1 paratype, figured, U.S.N.M. 105696; 1 paratype, unfigured, U.S.N.M. 105697; 1 paratype, figured, U.S.N.M. 105698; 1 paratype, unfigured, U.S.N.M. 105699; 3 paratypes, unfigured, U.S.N.M. 105700.

Occurrence.—Tarrant County: Loc. 41; Denton County: loc. 75 (paratype, figured); also one specimen in collection of Bureau of Economic Geology, Austin, R17600, figured; Grayson County: locs. 117, 219, 224; Fannin County: locs. 179, 184 (holotype), 186 (2 paratypes, 1 figured); Lamar County: loc. 201 (5 paratypes, 1 figured).

Range.—Lewisville member to Templeton member.

Genus GYMMENTOME Cossmann, 1909

Type species: *Turritella renauziana* D'Orbigny (D'Orbigny, 1842, tome 2, p. 41; Cossmann, 1909, p. 169; Wenz, 1939, p. 695).

Wenz classified *Gymmentome* Cossmann as a subgenus of *Glaucônia* Giebel (preoccupied) in the family Thiaridae, but the shell bears little resemblance to the type species, *Glaucônia kefersteini* (Goldfuss). The shell also seems equally remote from the Recent *Thiara*

amarula (Linné), the type of the family Thiaridae. I am provisionally placing *Gymmentome* in the family Turritellidae.

This genus is represented in the beds of Kiamichi (Comanche) age at Mesa Tucumcari, N. Mex., by a shell described by Stanton (1947, p. 78) under the new name *Cassiope hyatti*. The resemblance between *Gymmentome valida* and *G. hyatti* (Stanton) is quite close, but the sides of the whorls of the latter are higher and a pronounced revolving swell characterizes the lower half of the body whorl and the penultimate whorl.

Gymmentome valida Stephenson, n. sp.

Plate 37, figures 31, 32

1893. *Turritella renauziana* D'Orbigny. Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 231. (Not *T. renauziana* D'Orbigny.)

Shell large, turreted, with spiral angle of about 20° on the larger whorls, increasing to 30° above mid-height. Apex not preserved. Suture closely appressed, sharply and slightly to moderately impressed. Whorls about 10 (estimated), flattish to gently concave, to gently convex on the side. Periphery of body whorl rounded, base moderately steep and broadly convex. The body whorl bears several obscure revolving lines on the side and part way down over the base; those above the periphery are traceable back to the fifth whorl from the aperture, where a pair of them increases in strength and forms distinct, narrow spiral ribs that become more prominent on the still earlier whorls. The spiral ornamentation on these earlier whorls resembles that on *Craginia turriiformis* and seems to indicate at least a family relationship between the two genera. On the body whorl just above mid-height is a broad, very shallow revolving depression; passing to the penultimate whorl, a gentle revolving swell rises centrally in the depression, thus producing in this whorl three weak revolving swells about equally spaced; continuing to the antepenultimate and earlier whorls, these swells flatten out and merge again into a broad, gentle depression, which toward the apex is modified by the two narrow spirals already mentioned. The growth lines trend directly upward across the base to the periphery, above which they curve first to the right, thence sharply to left, continuing in a broad, oblique curve upward to the suture; the sharp turn in trend above the periphery is the reflection of a notch in the outer lip of the aperture. Aperture broadly subquadrangular, with an obtuse subangulation at the rear and a rather sharply rounded anterior edge. Outer lip broken away in the holotype, but, as seen in one adult specimen, it is thin at the edge and obtusely subangulated at the intersection of the periphery. Inner lip thick at each end, thin a little above the middle, where, for a distance of 8 or 10 mm it is attached to the parietal wall.

Dimensions of the holotype, which is incomplete at both ends: Height 76+ mm, diameter 33+ mm.

This species bears a close resemblance to *Gymnentome renauxiana* (D'Orbigny) (1842, tome 2, p. 41), from the so-called chloritic chalk (Cenomanian) of France. Cragin actually referred the specimen from Texas to *Turritella renauxiana* (1893, p. 231), but it differs from that species in having a more slender spire, with straighter sides, a sharper angulation in the trend of the growth lines, and a less evenly rounded aperture. One specimen identified by Cragin is in the collection of the Bureau of Economic Geology, Austin (red ticket 708; Bureau number R17594); it is incomplete, but, after cleaning, it shows the features of the adult aperture quite well; the outer lip is curiously constricted, giving to the aperture a squarish outline.

Type.—Holotype, U.S.N.M. 105701; from the Lewisville member on Timber Creek, southwest of Lewisville, Denton County.

Occurrence.—Tarrant County: Locs. 36, 39, 43, 44; Denton County: locs. 72, 73 (holotype), 76, 81; Cooke County: loc. 99; Grayson County: locs. 126, 132; Lamar County: loc. 201.

Range.—Lewisville member to Templeton member.

Gymnentome valida brevis Stephenson, n. var.

Plate 37, figure 30

Shell large, with spiral angle of 37° to 40° on the larger whorls, increasing to as much as 45° toward the apex. Apex not preserved. Suture closely appressed, sharply but not deeply impressed. Whorls 6 or more, flattish to gently concave to gently convex on the side. Body whorl with a broadly convex spiral swell above the periphery and a gently concave band between this swell and the suture above; the swell gradually decreases in prominence backward on the penultimate and antepenultimate whorls, whereas the spiral depression above the swell continues on the earlier whorls well back toward the apex. Indication of the presence of a pair of spiral ribs may be seen on the earliest whorl preserved on the holotype. The growth lines are sinuous in trend, presenting a decided concavity facing in the direction of the aperture on the spiral swell. The aperture is incomplete on the available material. The inner lip is thick but bevels down to an edge on the parietal wall.

The incomplete holotype measures: Height 41+ mm, diameter 23+ mm.

The features of this shell are essentially like those of the typical *Gymnentome valida*, except that the spire is markedly shorter and the spiral angle is greater. The recognition of the varietal form seems justified unless a large suite of the shells would show these differences to be individual variations.

Types.—Holotype, U.S.N.M. 105702; 2 unfigured fragmentary paratypes, U.S.N.M. 105703; all from the Lewisville member in a branch north of Chicago, Rock Island and Pacific Railroad, 1 mile west of Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Loc. 44 (holotype and 2 unfigured paratypes); Denton County: loc. 83; Grayson County:

locs. 122, 132, 137, 138, 224; Fannin County: locs. 184, ?187, 191; Lamar County: loc. 201.

Range.—Lewisville member to Templeton member.

Family THIARIDAE

Genus PYRGULIFERA Meek, 1871

Type species: *Melania humerosa* Meek (= *Pyrgulifera humerosa* (Meek)), by monotypy (1871, p. 294), from the Bear River formation (lower part of Upper Cretaceous) on Sulphur Creek, a tributary of Bear River, near Bear River, Wyo.

The genus *Pyrgulifera* Meek is represented in the Woodbine formation by two new species, *P. ornata* and *P. costata*; two varietal forms of the latter, *tuberata* and *sublevis*, are recognized. *P. ornata* is very similar in form and ornamentation to Meek's species, but is smaller and much less rugged in its ornamentation, and possesses a relatively weaker indication of the presence of a siphonal notch; this notch is weakly developed in *humerosa* and is scarcely more than a trace in *ornata*. The aperture is broadly subovate, with a small but distinct anal notch at the rear. The callus on the inner lip is thick, and there is a narrow, shallow umbilical fissure. The shoulder, which, in *P. ornata*, is a conspicuous feature owing to the presence of a row of nodes on the shoulder angle, becomes inconspicuous on *P. costata* and its two varieties. In collections containing many specimens it is obvious that allowance must be made for considerable individual variation in ornamentation.

Pyrgulifera ornata Stephenson, n. sp.

Plate 37, figures 9–13

Shell of medium size, with spire slightly higher than the vertical length of the aperture; spiral angle about 54°. Protoconch not preserved. Suture in a narrow groove in the bottom of a wide V-shaped depression. Whorls 4½ or 5, plumply inflated, with a wide, steep shoulder obtusely angulated at the outer border. Anal collar narrow and weak. Base of body whorl broadly rounded, with no angulation at the periphery. Shoulder angle bearing a row of somewhat irregular nodes that continue well developed back to the earliest whorl; the individual nodes may be either cone-shaped or more or less elongated in the spiral direction. The body whorl below the row of shoulder nodes bears 6 or 7 moderately strong spiral ribs, separated by wider interspaces; the spirals are irregularly noded. The two uppermost spirals are most distinctly and regularly noded; they pass backward well exposed, on the penultimate and earlier whorls, the upper one rather weakly developed; the nodes on these two spirals are distinctly elongated. The shoulder slope lacks spirals but bears a row of nodes that may be weak or strong on different individuals. The axial ribs number 15 or 16 on the body whorl and 13 on the penultimate whorl; they are most strongly developed on the inflated part of each

whorl and fade out in a short distance both above and below the shoulder angle; each of the conspicuous nodes on the shoulder angle is at the intersection of one of the axials. Growth lines rather strongly and irregularly developed; they are slightly sinuous, being broadly concave in trend toward the aperture on the inflated part of the shell. Aperture subquadrate, with an angulation and an upturned anal canal at the rear and a very faintly impressed siphonal notch at the front. Outer lip arched, with an obtuse subangulation at the intersection of the shoulder angle. Inner lip thick, attached to the parietal wall above, and bordering a narrow, shallow umbilical fissure below. The 13 unfigured paratypes exhibit considerable individual variation in the details of the ornamentation.

Dimensions of the incomplete holotype: Height 22+ mm, diameter about 16 mm.

The species is distinguishable from the other species of *Pyrgulifera* in the Woodbine formation by its strongly developed, noded shoulder.

Types.—Holotype, U.S.N.M. 105704; 2 figured paratypes, U.S.N.M. 105705a-b; 12 unfigured paratypes, U.S.N.M. 105706; all from a gully near fence, 1,250 feet north of an east-west road, approximately 3.5 miles N. 28° E. of Savoy, Fannin County.

Occurrence.—Cooke County: Loc. 100; Grayson County: loc. 135; Fannin County: locs. 180, 184, ?186, 191 (types), 195; Red River County: loc. ?209.

Range.—Lewisville member.

Pyrgulifera costata Stephenson, n. sp.

Plate 37, figures 14-16

Shell of medium size, with spire about equal in height to the vertical length of the aperture; spiral angle about 52°. Protoconch not preserved. Suture deeply impressed. Whorls 4 or 5, plumply rounded in profile, with shoulder practically wanting and periphery not angulated. Anal collar wanting. Body whorl of holotype ornamented with about 10 moderately strong spiral costae which differ somewhat on different parts of the surface but which are in the main about equal in width to the interspaces; the uppermost spiral lies close to the suture and is rather crudely noded; the next two spirals below are broken into more regular, rounded, slightly elongated nodes; the rest of the spirals on the medial and lower parts of the body whorl are without well-defined nodes for some distance back of the aperture but tend to become regularly noded still further back toward the penultimate whorl; an occasional small spiral may appear by intercalation between the larger ones on the body whorl. The growth lines are gently sinuous, being broadly concave in trend toward the aperture on the inflated part of the body whorl, inclining forward as they approach the suture above. The numerous available imprints of this species indicate considerable individual variation in the details of ornamentation. The aperture is subovate to sub-

quadrate, with an anal canal at the rear and a very faint indication of an anterior siphonal notch. The outer lip is arched and rather thin. The inner lip is thick, is attached to the parietal wall above, and borders a narrow, shallow umbilical fissure below.

The available material does not lend itself to accurate measurement, but the holotype is 20+ mm high and 14+ mm in diameter.

This species differs from *Pyrgulifera ornata* in the absence of an angulated, strongly noded shoulder and in its stronger and more regularly developed spiral costae. The two species resemble each other in general form, in the character of the nodes where they are present, and in the features of the aperture.

Types.—Holotype, U.S.N.M. 105707; 2 figured paratypes, U.S.N.M. 105708a-b; 15 unfigured paratypes and numerous fragments, U.S.N.M. 105709; all from the Euless member in a cut on the Arlington-Grapevine highway, 0.2 mile north of State Highway 183, 1 mile west by south of Euless, Tarrant County.

Occurrence.—Tarrant County: Locs. 16, 18, 19, 25 (types), 27, 31, 34, 47, 54; Denton County: locs. 56, 93; Cooke County: loc. 99; Grayson County: locs. ?103, 131, 132.

Range.—Dexter member to Lewisville member.

Pyrgulifera costata tuberata Stephenson, n. var.

Plate 37, figures 3, 4

Shell of medium size, with spiral angle of about 50°. Protoconch not preserved. Suture deeply impressed. Whorls 4 or 5, plumply and regularly convex, modified on some individuals by a weakly developed shoulder. Anal collar very narrow and weakly developed. Base of body whorl broadly rounded, with no peripheral angle above. Body whorl ornamented with weakly developed spirals and axials. The growth lines are sinuous, being convex forward below and concave forward above. The spiral ribs number 10 on the body whorl of the holotype; the lower 5 are smooth or only very weakly noded and are much narrower than the interspaces; the upper 5 spirals are noded at the intersections with the axials, the nodes ranging from round, to squarish, to slightly elongated; the most prominent nodes are on the spiral next below the uppermost one, and nodes may be weak or wanting on the fourth and fifth spirals from the top. The axial ribs are numerous, irregular, and trend parallel to the growth lines; they have their principal development on the upper half of the body whorl. The spirals are weakly developed on the penultimate and earlier whorls; the axials are small and narrow but distinct, and they produce small nodes at their intersections with the spirals. The fifth spiral from the top may become concealed by the overlapping upper edge of the whorl below. Aperture subovate to broadly subquadrate, obtusely subangulated at the rear, rounded in front but showing a faint depression caused by the protruding siphon. Outer lip broadly arched, broken above at the anal angle in the holotype.

Inner lip forming a thin to moderately thick callus over the parietal wall and a thick marginal edge, separated from a narrow, shallow umbilical fissure below.

Dimensions of the incomplete holotype: Height 20+ mm, diameter about 14 mm.

The variety differs from the typical *Pyrgulifera costata* in the weaker development of its ornamentation. The tubercles, though weak, form the most conspicuous part of the sculpture.

Types.—Holotype, U.S.N.M. 105710; 2 unfigured paratypes, U.S.N.M. 105711; all from the Lewisville member on Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 34, 35 (types); Denton County: locs. 58, 59.

Range.—Dexter member to Lewisville member.

***Pyrgulifera costata sublevis* Stephenson, n. var.**

Plate 37, figures 1, 2

This variety is similar in its general form to the typical *Pyrgulifera costata* but differs rather markedly from both *costata* and the variety *tuberata* in certain of its detailed features. In the holotype the upper part of each whorl is noticeably more constricted below the anal collar. The sculpture, both spiral and axial, is much more subdued, giving the appearance of being nearly smooth. The body whorl is ornamented with 11 very weak spiral ribs, which are coarsest on the base, most crowded in the peripheral zone, and weakest above in a zone below the collar band; obscure nodes are present on the upper 2 or 3 spirals. The upper 6 spirals are exposed on the largest part of the penultimate whorl and only the upper 4 on the antepenultimate whorl. Traced backward, the nodes on the upper 2 or 3 spirals gradually become a little stronger and are fairly distinct on the antepenultimate and earlier whorls. Weak axial ribs appear on the earlier whorls and an occasional one tends to form a weak varix. The features of the aperture are about the same as in the typical *costata*.

Dimensions of the incomplete holotype: Height 21+ mm, diameter about 13 mm.

Types.—Holotype, U.S.N.M. 105712; 1 unfigured paratype, U.S.N.M. 105713; both from the Lewisville member on Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 24, 35 (types).

Range.—Euless member to Lewisville member.

***Pyrgulifera?* sp.**

One individual represented by an incomplete internal mold and an incomplete and very imperfectly preserved external mold, in ferruginous sandstone of the Red Branch member, in northeastern Grayson County (loc. 102), is questionably referred to *Pyrgulifera* Meek. The form is essentially like that of *Pyrgulifera*. The suture is deeply impressed, and the whorls are plumply and evenly rounded in profile. As revealed by a rubber cast of the external mold, the body whorl is regularly rounded on the periphery and bears

7 or 8 nonprominent primary spiral ribs, with a weak secondary rib in each of the interspaces. The presence of an umbilicus or deep umbilical fissure is indicated. This gastropod was found in association with at least three species of *Unio*, indicating a fresh-water habitat. The external mold measures: Height 24+ mm, diameter about 18 mm. U.S.N.M. 105714.

Family CERITHIOPSIDAE

Genus MONROEA Stephenson, n. gen.

Type species: *Monroea castellana* Stephenson.

Etymology: Named in honor of Watson H. Monroe.

This new genus *Monroea* is characterized by its turreted form, its strong, regular, cancellated sculpture, short, moderately wide, strongly twisted anterior canal, smooth columella, and flattish, nearly smooth base.

The genus appears to be related to *Cerithiella* Verrill (1882) whose type species is the Recent *Cerithium metula* (Lovén) from the North Sea. Compared with that species, *Monroea castellana* has a much shorter spire, with only about half as many whorls, the shell is thicker, and the sculpture is much coarser. The apertures of the two species are very similar.

***Monroea castellana* Stephenson, n. sp.**

Plate 37, figures 5-8

Shell small, turreted, with spiral angle of about 20° on the larger whorls, increasing to about 32° at the apex. Suture closely appressed at the lower edge of a sharply defined sutural channel of moderate width and depth. Protoconch incompletely preserved but apparently a loosely coiled spiral of 1½ or 2 volutions. Whorls 8 or 9, flat on the sides, elegantly ornamented all over with axial and spiral ribs, the latter dominant. Axials of medium strength, numbering 18 on the larger whorls, decreasing to 13 or 14 on the small apical whorls, trending upward and slightly backward across the sides. Spirals 3, moderately thick and squarish, subequal but the median one slightly the weaker, overriding the axials and forming strong, squarish nodes at the intersections. Periphery of body whorl marked with a narrow unnoded spiral ridge, weaker than the spirals above, below which is a shallow groove of medium width bordered below by a still weaker unnoded ridge. The sharply constricted base below the lowest spiral ridge is nearly plain but may bear 2 or 3 fine, weak to obscure, threadlike spiral ridges. Aperture broadly lanceolate, widely angulated at the rear, passing anteriorly into a short, strongly twisted siphonal canal of medium width. Outer lip strongly arched. Inner lip rather deeply excavated, forming a thin callus over the parietal wall.

Dimensions of the incomplete holotype: Height: 10.5+ mm, diameter 4.3 mm. The largest fragmentary paratype has a diameter of 5 mm.

Types.—Holotype, U.S.N.M. 105715; 2 figured paratypes, U.S.N.M. 105716a-b; 9 unfigured paratypes, U.S.N.M. 105717; all from Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Loc. 75.

Range.—Lewisville member.

Monroea? sp.

Associated with *Monroea castellana* (loc. 75) is one small incomplete gastropod having a closely similar kind of sculpture but apparently having a lower spire. The three noded spiral ribs differ slightly from those of *M. castellana* in that that the medial one is a little weaker than the lower one, and the upper one is still weaker, thus giving to the spire a slightly different lateral profile. The shell measures: Height 3+ mm, diameter 2.3 mm. U.S.N.M. 105718.

Family CERITHIIDAE

Genus MACROCERITHIUM Stephenson, n. gen.

Type species: *Cerithium tramitense* Cragin.

Etymology: Greek *μακρος*, long; *Cerithium*, a genus of gastropods.

This genus differs from the more typical members of the Cerithiidae in the great elongation of the spire, the flattish and feebly ornamented sides of the whorls, the short, very narrow, and sharply twisted siphonal canal, and the flattish, strongly constricted base. In its slender profile, its weak ornamentation, its flat-sided whorls, and the simplicity of its aperture, *Macrocerithium tramitense* (Cragin) is in strong contrast to the Recent *Cerithium nodulosum* Bruguière, the genotype of *Cerithium* Bruguière.

Macrocerithium tramitense (Cragin)

Plate 37, figures 23-29

1893. *Cerithium tramitensis* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 222. (No figures.)

1928. *Cerithium tramitense* Cragin. Adkins, Texas Univ. Bull. 2838, p. 189.

Shell high and slender, with spiral angle of about 12°. Suture closely appressed, forming a sharply incised line. Protoconch not preserved. Maximum number of whorls counted on available material about 20. Sides of whorls flattish to very broadly convex. The surface of most available shells is corroded and smooth in appearance, but the better-preserved shells show 2 or 3 weak revolving lirae. A low, narrow, fairly distinct revolving ridge lies immediately below the suture. Beneath this ridge on the adult stages is a broad, very shallow revolving depression, followed below by a broad, very gentle swell. On the surface of the depression and the swell are 2 or more weak revolving ridges. On the younger stages of well-preserved shells the side of each whorl from the ridge above to the suture below is broadly and gently concave and in addition to the 2 or 3 revolving ridges finer intermediate lines may ap-

pear. On the young stages of some shells the two ridges nearest to and on either side of the suture are faintly and rather finely noded. In detail the revolving sculpture, where well enough preserved, exhibits considerable individual variation in strength and in number of ribs. The spiral ornamentation is not clearly preserved on any of the cotype material. The growth lines trend in a straight upward and obliquely backward direction across the sides of the whorls, bending back sharply, however, near the suture above. The periphery of the body whorl is obtusely subangular. The base is sharply constricted and flattish to broadly convex, and on well-preserved shells is ornamented with three or more weak revolving ridges. Aperture rhomboidal, with acute posterior angle and a short, narrow, sharply twisted siphonal canal. Outer lip arched, sharp, simple; inner lip forming a thin callus on the parietal wall. Columella smooth, broadly excavated, rising below to form a sharp rim bordering the upper side of the canal.

Although the species is abundantly represented in the collections, no complete shell is available for measurement. The largest nearly complete shell among the cotypes measures: Height 38+ mm, diameter 8 mm.

The individuals of this species are present in great numbers in certain calcareous facies of the Lewisville member.

Types.—Cotypes, many specimens in a piece of limestone; 7 cotypes in separate tray, 2 figured (Pl. 37, figs. 24, 25). These types, from Timber Creek, southwest of Lewisville, Denton County, are in the collection of the Bureau of Economic Geology, Austin, Tex. (See plastotypes, U.S.N.M. 105721a-c.) Three plesiotypes, U.S.N.M. 105719a-c; 1 plesiotype, U.S.N.M. 105720.

Occurrence.—Tarrant County: Loc. 44 (plesiotype); Denton County: locs. 71, 72, 73 (includes 3 plesiotypes), 74, 75-77, 79, 81, and the cotypes from Timber Creek southwest of Lewisville, Denton County; Grayson County: locs. 107, 132; Fannin County: loc. 179.

Range.—Lewisville member.

Genus LEVICERITHIUM Stephenson, n. gen.

Type species: *Levicerithium timberanum* Stephenson.

Etymology: Latin *levis*, smooth; *Cerithium*, a genus of gastropods.

The genus *Levicerithium* possesses a spire of moderate height; the sides of the whorls above the periphery are smooth and flattish to very gently convex. The bases of all the species except *L. basicostae* are smooth; on the lower part of the base and on the exterior of the canal of the last named species are 8 to 10 narrow low spiral costae. The suture is closely appressed, the base is steep, columella smooth, and the twisted siphonal canal is short and narrow. On the the inner surface of the more inflated part of the shell, rather far back from the aperture, are 1 to 3 or more narrow, irregularly spaced spiral ridges. The termini of these ridges are in view on the holotypes of *Levicerithium timberanum*, *L. breviforme*, *L. planum*, and *L. basicostae*, but

were not seen on *L.?* *altum*, *L.?* *subaltum*, and *L.?* *microilirae*, which are questionably referred to this genus.

Levicerithium timberanum Stephenson, n. sp.

Plate 38, figures 1-3

Shell small and smooth, spire moderately high, with apical angle of about 42°, narrowing to about 32° on the larger whorls below. Suture closely appressed in a broad shallow depression. Protoconch not preserved. Whorls 6 or 7, smooth, very broadly convex on the side. Periphery of body whorl rounded, descending steeply on the base. Fine, very obscure spiral lines are present on the paratype. The growth lines curve with a marked convexity toward the aperture on the lower part of the base, above which they pass nearly directly up over the periphery and, with slight obliquity and a gentle, concave, forward trend, cross the side of the whorl to the suture. Aperture broadly lanceolate, acutely angular with a narrow anal channel at the rear, passing anteriorly into a short, narrow strongly twisted siphonal channel. Outer lip broadly arched, thin edged, simple. Inner lip broadly excavated, forming on the parietal wall a thin wash of callus; on adults this callus thickens to a low, broad, ridge of callus just below the anal channel. Columella smooth, with a gently upturned rounded edge bordering the siphonal channel. The termini of four unevenly spaced ribs can be seen well back from the aperture on the inner surface of the outer wall of the holotype.

Dimensions of the holotype: Height 11.8 mm, diameter 5.8 mm. The paratype measures: Height 15.5 mm, diameter 7.3 mm.

Types.—Holotype, U.S.N.M. 105722; 1 paratype, U.S.N.M. 105723; both from Timber Creek, southwest of Lewisville, Denton County.

Occurrence.—Tarrant County: Loc. 47; Denton County: loc. 73 (types).

Range.—Lewisville member.

Levicerithium planum Stephenson, n. sp.

Plate 38, figures 4, 5

Shell small, with apical angle of about 45°, decreasing to about 30° on the side below. Protoconch small and badly corroded. Whorls 6, smooth, nearly flat on the sides, with a weak spiral constriction just below the suture. Suture closely appressed. Periphery of body whorl with a weak obtuse subangle; base steep, broadly convex, smooth. Aperture broadly lanceolate, with a wide acute angulation at the rear; anterior canal short, narrow, strongly twisted. Outer lip thin, broadly arched, partly broken away in the holotype. On the inner surface of the outer wall of the body whorl are at least four distinct, narrow, irregularly spaced spiral ridges that terminate well back of the aperture. Inner

lip broadly excavated, forming a very thin callus over the parietal wall. Compared with *Levicerithium timberanum*, the sides of the whorls are much flatter, and a weak angulation is present on the periphery of the body whorl.

Dimensions of the holotype: Height 12 mm, diameter 5.8 mm.

Types.—Holotype, U.S.N.M. 105724; from Timber Creek, 2.5 miles southwest of Lewisville, Denton County. One paratype, U.S.N.M. 105725.

Occurrence.—Tarrant County: Loc. 44 (paratype); Denton County: locs. 72, 78 (holotype).

Range.—Lewisville member.

Levicerithium basicostae Stephenson, n. sp.

Plate 58, figures 9, 10

Shell small and smooth with the exception of the basal slope, which bears spiral costae. Spire of medium height with spiral angle of about 33°. Whorls 6; suture closely appressed, narrowly and slightly impressed; sides of whorls nearly flat. Periphery rounded, base steep; basal slope and exterior of canal ornamented with 8 to 10 narrow low spiral costae. Aperture broadly lanceolate, narrowly acute at the rear, passing in front into a short, narrow, twisted canal. Outer lip thin; on the inner surface, well back of the outer lip of the holotype, one narrow, weak spiral ridge can be seen projecting from beneath the matrix that fills the interior of the shell. This is the only one of the species here described that bears spiral costae on the base.

Dimensions of the holotype: Height 8.1 mm, diameter 4 mm.

Types.—Holotype, U.S.N.M. 105726; 4 incomplete paratypes, U.S.N.M. 105727; all from a small stream gorge, 0.35 mile west of a road, 1.9 miles S. 54° W. of the center of Ambrose, Grayson County.

Occurrence.—Grayson County: Loc. 135.

Range.—Lewisville member.

Levicerithium breviforme Stephenson, n. sp.

Plate 38, figures 8, 9

Shell small, nearly smooth, with spiral angle of about 43°, the angle apparently not narrowing on the larger whorls below. Whorls 5 or 6, suture sharp, closely appressed, scarcely impressed. Periphery weakly angulated. Fine, very obscure spiral lining can be detected on the surface. Siphonal channel narrow, twisted. The shell is similar to *Levicerithium timberanum* but is smaller, has a lower spire, and the sides of the whorls are flatter. On the inner surface of the body whorl of one of the paratypes the termini of three narrow, internal ridges can be seen well back from the aperture.

Dimensions of the holotype: Height 9+ mm, diameter 5.2 mm.

Types.—Holotype, U.S.N.M. 105728; 3 paratypes, U.S.N.M. 105729; all from Timber Creek, southwest of Lewisville, Denton County.

Occurrence.—Denton County: Locs. 72, 73 (types), 75, 79; Grayson County: loc. ?131.

Range.—Lewisville member.

Levicerithium? *microlirae* Stephenson, n. sp.

Plate 38, figures 6, 7

Shell small, nearly smooth, relatively short, with spiral angle of about 32°. Whorls 6 or 7 (estimated), very gently convex on the sides. Suture sharp, closely appressed, somewhat impressed. Surface of shell covered with fine, weak revolving lines. Periphery of body whorl faintly subangulated, base broadly convex, strongly constricted. Aperture broadly lanceolate, angulated at the rear. Outer lip badly broken but is strongly arched. Inner lip broadly excavated. Anterior of shell partly broken away but affords evidence of a short twisted canal. The shell has a much lower spire than that of *Levicerithium?* *subaltum* and a higher spire than that of *L. breviforme*. Two or 3 apical whorls broken away. Flatter sides, fine spiral lining on the surface, and the presence of a weak peripheral angle serve to distinguish this species from *L. timberanum*.

Dimensions of the incomplete holotype: Height 11+ mm, diameter 11.3 mm.

Types.—Holotype, U.S.N.M. 105730; 1 paratype, unfigured, U.S.N.M. 105731; both from Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Loc. 75.

Range.—Lewisville member.

Levicerithium? *altum* Stephenson, n. sp.

Plate 38, figures 10, 11

Shell small, turreted, nearly smooth, nearly flat on the sides, with spiral angle of about 18°. Whorls 9 or 10 (estimated). Suture sharp, closely appressed, scarcely impressed. Periphery of body whorl slightly swollen, rounded, base descending; the body whorl presents several faint revolving striae in a band below the suture and several irregular axial undulations. Very fine, obscure, revolving lines can be seen over most of the shell. The growth lines are broadly sinuous, with convex curvature toward the aperture on the base of the body whorl and concave curvature in the same direction on the side above the periphery. Anterior part of shell broken away, but the aperture appears to be broadly lanceolate, with a narrow anal channel in the angle at the rear; inner lip broadly excavated, with a thick callus ending abruptly forward on the parietal wall. Presence or absence of an anterior canal not determined. No evidence of internal ribs observed.

Dimensions of the incomplete holotype, several of the posterior whorls of which are broken away: Height 14+ mm, diameter 6 mm.

In general form and surface features this shell resembles those that have been referred to *Levicerithium*, but the spire is noticeably more slender. The sinuous curvature of the growth lines and the thick inner lip suggest that the shell may belong to another genus.

Type.—Holotype, U.S.N.M. 105732; 6 paratypes, unfigured, U.S.N.M. 105733; all from Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Tarrant County: Loc. 35; Fannin County: locs. 179, 184 (holotype and 6 paratypes, unfigured), 195.

Range.—Lewisville member.

Levicerithium? *subaltum* Stephenson, n. sp.

Plate 38, figures 12, 13

Shell small, nearly smooth, with spiral angle of about 20°, widening slightly toward the apex. Whorls 7 or 8, very gently convex on the sides. Suture sharp, closely appressed, a little impressed. The whole surface covered with very fine, obscure revolving lines. Body whorl very slightly constricted below the suture, swelling gently toward the periphery, which is rounded, with a faint suggestion of an obtuse angulation; base steeply constricted, with several obscure revolving ridges on its extreme lower part. Columella broadly excavated, bearing, in addition, toward the lower part a shallow depression paralleling the slightly twisted siphonal canal, which on the holotype is only partly preserved. The shell is similar to *Levicerithium?* *altum* but differs in its shorter spire, its thinner inner lip, and in the presence of a shallow revolving depression on the lower part of the columella. Protoconch and 1 or 2 apical whorls not preserved.

Dimensions of the holotype: Height 14.7+ mm, diameter 6.3 mm.

Types.—Holotype, U.S.N.M. 105734; 1 paratype, unfigured, U.S.N.M. 105735; both from Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Fannin County: Loc. 184.

Range.—Lewisville member.

Levicerithium? sp.

Three small shells from the Lewisville member on Timber Creek (loc. 73), southwest of Lewisville, Denton County, cannot be satisfactorily matched with any of the preceding species. They are smooth and have an apical angle of about 33°, widening noticeably on the larger whorls below. The aperture is broadly lanceolate, with an angulation in the rear; the anterior part of each of the shells is broken away, and the presence or absence of a siphonal canal is not determinable. U.S.N.M. 105736.

Genus **HEMICERITHIUM** Cossmann, 1893

Type species: *Cerithium imperfectum* Deshayes, from the middle Eocene of France. (Cossmann, Jour. conchyliologie, vol. 41, p. 302, 1893.)

Cragin's species *Cerithium interlineatum* is referred questionably to *Hemicerithium* Cossmann. The species

from Texas resembles the type species in form and in its short, twisted anterior canal. There are, however, differences. The axial ribs on the type species are more prominent and shorter, and one or two of them on each whorl swell into a rather prominent varix. The spiral ribs are much finer and more numerous and override the axials. The periphery is more angular, the base somewhat flatter, and the periphery bears a prominent spiral that appears to be analogous to the sixth primary spiral on the Texas species. The differences noted and the wide stratigraphic and geographic separation between the two species would seem to justify caution in assigning them to the same generic position.

Hemicerithium? interlineatum (Cragin)

Plate 37, figures 19–22

1893. *Cerithium interlineatum* Cragin (part), Texas Geol. Survey 4th Ann. Rept. for 1892, p. 221.

1928. *Cerithium interlineatum* Cragin. Adkins, Texas Univ. Bull. 2838, p. 188.

Cragin's two cotypes appear to represent two distinct species, of which the shell measured by Cragin is selected as lectotype. The latter is badly corroded, and the following description is based in part on the figured plesiotype.

Shell small, turreted, elongate, with spiral angle of about 22° on the larger whorls, widening to about 30° at the apex. Suture closely appressed, situated at the bottom of a rather wide, deep depression. Protoconch not preserved but obviously very small. Whorls 8, of medium and regular convexity on the sides, with axial and spiral ornamentation, the axials dominant. The periphery of the body whorl rounds down to a sharply constricted base. Axial ribs thick, of medium prominence, directed upward and a little forward, somewhat irregular in width and strength, with some tendency to the development of an occasional weak varix; they extend from suture to suture on the whorls of the spire, decreasing from 9 or 10 on the body whorl of the larger adults to 6 or 7 on the small whorls near the apex; on the body whorl the axials die out near the periphery. On the body whorl are 7 primary spiral ribs, with one secondary rib in each of the interspaces except the one on the periphery in which there is a pair of secondary spirals. The sixth primary rib just below the pair of secondaries is thicker and more prominent than any of the 5 primaries above it. On the base below the sixth primary is a pair of secondaries, followed by the seventh primary. Between the seventh primary and the anterior canal 1 or 2 obscure secondaries may be seen on well-preserved shells. The spirals on the side of the shell above the periphery override the axials with undiminished strength. The spirals vary somewhat in strength and spacing on different individuals. Growth lines sinuous, with trend broadly concave toward aperture on the inflated part of the shell. Aperture broadly

lanceolate, with a narrow anal canal in the posterior angle passing anteriorly into a short, slightly twisted siphonal canal of medium width. Outer lip broadly arched, with a broad notch above. Inner lip broadly excavated, forming a thin callus on the parietal wall. Columella smooth.

Dimensions of the incomplete lectotype: Height 10.8+ mm, diameter 4.5 mm. Individuals may attain a height of 14 mm.

Types.—The selected lectotype, a rather badly corroded shell but apparently the one measured by Cragin, is in the collection of the Bureau of Economic Geology, Austin, Tex. (loc. 64, coll. 708); it is from "Timber Creek, 2 miles below [probably above] the Dallas-Lewisville road, Denton County." One plesiotype, U.S.N.M. 105737; 5 unfigured examples, U.S.N.M. 105738.

Occurrence.—Denton County: Locs. 64 (lectotype), 72, 73 (1 figured), 75, 77, 79, 81; Grayson County: locs. ?117, 132.

Range.—Lewisville member.

Hemicerithium? insigne Stephenson, n. sp.

Plate 37, figures 17, 18

1893. *Cerithium interlineatum* Cragin (part), Texas Geol. Survey 4th Ann. Rept. for 1892, p. 221.

This species is similar in form and in the general pattern of its ornamentation to *Hemicerithium? interlineatum* (Cragin) but differs in certain details. The axial ribs, though of about the same number and thickness, are more prominent. The primary spiral ribs are thicker and more prominent and number 6 instead of 7 on the body whorl; the 3 upper spirals are the most prominent, and the sixth spiral is nonprominent. In the interspaces between the axials each spiral is broken into more or less distinctly developed rounded nodes; similar nodes may be present on *H.? interlineatum*, but they are weaker and much less conspicuous. A seventh primary spiral is wanting, the base below the sixth spiral bearing only 5 or 6 weak to obscure spiral threads.

Dimensions of the incomplete holotype: Height 9+ mm, diameter 4.5 mm.

Types.—The holotype is one of the two cotypes of *Cerithium interlineatum* Cragin in the collection of the Bureau of Economic Geology, Austin, Tex. (loc. 64, coll. 708).

Occurrence.—Denton County: "Timber Creek, 2 miles below [probably above] the crossing of the Dallas-Lewisville road."

Range.—Lewisville member.

Genus *VASCELLUM* Stephenson, n. gen.

Type species: *Vascellum vascellum* Stephenson.

Etymology: Latin *vascellum*, a small vase or urn.

The genus *Vascellum* is erected to include gastropods having the following characteristics: The shells are of small to medium size and turreted; the apical angles range from 25° to 40°, and the spiral angles on the larger whorls below range from 5° to 35°; the spiral angle is always narrower than the apical angle; the whorls range from 6 to 9, the axial ribs from 7 to 10, and the spiral ribs on the body whorl from 12

to 20; the spirals exposed on the penultimate and earlier whorls range from 5 to 7. The axials are broad and rounded on the crests; the spirals are broad and flattish on top and are separated by narrow, even, threadlike interspaces; the axials and spirals, one or both, may be suppressed but are always sufficiently represented for the determination of their characteristics. There is a strong tendency for the axials on the different whorls to aline themselves in rows up and down the side of the spire, and this is conspicuously true of most of the species. The aperture is narrowly to broadly lanceolate, with an acute posterior angle and a short, narrow, twisted siphonal canal in front. The columella is smooth and twisted. In subdividing this generic group, considerable allowance has been made for individual variation, in order to avoid excessive splitting into species and varieties.

Five of the 17 species and varieties were found closely associated in one piece of sandstone (loc. 189).

Vascellum vascellum Stephenson, n. sp.

Plate 38, figures 35-38

Shell of medium size, turreted. Apical angle about 35°, decreasing to about 25° on the larger whorls of adults. Protoconch not preserved. Suture closely appressed, shallow, gently undulating. Whorls 7 or 8, gradually increasing in size, very gently convex on the side. Body whorl at the aperture about 0.3 the height of the shell. In profile the body whorl is gently convex above, not angulated at the periphery, rounding down steeply to a strongly constricted base. Eight axial ribs are present on the body whorl; these are alined with the earlier axials above and also number 8 on each whorl; axials thick, moderately prominent, broadly rounded on the crest, separated by narrow interspaces. Seven spiral ribs on the upper part of the body whorl are thick, low, separated by narrow interspaces, and override the axials without diminishing strength; the base bears 6 or 7 narrower, subdued, obscurely noded spiral ribs. On most specimens the uppermost spiral is broader than any of the others, and in some cases, though not all, this spiral is formed by the partial or complete merging of 2 narrower spirals. Usually 5, sometimes 6, spirals are exposed on the penultimate and earlier whorls. The growth lines are very fine and trend across the whorls, with a gentle convexity toward the front on the body whorl and a broad, gentle concavity toward the front on the upper part of the whorls. Both axials and spirals are well developed on the earlier whorls to the smallest one observed (diameter 2 mm). Aperture proportionately short, broadly lanceolate, with an acute angle at the rear and a short, narrow, twisted siphonal canal in front. Outer lip strongly arcuate; inner lip broadly and deeply excavated, forming a thin callus that spreads

a little forward on the parietal wall. Columella smooth but twisted.

Dimensions of the incomplete holotype: Height 14+ mm, diameter 7.6 mm. Another shell measures: Height 18+ mm, diameter 8 mm.

This species is represented by 12 specimens, none of which is complete. They exhibit some individual variation in profile and ornamentation.

Types.—Holotype, U.S.N.M. 105739; 2 figured paratypes, U.S.N.M. 105740a-b; 9 unfigured paratypes, U.S.N.M. 105741; all from a loose piece of calcareous sandstone from the Lewisville member of the Woodbine formation, in the bed of Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin County.

Occurrence.—Grayson County: Loc. 135; Fannin County: loc. 189 (types).

Range.—Lewisville member.

Vascellum vascellum pressulum Stephenson, n. var.

Plate 38, figures 43, 44

This variety resembles the typical species in form and size, but the spiral and axial ribs are very weakly developed on the body whorl and are wanting on earlier whorls except the penultimate, on which they may be either wanting or obscurely present. Several spirals low on the base are of medium strength and are noded.

Types.—Holotype, U.S.N.M. 105742; 3 paratypes, 1 figured, U.S.N.M. 105743; 2 unfigured paratypes, U.S.N.M. 105744; all from a cut on the Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant County.

Occurrence.—Tarrant County: Loc. 25.

Range.—Eules member.

Vascellum vascellum subornatum Stephenson, n. var.

Plate 38, figures 45, 46

This variety resembles the typical species in form and size but differs from it in that the spiral and axial ribs on the larger whorls are more weakly developed and become progressively more subdued on the earlier whorls. They finally disappear on the apical whorls, which are essentially smooth. The spirals on the base are stronger and more distinctly noded. Compared with the variety *pressulum*, this variety possesses a similar, though somewhat more strongly developed sculpture, but its spire is higher and more slender.

Types.—Holotype, U.S.N.M. 105745; 1 figured paratype, U.S.N.M. 105746; 5 unfigured paratypes, U.S.N.M. 105747; all from the Eules member in a cut on the Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant County.

Occurrence.—Tarrant County: Loc. 25 (types); Fannin County: loc. 184.

Range.—Eules member to Lewisville member.

Vascellum elegans Stephenson, n. sp.

Plate 38, figures 31, 32

Shell of medium size, turreted, with apical angle of about 35°, decreasing regularly to about 20° on the two larger whorls. Protoconch not preserved. Suture closely appressed, slightly impressed, linear. Whorls

7 or 8, flattish to very gently convex on the side. Body whorl somewhat constricted, with length of aperture about 0.35 the height of the shell. The body whorl bears 7 strong axial ribs, and the same number is present on each of the earlier whorls, but their strength decreases upward; with the exception of the 2 axials immediately back of the aperture, which are subdued and exhibit the characteristics of senility, the axials are strong, relatively narrow and wide apart, and are arranged in straight alinement with axials on the earlier whorls. On the body whorl the axials extend without diminishing strength to the suture above and die out below on the basal slope a little below the periphery. The body whorl bears about 15 spirals; those above the periphery are low and broad and are separated by narrow interspaces; the uppermost 2 are merged to form one broad band; these upper spirals override the axials and are weakly noded in the bottoms of the axial interspaces; 4 of the spirals on the base are narrower than those above, become progressively narrower downward, and are noded; in the basal constriction are several still narrower, small spirals. Six spirals are exposed on the penultimate whorl, but rearward they fade out and disappear before the antepenultimate is reached, the earlier whorls being smooth or with only obscure indications of spirals. The growth lines on the body whorl are gently sinuous, with a broad convexity in trend toward the aperture on the upper part of the whorl. Aperture lanceolate, with an acute angle at the rear and a short, narrow, twisted siphonal canal in front. Outer lip thin and broadly arched. Inner lip broadly excavated and forming a thin veneer of callus on the parietal wall. Columella smooth.

This species is noticeably more slender than the genotype and its varieties, and its sculpture is more subdued than that of the genotype.

Dimensions of the holotype: Height 19 mm, diameter 6.6 mm.

Type.—Holotype, the only specimen, U.S.N.M. 105748; from Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Loc. 35.

Range.—Lewisville member.

***Vascellum robustum* Stephenson, n. sp.**

Plate 38, figures 55-59

Shell of medium size, turreted, with apical angle of about 40°, decreasing to about 35° on the larger whorls of the spire. Height of spire about 0.65 the total height of the shell. Protoconch not preserved. Suture narrowly channeled, slightly impressed, strongly undulating in trend owing to upward projections of the axial costae. Whorls 6 or 7 (estimated), gently convex on the sides. Body whorl broadly rounded in profile, becoming sharply constricted at base, bearing 8 or 9 strong, thick moderately prominent axial costae, which reach the suture above and die out at the periphery

below. As a rule the costae on the successive whorls are in alinement, and trend upward and a little backward, giving a twisted appearance to the spire. The spiral ribs on the body whorl number 16 to 18 and cover all the surface from the suture above to the canal below. Eight or 9 of the spirals on the upper part of the whorl are broad, low, with narrow threadlike interspaces, and they override the axials; on some shells 2 or 3 of the uppermost spirals are merged to form one broad spiral; where the spirals dip into the axial interspaces they may or may not be broken into one or more dull nodes. The spirals on the basal slope are narrower than those above and are regularly noded, giving to the surface an elegant cancellated appearance. Six or 7 spirals are exposed on the penultimate and earlier whorls. Aperture lanceolate, acutely angular at the rear, with a short, twisted, fairly open siphonal canal at the front. Outer lip broadly arched. Inner lip deeply and widely excavated, forming a moderately thick callus on the parietal wall. Columella smooth.

Dimensions of the incomplete holotype: Height 18+ mm, diameter 9+ mm. Fragments of larger shells attain diameters of 10+ mm.

This species is closely allied to *Vascellum vascellum*, with which it is associated at the type locality, but has a slightly shorter spire, more robust axial ornamentation, wider spaces between the axials, and a more liberal development of nodes on the spirals, particularly on the base of the body whorl. The strongly undulating suture is also a distinguishing feature. None of the available specimens is complete.

Types.—Holotype, U.S.N.M. 105749; 3 figured paratypes, U.S.N.M. 105750a-c; 11 unfigured paratypes, U.S.N.M. 105751; all from Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin County.

Occurrence.—Grayson County: Loc. 135; Fannin County: loc. 189 (types).

Range.—Lewisville member.

***Vascellum pingue* Stephenson, n. sp.**

Plate 38, figure 47

This species is very much like *Vascellum robustum* in form and in the kind and pattern of its ornamentation. However, it is larger, has a proportionately longer aperture, a longer siphonal canal, and a more subdued sculpture, both axial and spiral, particularly the latter. The number of axial ribs to the volution is about the same (8 or 9) throughout, and the number of spiral ribs on the body whorl and the number exposed on the earlier whorls are also about the same. Subdued nodding is present on the spirals of the base and is also detectable in the axial interspaces. The aperture is rather long lanceolate, and the siphonal canal is narrow and strongly twisted.

Dimensions of the incomplete holotype: Height 25+ mm, diameter 13+ mm.

Types.—Holotype, U.S.N.M. 105752; 3 unfigured paratypes, U.S.N.M. 105753; all from Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin County.

Occurrence.—Fannin County: Loc. 189.

Range.—Lewisville member.

Vascellum magnum Stephenson, n. sp.

Plate 38, figures 33, 34

Shell large for the genus, turreted. Apical angle about 40°, the spiral angle decreasing to about 25° on the larger whorls. Protoconch not preserved. Suture closely appressed, moderately impressed, gently undulating. Whorls 8 or 9 (estimated), slightly convex on the side. Body whorl broadly rounded at the periphery, moderately steep and broadly convex on the basal slope, becoming broadly excavated below. Axial ribs strong, thick, broadly rounded on the crests, separated by narrower interspaces. The axials number 9 on the body whorl of the holotype, and, since they are in alinement from whorl to whorl, the number remains the same on all the earlier whorls. The number of axials may vary from 8 to 10 on different individuals. The body whorl is ornamented with about 20 spiral ribs, those above the periphery being broad, low, and separated by very narrow interspaces and those on the basal slope broad, more prominent, and bearing coarse low nodes, the nodes on the upper two or three ribs being squarish; as the spirals pass out on the siphonal canal they become small and narrow. Five or 6 spirals are exposed on the penultimate and earlier whorls. The spirals become weak or may even fade out where they override the crests of the axials. As in other closely related species, the growth lines are slightly and broadly sinuous in trend. Toward the apex both the axial and spiral ribs become progressively smoother, several of the earlier whorls probably being nearly smooth. The aperture is not seen completely preserved in the type material, but it is obviously much shorter than the height of the spire; it is lanceolate, of medium width, very narrowly acute at the rear, and appears to pass into a short, narrow siphonal canal at the front. Outer lip broadly arched. Inner lip rather deeply excavated and forming only a thin coat of callus on the parietal wall. Columella smooth, twisted. Weak impressions of 9 or 10 narrow internal ribs appear on an exposed portion of the internal mold of the body whorl of the holotype.

Dimensions of the incomplete holotype: Height 31+ mm, diameter 13+ mm.

This species is characterized by its large size, its thick, strong axial ribs and its subdued spiral ones. It is closely related to the six preceding species and varieties.

Types.—Holotype, U.S.N.M. 105754; 2 unfigured paratypes, U.S.N.M. 105755; all from a stream in gorge, 0.35 mile west of road, 1.9 miles S. 54° W. of Ambrose, Grayson County.

Occurrence.—Grayson County: Loc. 135 (types); Fannin County: loc. 186.

Range.—Lewisville member.

Vascellum vianum Stephenson, n. sp.

Plate 38, figures 53, 54

The species is based on incomplete external molds. Shell of medium size, turreted. Apical angle about 25°, decreasing to about 20° on the larger whorls. Suture closely appressed, moderately impressed. Whorls 10 or more in adults, increasing very gradually in size, flattish to very gently convex on the side. Body whorl rounded at the periphery, slightly constricted below the suture, rather steep on the base, ornamented with 11 spiral ribs and 9 or 10 (estimated) axial ribs on the upper part above the periphery. The spirals are low, broadly rounded to flattish, weak to obscure above the periphery, broken into low, broadly rounded nodes on the periphery and base. The uppermost spiral is broader than the ones below. The interspaces are narrow. Five or 6 spirals are exposed on the penultimate and earlier whorls. There is a tendency to alinement of the axials from one whorl to the next above.

Dimensions of the incomplete holotype: Height 22+ mm, diameter 7.5 mm. The figured paratype is 25+ mm high.

The species bears some resemblance to the genotype but is much more elongated and has more subdued surface sculpture.

Types.—Holotype, U.S.N.M. 105756; 1 figured paratype, U.S.N.M. 105757; 2 paratypes, unfigured, U.S.N.M. 105758; all from the Eules member in a cut on the Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant County.

Occurrence.—Tarrant County: Locs. 25 (types), 54.

Range.—Eules member to Lewisville member.

Vascellum tensum Stephenson, n. sp.

Plate 38, figures 50-52

Shell proportionately large, very slender, with spiral angle on the larger whorls of 10° or less. The angle widens out at the apex to perhaps as much as 25°. The lateral profile of the whorls is very broadly convex or practically flat in some specimens. Suture closely appressed, slightly impressed, wavy. Whorls 10 or more (estimated). Axial ribs probably 9, broad and low, those on successive whorls being in essential alinement; they die out on the body whorl near the periphery. Spiral ribs practically wanting on all except the basal slope, where 5 broad, low spirals such as characterize the genus *Vascellum* are present. The two lower ones are noded. The periphery is rounded, the base below becoming rather sharply constricted. The growth lines on the body whorl are broadly sinuous, the curvature being convex forward below and concave forward above. Aperture not seen. The species is based on incomplete molds in ferruginous sandstone. Compared with the other species of the genus, it appears to be most nearly related to *V. vianum*, but the adult shell is larger and the surface ornamentation is much more subdued.

Dimensions of the very incomplete holotype: Height 28+ mm, diameter about 10 mm. Adults probably attain a height of 40 mm or more.

Types.—Holotype, U.S.N.M. 105759; 2 figured paratypes, U.S.N.M. 105760a-b; 7 unfigured paratypes, U.S.N.M. 105761; all from the Lewisville member in the bed of Johnson Creek, 1.3 miles northeast of the Methodist Church at Arlington, Tarrant County.

Occurrence.—Tarrant County: Loc. 54 (types); Denton County: loc. 58.

Range.—Dexter member to Lewisville member.

***Vascellum procerum* Stephenson, n. sp.**

Plate 38, figures 24-26

Shell of medium size, elongate, with apical angle of about 33°, decreasing to less than 10° on the larger whorls. Protoconch not preserved. Suture linear, slightly impressed. Whorls 7 or 8, nearly flat to very gently convex on the side, increasing very gradually in size. Aperture about 0.25 the total height of the shell. Body whorl broadly rounded at the periphery, descending with moderate steepness, constricted at the base; with the exception of several gentle longitudinal undulations, axial ribs are wanting on the body whorl of the holotype, but the penultimate whorl bears 7 broad, gentle axial swells; the earlier whorls are also nearly lacking in axial ribs. The body whorl bears 9 or more low spiral ribs with very narrow interspaces; the 3 or 4 uppermost ones are coarser and more prominent than the others and are obscurely noded; the spirals on the base are not well preserved on the holotype. Five spirals are preserved on the penultimate whorl. Toward the apex the spirals become progressively weaker and are only faintly discernible on the earlier whorls. Growth lines sinuous, broadly convex in trend forward at and below the periphery, and broadly concave forward between the periphery and the suture above. Aperture broadly sublanceolate, acutely angular at the rear, passing anteriorly into a short, narrow, twisted siphonal canal. Outer lip broadly and regularly arched. Inner lip broadly excavated, with a thin wash of callus on the parietal wall. Columella smooth, with a faint trace of an umbilical fissure in front of its anterior portion. Some allowance must be made for individual variations in form and sculpture, some shells being more slender and some more strongly ornamented than others.

Dimensions of the incomplete holotype: Height 17.5+ mm, diameter 6.3 mm. The paratype measures: Height 13.8+ mm, diameter 5.2 mm.

The holotype and paratype are from the same locality and, if correctly referred to the same species, indicate considerable individual variation in form and ornamentation. The holotype is larger than the paratype, has a proportionately greater diameter and a somewhat more vigorous development of spirals and growth lines on the larger whorls. The paratype is better preserved

than the holotype and shows more clearly the spirals on the body whorl, all of which are more or less noded, but the upper 3 of which are coarsely noded.

Types.—Holotype, U.S.N.M. 105762; 1 figured paratype, U.S.N.M. 105763; both from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. Three unfigured paratypes, U.S.N.M. 105764.

Occurrence.—Tarrant County: Loc. 25; Fannin County: locs. 184 (holotype and paratype), 191, (3 paratypes).

Range.—Euless member to Lewisville member.

***Vascellum leve* Stephenson, n. sp.**

Plate 38, figures 27-30

Shell small, essentially smooth, slender, with spiral angle of about 15° on the larger whorls, increasing to about 30° at the apex. Suture closely appressed, slightly impressed. Whorls 8 or 9, nearly flat on the sides. Axial ribs not certainly recognizable but possibly represented by gentle swells that are present here and there on the whorls. Although the surface is practically smooth, obscure traces of broad spiral costae such as characterize the genus *Vascellum* are detectable on some of the shells; these are a little stronger on some shells than on others. Periphery of body whorl rounded, base constricted below. Growth lines sinuous in trend with a noticeable concavity toward the front on the upper part of the whorl. Aperture broadly lanceolate, with an acute angle at the rear and a short, narrow, twisted siphonal canal at the front.

Dimensions of the incomplete holotype: Height 15+ mm, diameter 5 mm.

One rather well-preserved shell from the type locality has the general form of this species but is not quite so slender, the whorls are gently convex on the side instead of nearly flat, and there is no indication of either spiral or axial sculpture. It is questionably referred to the species.

Types.—Holotype, U.S.N.M. 105765; 1 figured paratype, U.S.N.M. 105766; 7 unfigured paratypes, U.S.N.M. 105767; all from a gully near a fence 1,250 feet north of an east-west road, about 3.5 miles N. 28° E. of center of Savoy, Fannin County. One questionable example, U.S.N.M. 105768.

Occurrence.—Grayson County: Loc. 143; Fannin County: locs. ?180, 191 (types and 1 questionable example).

Range.—Lewisville member.

***Vascellum subleve* Stephenson, n. sp.**

Plate 38, figures 17-19

Shell of medium size, turreted, with spiral angle of 25° to 35°. Protoconch not preserved. Suture closely appressed, slightly impressed. Whorls 6 or 7, increasing gradually in size, flattish to very gently convex on the sides. Spire about 0.6 the total height of the shell. Body whorl broadly rounded on the periphery, rather strongly constricted at the base. Axials are represented by broad, very weak swells or undulations numbering 7 on each whorl, with those on different whorls

in rough alinement. Spirals are so obscurely developed as to give the appearance of smoothness to the shells; where they can be seen they are broad and low, with very narrow interspaces, such as are characteristic of the genus. The growth lines are gently sinuous as in the other species of the genus.

Dimensions of the incomplete holotype: Height 14+ mm, diameter 5.9 mm. One broken shell has a diameter of 6.7 mm.

Compared with *Vascellum leve*, this species is much less slender, and exhibits more definite evidence of axial and spiral ornamentation.

Types.—Holotype, U.S.N.M. 105769; 1 figured paratype, U.S.N.M. 105770; 2 unfigured paratypes, U.S.N.M. 105771; all from Johnson Creek, 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 35 (types), 47; Fannin County: loc. ?191.

Range.—Lewisville member.

Vascellum fortispirae Stephenson, n. sp.

Plate 38, figures 22, 23

This species is similar to *Vascellum procerum* in profile and in the feeble development of its axial ribs but differs in that it is more slender and the spiral ornamentation is strong over all the shell, with the possible exception of 2 or 3 of the small apical whorls, which are badly corroded in the one available specimen. Apical angle about 30°, decreasing to about 5° on the two larger whorls of the spire. The axial ribs are broad and weak; they number 8 and are strongest on 2 or 3 whorls midway of the spire; they fade out both toward the apex and the aperture. On the body whorl the spiral ribs number about 10 and are weakly noded; they are broad, are separated by narrower interspaces, and are rather strong, except in the zone of the periphery, where 2 or 3 of them are obscure; the base and anterior end of the body whorl are poorly preserved. Five spirals are exposed on the penultimate whorl and on each of the earlier whorls, where they are in part weakly noded.

Dimensions of the holotype: Height 16.4+ mm, diameter 5 mm.

Type.—Holotype, U.S.N.M. 105772; from Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Locs. 75 (holotype), ?76.

Range.—Lewisville member.

Vascellum mundum Stephenson, n. sp.

Plate 38, figures 39–42

Shell of medium size for the genus, turreted, with apical angle about 35°, decreasing to about 25° on the larger whorls. Protoconch not preserved. Suture slightly impressed, gently wavy in trend. Whorls 7 or 8, increasing gradually in size, flattish to very gently convex on the sides. Length of spire about 0.6 (estimated) the total height of the shell. Body whorl broadly rounded from above the periphery downward

to the base, which is moderately constricted. Axial ribs are represented on the body whorl by 8 broad, very gentle longitudinal swells; in alinement with these are 8 similar swells on each of the earlier whorls of the spire. The body whorl, including the outer surface of the siphonal canal, bears about 20 spiral ribs separated by narrow interspaces. The upper 6 or 7 spirals are broad and low, the one bordering the suture being nearly twice as broad as the others; the spirals from the periphery downward become progressively narrower and less flat-topped, and the ones on the basal slope show a tendency to obscure nodding. Five spirals are exposed on each of the whorls of the spire. Very fine, obscure spiral lining is present over the whole surface of the shell. The growth lines exhibit gentle sinuosity, as in the other species of the genus. Aperture elongate-lanceolate, with a narrowly acute angle at the rear, passing in front into a narrow, somewhat twisted siphonal canal of moderate length. Outer lip very broadly arched. Inner lip broadly excavated and forming a thin callus over the parietal wall. Columella smooth and twisted.

Dimensions of the incomplete holotype: Height 19+ mm, diameter 8 mm.

The species is distinguished by its elegance of form and its clean-cut spiral ornamentation. Its subdued axial ribs are like those of *Vascellum procerum* and *V. fortispirae*, but both of these species are smaller and much more slender.

Types.—Holotype, U.S.N.M. 105773; 1 figured paratype, U.S.N.M. 105774; 1 unfigured paratype, U.S.N.M. 105775; all from Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin County.

Occurrence.—Fannin County: Loc. 189.

Range.—Lewisville member.

Vascellum mundum subteres Stephenson, n. var.

Plate 38, figures 48, 49

This variety compares closely in form and in the subdued development of the axials with *Vascellum mundum* but has the spiral ornamentation only obscurely present or wanting on all except the basal slope of the shell. In strength and character the spirals on the basal slope are essentially like those on a shell of the typical *mundum* at the same stage of growth. On the upper part of the body whorl and of the penultimate whorl of the holotype of *subteres* several flattish, obscure spirals are present, but these gradually fade out toward the rear, and 3 or 4 of the earlier whorls are practically smooth.

Dimensions of the incomplete holotype: Height 11+ mm, diameter 6 mm.

Types.—Holotype, U.S.N.M. 105776; 2 unfigured paratypes, U.S.N.M. 105777; all from Sheep Creek, 4.1 miles N., 36° E. of Savoy, Fannin County.

Occurrence.—Grayson County: Loc. 219; Fannin County: loc. 189 (types).

Range.—Lewisville member.

Vascellum minusculum Stephenson, n. sp.

Plate 38, figures 14-16

Shell small, turreted, with apical angle of about 30°, decreasing to 15° on the larger whorls of the spire below. Protoconch not preserved. Suture shallow, narrowly channeled, gently undulating in trend. Whorls 7 or 8, very gently convex on the side, increasing gradually in size. Periphery of body whorl rounded, steep on slope below, and moderately constricted at base. Body whorl ornamented with 7 broad, thick axial ribs of moderate prominence, which end at the suture above and at the periphery below; axials on succeeding whorls regularly alined. The body whorl bears about 12 rather thick spiral ribs with narrower interspaces; the spirals on the basal slope are more or less noded, and those on the side above the periphery are conspicuously noded where they cross the interspaces between the axials; the spirals override the axials. Five spirals are exposed on the penultimate and earlier whorls. Aperture sublanceolate, with acute angle at the rear, passing in front into a strongly twisted, short, narrow siphonal canal. Outer lip broadly arched. Inner lip deeply excavated a little above midheight, forming a rather thick callus on the parietal wall. Columella smooth. The few available specimens exhibit some individual variation in form and ornamentation.

The holotype, an external mold, selected because the impression of the ornamentation is clearly preserved, is 11+ mm high. One incomplete paratype measures: Height 11.2+ mm, diameter 4+ mm.

Compared with the other species of *Vascellum*, this species appears to be most nearly related to *V. elegans* but is smaller and has the spiral ornamentation strongly developed on all the whorls of the spire, in contrast to the smooth earlier whorls of *elegans*.

Types.—Holotype, an incomplete external mold, U.S.N.M. 105778; 1 unfigured paratype, U.S.N.M. 105779; 2 figured paratypes, U.S.N.M. 105780a-b; 3 unfigured paratypes, U.S.N.M. 105781; all from Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Loc. 75 (holotype and 6 paratypes, 2 figured).

Range.—Lewisville member.

Vascellum? *rivanum* Stephenson, n. sp.

Plate 38, figures 20, 21

Shell turreted, with spiral angle of about 30°. Whorls 8, flat or only very gently convex on the sides. Suture sharply but slightly impressed. Body whorl with a subobtusely angular periphery and a steep, flat-tish, sharply constricted base; the side of the whorl above the periphery is ornamented with 5 nonprominent, squarish-topped spiral ribs, the lowest one of which traverses the periphery; the interspaces are narrower than the ribs. The base is partly corroded, but it bears at least 3 narrow revolving ribs below the periph-

eral angle. Four or 5 spiral ribs are exposed on the sides of the penultimate and earlier whorls. Obscure, broad axial swells, numbering 8 or 9 to the whorl, are present; they appear to be in alinement from one whorl to another. The aperture is broadly lanceolate, with a wide acute angle at the rear; the anterior margin is partly broken away but shows the beginning of what appears to be a short, twisted siphonal canal. The outer lip is broadly arched, and the inner surface of the outer wall bears at least 3 well-developed spiral ribs. Inner lip broadly excavated. Columella smooth.

Dimensions of the holotype: Height 9.5 mm, diameter 4 mm.

The apparent alinement of the axial ribs suggests relationship of this shell to the genus *Vascellum*, but the presence of internal ribs, which have not been seen on any of the species of *Vascellum* herein described, throws doubt on the assignment. The inner surface of most of the shells referred to *Vascellum* cannot be seen because of a filling of hard matrix. However, the internal mold of one species, *V. magnum* shows the weak impressions of several internal ribs.

Holotype.—U.S.N.M. 105782; from a small stream gorge, 0.35 mile west of road, 1.9 miles S. 54° W. of Ambrose, Grayson County.

Occurrence.—Grayson County: Loc. 135.

Range.—Lewisville member.

Unidentified specimens of *Vascellum*?

Fifteen incomplete shells showing considerable individual variation, and probably representing two or more species, from the Lewisville member, 1.9 miles S. 54° W. of the center of Ambrose, Grayson County (loc. 135), are questionably referred to *Vascellum*. The axial ribs vary in strength and show the characteristic tendency to alinement from one whorl to another. The spiral ribs vary considerably in strength on the different shells and are narrower than those on the more typical species. On some of the individuals, both the axials and spirals are subdued or wanting on several of the earlier whorls.

Dimensions of the largest shell, which is incomplete at both extremities: Height 9.6 mm, diameter 6.3 mm. U.S.N.M. 105783.

Genus *VOYSA* Stephenson, n. gen.

Type species: *Voysa planolata* Stephenson.

Etymology: By anagram from Savoy, a town in Fannin County; gender, feminine.

The genus *Voysa* is characterized by its rather slender, turreted form and noded sculpture, by a wide siphonal notch in the outer lip but no canal proper, by the wide outward downbent attitude of the lower part of the inner lip, which may conceal a narrow umbilical fissure, and by the trend of the growth lines, which, on the upper part of the body whorl, are strongly concave toward the aperture, thus producing a wide notch in

the outer lip. The form and the trend of the growth lines appear to relate this genus to the Eocene *Clavocerithium* Cossmann, but the latter has a short, wide, twisted canal and is much larger and smoother.

Voysa planolata Stephenson, n. sp.

Plate 39, figures 47-50

The species is based on imprints in fine ferruginous sandstone. Shell small, spire turreted, spiral angle about 30° on the earlier whorls, decreasing to about 20° on the larger whorls. Suture closely appressed in the bottom of a narrow, shallow depression. Whorls 8, nearly flat on the sides, ornamented with both axial and spiral ribs. Axials numerous, weak, trending a little forward as they pass up over the side. Spirals 4 on the exposed sides, weakly developed except as marked by nodes at the intersection with the axials; the uppermost and lowermost spirals are stronger than the intermediate two. The regularly rounded base bears a pair of unnoded spirals on its upper part, the upper one of which is the weaker and marks the periphery of the body whorl. Two or 3 very narrow, obscure striae may be seen on the lower part of the base. The lower edge of the base bears a narrow, sharp ridge, which borders the small umbilical fissure. The characters of the aperture are not completely preserved, but enough can be seen to show that they are essentially like the aperture of *Voysa savoiana* and of *V. compacta*. The trend of the growth lines is deeply concave toward the aperture, as best seen on the body whorl.

Dimensions of the holotype: Height about 16 mm, diameter about 6 mm.

Compared with the two species mentioned above, the sides of the whorls are definitely flatter and the sutures narrower and shallower. The sculpture is more sharply developed than that of the first-mentioned species and is very similar to that of the second. All three of the species are closely related.

Types.—Holotype, U.S.N.M. 105784; 2 paratypes, figured, U.S.N.M. 105785a-b; 3 paratypes, unfigured, U.S.N.M. 105786. The holotype is from the Lewisville member on Johnson Creek, "2 miles [sic] northeast of Arlington," and the paratypes are from the same creek, 1.5 miles northeast of Arlington, Tarrant County. The two locality descriptions may pertain to the same locality and certainly to the same zone, as the lithologic character of the two lots is the same.

Occurrence.—Hill County: Locs. 3, 7; Johnson County: loc. 9 (var. ?); Tarrant County: locs. 15, 28, 34 (holotype), 47 (paratypes); Denton County: locs. 75, 78; Cooke County: loc. 98; Grayson County: locs. 129, 132; Fannin County: loc. 180.

Range.—Dexter member (?); Eules member to Lewisville member.

Voysa savoiana Stephenson, n. sp.

Plate 39, figures 42-46

Shell small, turreted, with 7 or 8 whorls, which are moderately and regularly convex on the sides. Spiral angle about 19°, widening to about 28° near the apex.

Suture closely appressed at the bottom of an obtuse V-shaped depression, the upper limb of which is the steeper. Body whorl ornamented with 6 or 7 spirals. On the body whorl of the holotype the upper 4 or 5 spirals are narrow and weak; the one nearest the suture is rather coarsely noded just back of the aperture, but traced backward, the nodes become weak within less than half a revolution; the next 3 or 4 spirals below the upper one are weakly to obscurely noded. On the periphery are two stronger, irregularly noded spirals, the lower one the strongest, separated by a relatively broad, shallow groove; these are nearly engulfed by the advancing body whorl, leaving the 4 or 5 weaker spiral ribs exposed on the side of the penultimate and earlier whorls. On the holotype the sculpture is rather badly damaged by corrosion on the spire above the penultimate whorl. On one of the paratypes the whorls of the spire bear 4 weak spirals; these are noded at the intersections of weak axial ribs, which number 12 to 15 to the whorl. On the larger whorls of adults, axials are obscure or wanting, their place being taken by coarse growth lamellae. On successively smaller whorls, axials begin to appear, at first weak, becoming stronger toward the apex. Coincidentally the nodding increases in strength at the intersections of the axials and spirals. On the smaller whorls toward the apex the spirals become weak or disappear, and a node on each axial on the lower part of the whorl becomes relatively conspicuous. These features are present on numerous young shells. The periphery of the body whorl is rather broadly and regularly rounded. The base below the pair of peripheral spirals forms a rather wide broadly concave band, the lower side of which ends in a strong spiral ridge at the edge of a small umbilical fissure; this band is marked only by rather coarse growth lines or on some individuals by 1 or 2 very obscure spirals. In the adult stage the umbilical fissure may become concealed by the down-lapping callus of the inner lip. Aperture subovate, with a subangle at the rear in which is a shallow, upturned anal canal. The siphonal canal is represented by a broad notch with a downbent anterior edge. Outer lip thin, simple, and deeply concave centrally. Inner lip forming a thick callus on the parietal wall and anteriorly lapping conspicuously forward and downward over a small umbilical fissure. Protoconch not preserved.

Dimensions of the holotype, which is incomplete at the apex: Height 19+ mm, diameter 6.5 mm.

Allowance is made for considerable individual variation in form and ornamentation in this species.

Types.—Holotype, U.S.N.M. 105787; 2 paratypes, figured, U.S.N.M. 105788a-b; 1 paratype, figured, U.S.N.M. 105790; 19 paratypes, unfigured, U.S.N.M. 105791; 9 paratypes, unfigured, U.S.N.M. 105789; all from the Lewisville member on Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Tarrant County: Locs. 20, 21, 28, 34; Cooke County: loc. 98; Grayson County: loc. 117; Fannin County: locs.

179, 184 (holotype and 31 paratypes, 3 figured, some juvenile), 186, 195.

Range.—Eules member to Lewisville member.

Voysa compacta Stephenson, n. sp.

Plate 39, figures 32, 33

Shell small, spire turreted, compactly coiled, with 6 or 7 whorls. Spiral angle about 20° on the larger whorls, widening to about 32° at the apex. Suture closely appressed in a moderately deep, narrow depression. The whorls bear both axial and spiral ornamentation. The axials are nonprominent, rather thick, and range in number from 12 or 13 on the penultimate whorl to 10 or less on the smaller whorls near the apex. Four spirals are exposed on the sides of the whorls between the sutures; they are rather thick and form elongated nodes at their intersections with the axials; the uppermost spiral is a little thicker and more prominent than the others. The periphery of the body whorl is regularly rounded and the base strongly constricted. The periphery is marked by a narrow, low, unnoded ridge, and this is separated from a strong unnoded ridge on the base below by an interspace of moderate width; below the latter is a wide unribbed space that is bordered below by a sharp upturned ridge at the edge of the small umbilical fissure; in the adult stage the latter is concealed by the overlapping callus of the inner lip. Aperture essentially identical with that of *Voysa savoiana*; the outer lip is partly broken away. The trend of the growth lines on the sides of the whorls is deeply concave toward the aperture. Protoconch not preserved.

Dimensions of the holotype: Height 14+ mm, diameter 5.8 mm.

Compared with *Voysa savoiana*, this species has a shorter and more compact spire and a more pronounced development of both the axial and spiral sculpture. The two species are, however, closely related. *V. compacta* is perhaps even more closely related to *V. planolata* but has a shorter spire and a stronger development of sculpture both axial and spiral; its nodes are also stronger and more elongated. Allowance must be made for some individual variation in ornamentation within the species.

Types.—Holotype, U.S.N.M. 105792; 2 paratypes, unfigured, U.S.N.M. 105793; from the Lewisville member on the Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Tarrant County: Locs. 11, 14, 16, 21, 35, 47; Grayson County: locs. 107, 135; Fannin County: locs. 179, 184 (type lot), 186, 191, 195.

Range.—Dexter member to Lewisville member.

Voysa lepida Stephenson, n. sp.

Plate 39, figures 51, 52

This species is represented by the imprints of two shells in ferruginous sandstone, one each from two localities nearby in the same zone. In form and orna-

mentation the species is similar to *Voysa savoiana*, *V. planolata*, and *V. compacta*, the resemblance being closest to the latter. However, the shell is nearly twice as large as either of these species. In addition to size, several features distinguish it from *compacta*. The sides of the whorls are a little flatter; 5 instead of 4 spirals are exposed on 2 or 3 of the larger whorls, the fifth spiral apparently being introduced just below the upper suture in the later stages of growth; the flattish base, instead of being marked only by rather sharp growth lines, is crossed transversely by a series of 18 or 20 (estimated) round-crested, evenly spaced swells; centrally on the base is a gentle spiral swell, and the basal band bears 5 or 6 narrow, weak spiral threads that override the swells. On the periphery the sixth and seventh spirals below the suture form a pair separated by a shallow depression; the seventh spiral is stronger than any of the others above it. On the body whorl the strongest nodes are on the second and third and the fifth and seventh spirals below the suture. Axials are only feebly developed on the sides of the whorls. The growth lines on the body whorl are strongly sinuous, reflecting a deep, wide notch in the upper part of the outer lip. The features of the aperture were not observed.

Dimensions of the incomplete holotype: Height 23+ mm, diameter 9+ mm. Complete adults probably exceed 30 mm in height.

Types.—Holotype, U.S.N.M. 105794; from State Highway 183, within 1.2 miles west-southwest of Eules, Tarrant County. One unfigured paratype, U.S.N.M. 105795.

Occurrence.—Tarrant County: Locs. 25 (paratype), 28 (holotype).

Range.—Eules member.

Voysa speciosa Stephenson, n. sp.

Plate 39, figures 53, 54

This species is represented by numerous external and internal molds in fine, concretionary, ferruginous sandstone. It is the largest of the species here referred to the new genus *Voysa*. The apical angle is about 35°, decreasing to 20° or less on the larger whorls of the spire. Whorls 6 or 7, gently convex to nearly flat in profile, becoming broadly concave on the body whorl. Suture sharp but shallow. Periphery and base broadly rounded. The body whorl bears 10 or 11 narrow spiral ribs which are much narrower than the interspaces. From the base upward, the 2 or 3 lowest spirals are smooth and weak; the next 3 are smooth and stronger; and the upper 6 are broken into small nodes, the third to fifth spirals from the top being weak to obscure on the body whorl. Each of the larger whorls is ornamented with numerous narrow, weak axials that may number as many as 25. These follow the sinuous trend of the growth lines. The nodes are at the intersections of the axials and spirals. The trend of the growth lines is broadly convex forward on the base and periph-

ery and rather strongly concave forward on the side of the whorl above. The aperture is not well shown, but the growth lines indicate a notch in the outer lip like that in the other species of the genus. Apparently there is a shallow siphonal notch at the anterior margin.

Dimensions of the holotype: Height 23+ mm, diameter 12 mm. Some of the paratypes are somewhat larger than the holotype.

The species appears to be most closely related to *Voysa lepida* but is larger and has a more broadly rounded periphery and base, a shallower, sharper suture, and a more pronounced development of axial ribs.

Types.—Holotype, U.S.N.M. 105796; 1 figured paratype, U.S.N.M. 105797; 10+ selected unfigured paratypes, U.S.N.M. 105798; all from a field east of a road, 0.5 mile north of U. S. Highway 82, 0.5 mile west of the Grayson County line, in Cooke County.

Occurrence.—Cooke County: Loc. 100.

Range.—Lewisville member.

Voysa eulessana Stephenson, n. sp.

Plate 39, figures 55, 56

The description of the sculpture is based on rubber casts from external molds. Whorls 5 or 6. Suture narrowly channeled, impressed to moderate depth. Axial ribs sharp, strong above, fading out below about midway of the exposed part of the whorl, separated by interspaces wider than the axials; 15 or 16 axials present on the body whorl and 13 or 14 on the penultimate whorl. Primary spiral ribs 5 on exposed part of each whorl; the upper 2 primaries are the strongest and are coarsely noded where they intersect the axials; the lower 3 primaries are weak, the lowermost one being the strongest, and all 3 are weakly noded. Each interspace is occupied by 3 or more fine, weak, thread-like secondary spirals, which override the axials on the upper part of the whorl. Three strong noded spirals are present below the periphery on the upper part of the basal slope of the body whorl; the interspaces each contain 2 or 3 weak secondaries. Still lower on the base is a weak, noded spiral, below which are 5 or 6 small, closely spaced unnoded spirals. The aperture is not well preserved, but a small siphonal notch is present at the anterior end.

Dimensions of the holotype: Height 19+ mm, diameter 8 mm.

The sculpture is such that this species is not likely to be confused with any other species in the Woodbine fauna.

Types.—Holotype, U.S.N.M. 105799; from State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant County.

Occurrence.—Tarrant County: Loc. 28.

Range.—Euless member.

Voysa varia Stephenson, n. sp.

Plate 39, figures 17-20

The group of shells here included under one species is individually a variable one, and many specimens are

corroded. Several attempts were made to divide them into two or more species but with poor success. Scarcely any two shells are closely similar, the differences manifesting themselves both in form and sculpture. Some are relatively slender, some are relatively plump, and some are intermediate in profile. In sculpture some are nearly smooth, some are strongly ornamented, and some exhibit intermediate degrees of strength of ornamentation; the spiral costae may be smooth or noded, and both smooth and noded spirals may be present on the same shell; the nodes may be coarse on one part of a shell and much finer on another part even on a later stage of growth; on some shells 3 or 4 of the smaller whorls near the apex may be smooth and the remaining larger ones ornamented, whereas others are similarly ornamented on all whorls. Shells exhibiting extremes of form or of ornamentation may be selected, which, if considered independently of the intermediate forms, would be unhesitatingly accepted as separate species. However, when one sees the variations and combinations of characters presented by the intermediate forms, he hesitates to attempt to divide them into species and, making the attempt, he has difficulty in placing many of the shells in their proper species.

The individuals of the group have certain characters in common. They are all small; all have smooth, plumply rounded bases with a groove at the periphery above; all have similar apertures and similar growth lines on the body whorl, with the trend of the lines above the periphery strongly concave toward the aperture; except on the smooth apical whorls of some specimens, all whorls have 4 spirals, the uppermost one of which may be weak or perhaps wanting.

In recognition of the extreme differences in the character of the spiral ribs that some of the shells present, it seems expedient to recognize three varietal forms, with the reservation that even these variations may not form well-defined subgroups in the species. The specimen selected as holotype has fairly strong spirals, with weakly developed nodes; the variety at the one extreme has strong spirals practically unnoded; the one at the other extreme has the nodes conspicuously developed. If they had been distinguished on the basis of form, a different grouping would have resulted, particularly with reference to the noded forms, some of which are slender and some plump.

The selected holotype presents the following features: It is turreted, has 6 whorls and a spiral angle of about 15°, widening to 25° or 30° at the apex. Suture closely appressed and rather sharply impressed. Protoconch not preserved but obviously quite small. Sides of whorls gently convex. Whorls of spire ornamented with 4 thick revolving costae, with interspaces

of about the same width or narrower; on the penultimate whorl these spiral costae are distinctly, though not strongly, noded at their intersections with the very weakly developed axial ribs; on the other whorls the spirals are only weakly noded or are smooth. The periphery of the body whorl is marked by a low, narrow ridge below the peripheral groove, which, traced backward, serves as a buttress, against which the upper edge of the body whorl becomes closely appressed at the suture; just below this ridge is a narrow groove, weakly developed on the holotype but more distinct on some other shells referred to the species. Base broadly rounded, smooth, and moderately constricted. Aperture broadly lanceolate, acutely angular at the rear, with a rather wide-open, slightly twisted siphonal notch at the front. Outer lip, partly broken away in the holotype, broadly arched, sinuous in trend, with the upper part concave and the lower part convex toward the aperture. Inner lip broadly concave, smooth, with a very thin layer of callus. The growth lines are curved to conform with the sinuous outer lip.

Dimensions of the slightly defective holotype: Height 9 mm, diameter 3.4 mm.

As explained above, the specimens referred to the species and its three varieties present many deviations in form and sculpture from the respective holotypes. The species is much smaller than either of the preceding species.

Types.—Holotype, U.S.N.M. 105800; 2 unfigured paratypes, U.S.N.M. 105801; all from Timber Creek, southwest of Lewisville, Denton County. One figured paratype, U.S.N.M. 105804; 8 unfigured paratypes, U.S.N.M. 105805; 1 figured paratype, U.S.N.M. 105802; 1 unfigured paratype, U.S.N.M. 105803.

Occurrence.—Denton County: Locs. 73 (holotype and 2 unfigured paratypes), 74, 75 (2 paratypes, 1 figured), 78, 79 (9 paratypes, 1 figured), 81; Cooke County: loc. 98; Grayson County: locs. 135, 143.

Range.—Lewisville member.

Voysa varia levicostae Stephenson, n. var.

Plate 39, figures 38, 39

The specimen selected as holotype of this variety is larger than the holotype of the typical *varia*, having 8 whorls. It is similar in form to *varia*, having a spiral angle of about 14°. Part of the protoconch appears to be present, but is imperfect; it is small, smooth, and loosely spiral. The spiral ornamentation of the six larger whorls consists of 4 rather thick, moderately strong costae, the uppermost one of which is the weaker and the third one from the top the thickest and strongest; weak nodes can be detected, but the costae are essentially smooth. The two smaller whorls near the apex exhibit distinct axial ribs, which, however, are poorly preserved. The base and aperture are like that of the typical *varia*.

Dimensions of the holotype: Height 12 mm, diameter 4 mm.

Types.—Holotype, U.S.N.M. 105806; 1 unfigured paratype, U.S.N.M. 105823; both from Timber Creek, southwest of Lewisville, Denton County.

Occurrence.—Denton County: Locs. 72, 73 (holotype and paratype), 76, 79.

Range.—Lewisville member.

Voysa varia nodosa Stephenson, n. var.

Plate 39, figures 27–31

The specimen selected as holotype of this variety is of medium diameter as compared with the paratypes, some of which are more slender and some more rotund. Compared with the typical *varia*, the variety is of similar form but has stronger axial ribs and much stronger nodes at the intersection of the spirals with the axials. The base and aperture are closely similar except that the inner lip of *nodosa* is thicker. Among the paratypes, variations from the holotype of the variety are shown in the illustrations.

Dimensions of the holotype, which is incomplete at the anterior end: Height 8.4+ mm, diameter 3.4 mm.

Types.—Holotype, U.S.N.M. 105807; 4 figured paratypes, U.S.N.M. 105808a–d; 13 unfigured paratypes, U.S.N.M. 105809; all from Timber Creek, 3 miles west by south of Lewisville, Denton County.

Occurrence.—Denton County: Locs. 73, 75 (types), 79; Grayson County: loc. 135.

Range.—Lewisville member.

Voysa varia extensa Stephenson, n. var.

Plate 39, figures 21, 22

This variety is closely related to *Voysa varia*, the resemblance being mainly in the character of the sculpture. The species differs from the typical *varia* in its more slender spire, flatter whorl profile, and shallower suture. The body whorl is broadly rounded on the periphery and base and is broadly concave in profile in its upper half; it bears 5 spiral ribs. The uppermost rib closely parallels the suture, is rather strong, and is obscurely noded; the next two ribs below are weak but are distinctly and regularly noded; the fourth rib is stronger and is obscurely noded; and the fifth rib, which occupies the periphery, is smaller and is unnoded. All five ribs are exposed on the penultimate and antepenultimate whorls but on the earlier whorls of the holotype, the fifth rib is partly covered by the upper margin of the succeeding whorl. The nodes are more strongly developed on several of the earlier whorls than they are on the body whorl. The body whorl exhibits the sinuous growth lines typical of the genus, and the features of the aperture are also typical.

Dimensions of the holotype, several apical whorls of which are missing: Height 10.5+ mm, diameter 3.6 mm.

Types.—Holotype, U.S.N.M. 105810; 1 paratype, unfigured, U.S.N.M. 105811; both from near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County.

Occurrence.—Grayson County: Locs. 122 (types), 135.

Range.—Lewisville member.

Voysa minor Stephenson, n. sp.

Plate 39, figures 34–37

Shell small, turreted, very slender, spiral angle 11° or 12°, widening somewhat toward the apex. Protoconch not preserved in available material but obviously small. Whorls about 9 in adults, flat to very gently convex on the side. On most adults, the lower part of the last whorl bulges somewhat, and on large adults, the last two whorls expand a little more rapidly than the others. Suture closely appressed, slightly impressed. The surface lacks axial ribbing but bears narrow spiral ribs that range in strength from obscure or nearly smooth to distinct, and number 5 or 6 to the whorl. Periphery of body whorl broadly rounded. Base smooth or bearing several weak spirals, broadly convex, descending with moderate steepness. Growth lines sinuous; on the base they are convex in trend toward the aperture; on the side above the periphery they trend with a pronounced concavity toward the aperture, their upper ends bending forward before reaching the suture. Aperture narrowly acute at the rear, broadening out considerably below and becoming rather narrowly rounded at the front margin. Outer lip thin, broadly arched, sinuous in conformity with the growth lines. Inner lip broadly excavated, forming a thin callus over the parietal wall; below the parietal wall, the edge of the lip thickens and bends outward a little but not proportionally so much as does that of the genotype, *Voysa savoiana*. Strictly speaking there is no siphonal canal, but the rather sharp turn in the margin just below the end of the thickened inner lip may be regarded as a wide open siphonal notch.

Dimensions of the holotype, which is incomplete at the apical end: Height 7+ mm, diameter 2.3 mm. Dimensions of the largest available specimen, also incomplete at the apical end: Height 10.2+ mm, diameter 3.2 mm.

This species is smaller and more nearly smooth than any of the other species of the genus. It is present in considerable numbers at the type locality and at several of the other recorded localities.

Types.—Holotype, U.S.N.M. 105812; 2 figured paratypes, U.S.N.M. 105813a–b; 60 unfigured paratypes, U.S.N.M. 105814; all from the Lewisville member on Johnson Creek (formerly Trading House Creek), 1 mile east of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 34, 35 (types), 47; Denton County: loc. 58; Grayson County: locs. 135, 223, 227; Fannin County: locs. 179, 184.

Range.—Dexter member to Lewisville member.

Voysa? craticula Stephenson, n. sp.

Plate 39, figures 23–26

Shell small, spire of medium height, spiral angle about 26° on the larger whorls, widening to 30° or more at the apex. Protoconch smooth, turbinate, coiled about 1½ times. Whorls 6 on adults. Suture forming a narrow impressed groove in the bottom of a wide, deep sutural depression. Body whorl bearing strong spiral ribs above the periphery, separated by interspaces of about equal width. The periphery is marked by a weaker spiral rib, which is separated from the first strong rib above by a rather wide depression and from a still weaker rib below by a narrower depression. The base below the latter rib is steep and bears 2 or 3 obscure spiral lines. The flanks of the penultimate and earlier whorls back to the protoconch bear 3 strong spirals which exhibit obscure irregular nodding. On the largest of the 4 paratypes the upper 2 of the 3 strong spirals become abruptly reduced on the earlier part of the penultimate whorl, and on the body whorl several fine spiral threads appear in each of the interspaces and continue forward to the aperture; this change in sculpture appears to be an abnormal feature resulting from an injury during the life of the animal. The whole surface is covered with sharp, closely spaced growth ridges, which are well preserved in the interspaces between the spirals but which appear to be partly worn away from the crests of the spirals. The trend of the growth lines is sinuous, being convex toward the aperture below and broadly concave in the same direction on the flank above, the deepest part of the concavity being at the intersection of the lowest of the 3 strong spirals. The aperture is broadly subovate, with a wide acute angle at the rear and a wide siphonal notch at the front. The front edge of this notch droops forward and downward as in other members of this genus. The outer lip is thin and broadly arched; the inner lip is moderately excavated and forms a very thin callus over the parietal wall.

Dimensions of the holotype: Height 9.3 mm, diameter about 6.5 mm.

This species is in contrast to the other species of the genus *Voysa* in the strong, sharp development of its growth lines, in its stronger, more rugged spiral ribs, and in the shallower concavity of the notch on the upper part of the outer lip; because of these differences the generic assignment is questioned.

Types.—Holotype, U.S.N.M. 105815; from Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County. Two figured paratypes, U.S.N.M. 105816a–b; 2 unfigured paratypes, U.S.N.M. 105817.

Occurrence.—Fannin County: Locs. 183 (paratypes), 184 (holotype).

Range.—Lewisville member.

Voysa? constricta Stephenson, n. sp.

Plate 39, figures 40, 41

Shell small, conical in profile, with spiral angle of about 30°. Protoconch not preserved. Suture linear, not deeply impressed. Whorls 6 or 7, flattish on the side, noticeably constricted a little below the suture. Periphery of body whorl obtusely subangulated, basal slope steep. Axial ribs nonprominent, nearly vertical, numbering 13 on the body whorl, 13 on the penultimate, and 12 on the antepenultimate whorl; the axials end at the periphery below and reach the suture above. Four weak nodes on each axial rib mark the intersection of spiral ribs that are otherwise obscurely represented. The spirals of a pair on the body whorl, one at the periphery and the other lower on the basal slope, are separated by a narrow, shallow depression; spirals are wanting on the remainder of the basal slope. Growth lines obscure but appear to be rather deeply concave in trend toward the aperture on and above the periphery. Aperture subcircular, and subangulated at the rear. Outer lip partly broken away but appears to be thin and subobtusely angular at the intersection of the peripheral angle. Inner lip deeply and regularly excavated, with little or no callus on the parietal wall.

Dimensions of the incomplete holotype: Height 7+ mm, diameter 4 mm.

The constriction of the whorls below the suture, uncertainty as to the features of the aperture, and the trend of the growth lines render somewhat questionable reference of this species to the genus *Voysa*.

Type.—Holotype, the only specimen certainly representing the species, U.S.N.M. 105818; from Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin County.

Occurrence.—Tarrant County: Loc.? 28; Fannin County: loc. 184.

Range.—Eules member (?); Lewisville member.

Unidentified specimens of *Voysa*

One small external mold (pl. 39, fig. 58) in ferruginous sandstone of the Lewisville member, on Johnson Creek, Tarrant County (loc. 47), pertains to a rather high conical shell resembling *Voysa? craticula* in form. The spiral angle is about 30°. The whorls number 5 or 6, are flat on the sides, and bear 4 nonprominent, feebly noded spirals. On the periphery of the body whorl is a pair of spiral ribs, the upper one the stronger, with a weak spiral thread in the bottom of the interspace between them. The flat, sharply constricted, slightly excavated base bears 3 or 4 weak spirals. The 4 weak spiral ribs on the sides of the whorls distinguish this shell from *Voysa? craticula*, which bears 3 strong spirals. Height about 6.5 mm, diameter about 3 mm. U.S.N.M. 105819.

One external mold in ferruginous sandstone of the Lewisville member, from U. S. Highway 82, Cooke County (loc. 98), is similar in form to *Voysa compacta*

but possesses weaker spiral sculpture, stronger and more widely spaced axial ribs, and flatter sides and probably represents a distinct species (pl. 39, fig. 57). The mold indicates a shell 12+ mm high and 6+ mm in diameter. U.S.N.M. 105820.

A fragment of shell that may pertain to the same species as the preceding was found in the Lewisville member 1.9 miles S. 54° W. of the center of Ambrose, Grayson County (loc. 135). Both the axial and spiral sculpture are weakly developed. U.S.N.M. 105821.

A badly crushed fragment of a shell, which resembles *Voysa planolata* in form, is from the Lewisville member at Pine Bluff on Red River, Red River County (loc. 209). There are 4 noded spiral ribs exposed on the side of each whorl, but they appear to be narrower and weaker than the corresponding spirals on *V. planolata*. The fragment is 7 mm high and 4 mm in diameter. U.S.N.M. 105822.

Family APORRHAIIDAE

Genus ANCHURA Conrad, 1860

Type species: *Anchura abrupta* Conrad, from the Ripley formation or the Owl Creek formation (Upper Cretaceous), Tippah County, Miss. (Conrad, 1860, p. 284.)

The type of *Anchura abrupta* Conrad is recorded as having come from "Tippah County, Mississippi." It was collected by W. Spillman of Columbus, Miss. The specimen is not listed as present in the collections of the Academy of Natural Sciences of Philadelphia and presumably is lost. In terms of our present classification, its source may have been either the Ripley formation or the Owl Creek formation. Specimens in the National Museum collections from both of these formations agree fairly well with Conrad's original illustration (a drawing) except that they all possess well-developed axial ribs; the drawing indicates a shell lacking axials; this may be a fault in the drawing. A conspicuous feature of the genus as shown by the drawing and by the specimens in our collections is the long, slim, curved siphonal canal; another striking feature exhibited by some specimens is the extremely long, slender, spurlike upward projection of the expanded outer lip.

Anchura turricula Stephenson, n. sp.

Plate 40, figures 16-19

Shell of medium size, turreted, with spiral angle ranging from 27° to 32° on different individuals. Protoconch not preserved. Suture closely appressed, slightly impressed. Whorls about 8, broadly convex in lateral profile, ornamented with both spiral and axial ridges, the latter dominant except on the body whorl. Axials on penultimate whorl numerous, irregular, closely crowded, crossing the side in a strong curve concave toward the front, numbering about 23 on the holotype; the axials number 21 on the antepenultimate whorl and become weak and fade out on the next earlier

whorl; 3 or 4 of the early apical whorls are smooth, probably owing to mechanical wear. Most of the available shells show considerable wear, probably due in part to the movements of the animal during life and in part to mechanical wear on or near a beach prior to fossilization. The holotype is less worn than most specimens, but many of the finer details have been destroyed. On this type the upper part of the penultimate whorl bears 3 or 4 rather weak, irregularly noded primary spiral ribs, with more or less obscure secondaries and tertiaries in the interspaces; additional still finer lining may be seen in places. On the lower part of this whorl the spiral lining is very obscure. The spiral ornamentation continues rearward onto the antepenultimate whorl, where it becomes progressively weaker and more obscure. On the body whorl the axial ribs are small, weak, and closely spaced. On the upper part of this whorl the spiral sculpture is about the same as on the penultimate. At about the beginning of the last half of the body whorl a prominent, round-crested ridge abruptly appears on the line of greatest inflation and continues forward on the expanded outer lip, where it bends upward and continues to the tip of the upturned spurlike extension of the lip. The broadly rounded base bears 7 or 8 weak to obscure spirals, the upper 3 or 4 of which are coarser than the ones below. Growth lines sinuous in trend, with a strong convexity forward on the base and an opposite broad concavity in the same direction on the upper part of the whorl. The axial ribs follow the trend of the growth lines. Aperture long-lanceolate, with a wide anal angle at the rear, and projected forward at the front into a narrow, twisted siphonal canal; in the holotype an undetermined portion at the distal end of the canal is broken away, but it is probably short. On all other available specimens the canal is still less completely preserved. The outer lip is thick and is expanded into a long, moderately broad, thick wing that curves strongly upward spurlike to a point at the distal end. The ridge, which traverses the outer surface of this wing to its tip, is reflected on the inner surface by a narrow canal that also extends to the tip. The lower, outer part of the wing expands somewhat, producing a broadly convex margin; this appears to correspond to the short spurlike projection forming the lower part of the wing of the typical *Anchura abrupta* Conrad. Intermediate between this outer expansion and the columella is a lesser but fairly conspicuous marginal expansion, which is slightly warped. This corresponds to a similar expansion on *A. abrupta*. The inner lip is broadly excavated above and forms a thick callus that spreads forward on the parietal wall to a maximum of 11 or 12 mm and extends from above the anal angle downward to and out onto the siphonal canal.

One incomplete shell (pl. 40, fig. 19), which is not worn, shows the sculpture of the body and penultimate

whorls more sharply and accurately than does the holotype or any of the other paratypes.

Dimensions of the holotype: Height 59+ mm; diameter, exclusive of expanded lip, about 22 mm; diameter, including lip, 45 mm.

Compared with *Anchura abrupta* Conrad, the genotype, from the Upper Cretaceous (Maestrichtian), Tippah County, Miss., this species is similar in size, form, and in the pattern of its ornamentation, but it appears to lack an extremely long siphonal canal and possesses a more simple expanded outer lip. On the outer lip the short downward extension is represented by a downswelling of the lip, with broadly curved margin.

Types.—Holotype, U.S.N.M. 105824; 2 figured paratypes, U.S.N.M. 105825; about 30 unfigured, incomplete paratypes, U.S.N.M. 105826; all from the Templeton member near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Tarrant County: Loc. ?44; Denton County: locs. ?73, ?83; Grayson County: locs. ?153, ?171; Lamar County: locs. 201 (types), 206, 230.

Range.—Lewisville member (?); Templeton member.

Anchura horreana Stephenson, n. sp.

Plate 40, figures 22, 23

Shell of medium size, turreted, with spiral angle of about 30°; outer lip greatly expanded in the adult stage. Protoconch not preserved. Suture closely appressed, deeply impressed. Whorls about 7 (estimated), moderately and regularly convex in lateral profile, ornamented with spiral and axial ribs, the latter dominant. On the main part of the body whorl the axials number 18 or 19; the three axials nearest the beginning of the expanded wing are weakly developed, and no axials are present on the wing; the axials are sinuous in trend, with the curve convex forward on the base and concave forward above; they die out well down over the broadly rounded base. Six or seven of the axials nearest the expanded wing each bears a node on the inflated part of the whorl, 2 or 3 of which are moderately prominent. The penultimate whorl bears 15 nearly direct, round-crested axials, which are a little narrower than the separating interspaces. The main body whorl exhibits about 24 narrow, closely spaced nonprominent to obscure spiral ribs, which are most sharply developed on the basal slope and are least conspicuous on the inflation above. The outer lip is thick and expands broadly and prominently forward, curving upward at the outer corner in the form of a projecting spur of undetermined maximum length; there is also a slight rounded projection at the outer lower corner. Four of the small ribs on the body whorl diverge and increase in strength as they pass out on the expanded lip. In alignment with the afore-mentioned nodes on the body whorl is a prominent, thick rib that traverses the upper part of the lip and curves upward centrally on the outer spur; several secondary spirals traverse the first interspace below this rib. Seven or 8 obscure, narrow spirals are present on

the penultimate whorl. The aperture is long-lanceolate, with an acute, slightly rounded angle at the rear and a narrow, slightly twisted siphonal canal at the front; the point of this canal is broken away. Thick, smooth callus spreads away from the aperture in all directions, covering the inner surface of the outer wing and passing forward on the parietal wall and upward onto the penultimate whorl.

Dimensions of the incomplete holotype, the only available specimen: Height 36+ mm; diameter, exclusive of the wing, about 20 mm, diameter, including the wing, 36 mm.

Compared with *Anchura turricula*, this species has fewer and coarser axials, more numerous and finer spirals on the body whorl, and a broader and shorter wing expansion. The species is similar in form, ornamentation, and the pattern of its aperture and of its wing expansion to *A. whitneyensis*, but is larger and much more coarsely sculptured.

Types.—Holotype, U.S.N.M. 105827; from a gully south of a barn, 0.5 mile south and 0.75 mile west of Star School, northeastern Grayson County.

Occurrence.—Grayson County: Loc. 171.

Range.—Templeton member.

Anchura whitneyensis Stephenson, n. sp.

Plate 40, figures 24-26

This species is preserved as external and internal molds in weathered ferruginous sandstone. Shell of medium size for the genus, high-turreted, with spiral of angle of about 25°. Protoconch not preserved. Suture closely appressed, moderately impressed. Whorls 7 or 8, gently convex on the side, ornamented with spiral and axial ribs. The axials are dominant and number 14 or 15 on the penultimate whorl; they are gently concave toward the front in trend and from below upward are nearly direct or may be inclined a little backward; approaching the front on the body whorl of adults the axials become weaker and toward the outer lip are represented only by narrow, weak folds. The spiral ribs are small, numerous, closely crowded and on the larger whorls tend to alternate in size as new ones are added by intercalation; they completely cover the body whorl but die out as they pass out onto the expanded lip. The outer lip expands into a moderately broad, thick wing that projects outward and curves upward into a moderately long-pointed, spurlike projection; in adults the lower margin of the wing is modified by a short elbowlike extension. On the body whorl of adults about half a turn back from the lip and 3 or 4 mm below the suture, a subangular spiral rib makes its appearance and extends forward with increasing strength, passing out onto the wing and upward on the spurlike projection; where the otherwise weak axials cross this ridge they are expanded into distinct

nodes. The aperture is lanceolate above and passes below into a short, narrow, twisted siphonal canal.

Dimensions of the holotype: Height about 37 mm, diameter exclusive of the expanded lip about 15 mm; including the expanded lip the diameter would be about 27 mm.

Several incompletely preserved specimens (U.S.N.M. 105833) in the form of molds, found in ferruginous sandstone near Eules, Tarrant County (loc. 28), are similar to this species, but they reach the adult stage at a much smaller size and are doubtfully referred to it. The same may be said of several external and internal molds (U.S.N.M. 105834) from ferruginous sandstone resting on Grayson marl at a crossroad 1.5 miles northeast of Handley, Tarrant County (loc. 11), except that the spiral sculpture is a little more subdued, the secondary ribs being especially weak to obscure.

Compared with *Anchura turricula* this species is smaller, has a more slender spire, sharper, more direct, and more widely spaced axial ribs, and much finer spiral sculpture.

Types.—Holotype, U.S.N.M. 105828; 1 paratype, figured, U.S.N.M. 105829; 15+ unfigured paratypes, U.S.N.M. 105830; 1 paratype, figured, U.S.N.M. 105831; 1 paratype, unfigured, U.S.N.M. 105832; all from the Lewisville member on the Hillsboro road, 2 miles east of Whitney, Hill County.

Occurrence.—Hill County: Locs. 3 (holotype and 18+ paratypes, 2 figured), 5, 7; Tarrant County: locs. ?11, ?28.

Range.—Dexter member (?); Eules member (?); Lewisville member.

Anchura sp. a

Plate 40, figures 3-5

Six specimens from the Lewisville member in a branch of Sheep Creek, Fannin County (loc. 183), appear to represent a distinct species. The specimens are internal molds, two showing incomplete expanded outer lips, but patches of shell material adhere to several of them. Shell of medium size, spiral angle about 38°. Whorls 7 or 8, moderately convex on the side. Axial ribs numerous, 17 or 18 on the penultimate whorl, more or less curved in trend, with convexity directed rearward, subangular on the crest. Spirals narrow and weakly developed, being plainest on the upper part of each whorl, where 5 or 6 are present, and on the base of the body whorl, where 8 or 9 were counted on one specimen. Compared with *Anchura turricula*, the spire is shorter and the axials fewer. U.S.N.M. 105835a-c.

An incomplete external mold from the same member in a branch intersecting the Chicago, Rock Island and Pacific Railroad just east of Dorothy Siding, Tarrant County (loc. 44), may pertain to the same species as the preceding. U.S.N.M. 105836.

The same may be said of an incomplete, poorly preserved specimen from the Templeton member west of Star School, in northeastern Grayson County (loc. 171, coll. 20553). The body whorl appears to be nearly

smooth, and the penultimate and antepenultimate whorls show traces of axials that have been largely destroyed by corrosion. The specimen measures: Height 37+ mm, diameter about 18 mm. U.S.N.M. 105837.

Anchura sp. b

Plate 40, figure 12

Six internal molds from the Templeton member in a small branch near the Anthony road 2 miles north of Savoy, Fannin County (loc. 198), are more slender than either the preceding or *Anchura turricula*. The sculpture is not preserved. Three of the molds show the beginnings of an expanded lip. U.S.N.M. 105838 and 105838a.

Anchura sp. c

Plate 40, figure 20

One incomplete, much worn shell from the Templeton member on Red River near old Slate Shoals, Lamar County (loc. 201, coll. 13797), appears to belong to *Anchura*, but its spire is shorter than that of *A. turricula*, the whorls expand more rapidly, and the thick callus of the inner lip spreads upward from the anal angle to the next suture above. Although specifically distinct from *Anchura turricula* it is not sufficiently complete to serve as the type of a new species. U.S.N.M. 105839.

Anchura sp. d

Plate 40, figures 1, 2

Two incomplete specimens from the Templeton member near old Slate Shoals, Red River, Lamar County (loc. 201, coll. 14546), although smaller than the typical *Anchura* and having a proportionately shorter spire, agree in general form and pattern of ornamentation with the members of that genus. The whorls number 5, and the spiral angle is about 27°. On the penultimate whorl the axial ribs are rather coarse and number 12 or 13; on the body whorl these smooth down to rather coarse growth lines that are sinuous in trend. The base bears 10 or 12 narrow, low primary spirals alternating with still finer secondaries; above the periphery the body is covered with fine spiral lirae, with one stronger, feebly noded spiral a little below the suture. The siphonal canal is short and narrow, and the outer lip expands into a wing, which is broken away in the available specimens. The initial part of a ridge that passes out onto the lip is present on the internal mold of one specimen. The figured example is 26 mm high and 12 mm in diameter. U.S.N.M. 105840 and 105840a.

An internal mold questionably referred to *Anchura* sp. d was found in the Lewisville member on Walnut Creek, 4.5 miles (air line) east-northeast of Mansfield, Tarrant County (loc. 43). U.S.N.M. 105841.

Anchura sp. e

Plate 40, figures 10, 11

An incomplete shell with 6 of the earlier whorls preserved, from the Templeton member, 3 miles northeast of Sherman Junction, Grayson County (loc. 160, coll. 18257), has a spiral angle of 38° and both spiral and axial ornamentation, the latter dominant. The largest whorl bears 16 axial ribs, and 2 or 3 axials on each whorl are considerably enlarged to form widely spaced varices. Twelve to 14 fine spiral ridges, which override the axials, are present on the sides of each of the larger whorls. The sutures are rather deeply impressed. The ornamentation of this species is similar to that of *Anchura whitneyensis*, but the spire is shorter and the whorls a little more plumply rounded. U.S.N.M. 105842. Another incomplete shell from the same locality (160, coll. 18978) appears to belong to *Anchura* sp. e. U.S.N.M. 105843.

Anchura sp. f

Plate 40, figures 8, 9

Six poorly preserved specimens from the Templeton member at Golden Bluff on Red River, 3 miles east of Arthur City, Lamar County (loc. 203, coll. 19498), appear to belong to *Anchura*. In general form and pattern of ornamentation they are similar to *Anchura turricula* but are much smaller, have shorter spires, fewer axial ribs, and much finer spiral ribs. The spiral angle is about 35°. The expanded outer lip is partly preserved on two specimens. The spirals are small, closely spaced, and show considerable irregularity in size. The larger of the figured specimens measures: Height 30+ mm, diameter exclusive of the expanded lip about 14 mm. U. S. N. M. 105844a-b.

Anchura sp. g

Plate 40, figures 14, 15

One worn and broken specimen from the Lewisville member in a branch intersecting the Chicago, Rock Island and Pacific Railroad, about 1 mile west of the Dallas County line, Tarrant County (loc. 44, coll. 18218), is similar to *Anchura* sp. a, except that the spire is more slender, the axials are more numerous and more closely spaced, and the spirals are more weakly developed; the axials number about 18 on the penultimate whorl. The shell measures: Height 32+ mm, diameter 14 mm. U.S.N.M. 105845.

Three poorly preserved specimens from a calcareous concretion in sand in the Templeton member on a branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County (loc. 165) have about the same size, form, and ornamentation as *Anchura* sp. g. U.S.N.M. 105846.

The same may be said of an incomplete specimen from the same locality as the preceding, but from a layer of

gray silty shale underlying the concretion-bearing sand (loc. 163). U.S.N.M. 105847.

Anchura sp. h

Plate 40, figure 21

One incomplete shell from the Lewisville member on a tributary of Sheep Creek, Fannin County (loc. 193), is similar to *Anchura* sp. g, but it is larger, is less slender, has more numerous and more direct axials, and is less constricted at the base. The axials number 20 on the penultimate whorl. The spiral angle is about 32°. The expanded outer lip is thick and spurlike. Dimensions: Height 33+ mm; diameter, exclusive of the expanded lip, about 14 mm, including this lip, 29 mm. U.S.N.M. 105848.

Questionable unidentified specimens of *Anchura*

Prints in sandstone of the Lewisville member from the Hillsboro road, 2 miles east of Whitney, Hill County (loc. 3, coll. 11836), indicate the presence of a small *Anchura*-like gastropod having a shorter spire than that of *Anchura whitneyensis*, with deeply impressed suture, more numerous, somewhat sinuous oblique axials, and fine obscure spirals (pl. 40, figs. 6, 7). A low ridge on the body whorl of one mold shows the approach to the expanded lip. One of these incomplete prints measures: Height 15+ mm, diameter 8 mm. U.S.N.M. 105849a-b.

Two incomplete internal molds with some shell material adhering, from the Lewisville member in a branch north of the Chicago, Rock Island & Pacific Railroad just east of Dorothy Siding, Tarrant County (loc. 44, coll. 18218), are questionably referred to *Anchura*. The spire is moderately high, the suture of medium depth, the body whorl short, and the periphery rounded. Three ribs of medium strength, with slightly wider interspaces, are preserved on a shell fragment attached to the penultimate whorl of one specimen. The largest mold measures: Height 28+ mm, diameter about 25 mm. U.S.N.M. 105850.

The scar of attachment of the left valve of a young example of *Ostrea soleniscus* Meek, from the Templeton member near old Slate Shoals on Red River, Lamar County (loc. 201, coll. 14546), is an imprint of part of a large, high-spined gastropod, which may be an undescribed species of *Anchura*. Parts of 4 whorls are represented, the largest of which probably is the upper part of the body whorl (pl. 40, fig. 13). The suture appears to be rather loosely appressed and is moderately impressed. Sides of whorls low convex, with a fairly well defined, slightly tumid collar band bordering the suture above. Eight or 9 spiral costae of medium strength ornament the sides of the whorls between sutures, those on the inflated part being the strongest and the 2 or 3 uppermost ones being quite small and weak; interspaces wider than the costae. Some of the

costae are weakly and irregularly noded. On the upper margin of the largest whorl, closely bordering the suture, is a row of small, sharp projections produced by the upfolding of growth lamellae, the open part of each fold facing forward. The imprint measures 38 mm in greatest length, and 20 mm in greatest width, probably indicating a shell having a height of 75 or 80 mm. U.S.N.M. 105859. Two fragmentary specimens in the same lot (loc. 201 coll. 14546), one an external mold and the other an internal mold, appear to belong to the same species as the imprint on the oyster. U.S.N.M. 105860.

"*Anchura*" modesta Cragin

Plate 39, figures 7-11

1893. *Anchura modesta* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 18.

1928. *Anchura modesta* Cragin. Adkins, Texas Univ. Bull. 2838, p. 190.

Among the many available specimens from two localities in Grayson County, only one, a cotype, has the expanded outer lip sufficiently preserved to afford a clue as to its form. All the specimens are poorly preserved, having lost more or less of the shell substance by solution, and many are fragmentary, having been partly broken away, either before fossilization or accidentally, as they were being collected or prepared. The cotypes number about 35.

Shell small, turreted, with spiral angle ranging from 35° to 40°. Protoconch present on some specimens but somewhat worn; it consists of 1 or 1½ slightly tilted, smooth loose coils. Suture closely appressed, slightly but sharply impressed. Whorls 6, slightly and broadly convex on the side, nearly smooth with the exception of growth lines that are sinuous, being broadly convex in trend forward on the base and broadly and strongly concave forward on the part of the whorl above the periphery; on patches of better-preserved surface very obscure fine spiral lining can be detected. Aperture long-lanceolate, with a sharply acute anal angle, curving over against the body at the rear, and passing into a short, narrow, straight siphonal canal in front. Outer lip thin, broadly arched, in adults expanding below into a single winglike extension, which is incomplete where present on the available material; centrally at the initial stage of this wing a narrow ridge abruptly appears and continues forward toward the tip; the upper edge of the lip expands a little upward and is flexed outward. Inner lip broadly excavated, forming a thin callus over the parietal wall. The species exhibits some individual variation in the height of the spire.

Dimensions of the incomplete cotype shown in plate 39, figure 10: Height 18+ mm, diameter exclusive of expanded lip 10 mm. A larger incomplete topotype has a diameter of 11 mm. The species attains a maximum height of at least 25 mm.

Types.—Cotypes, 27 in number, 3 figured, Department of Paleontology, University of Texas no. 154 (loc. 148), some specimens bearing a small red ticket with the number 43. Eight cotypes in collection of Bureau of Economic Geology, Austin, Tex., 2 specimens bearing small red tickets with the number 43. "From 4 miles [sic] east of Whitesboro, Grayson County." (See plastotypes of 3 cotypes, U.S.N.M. 105852a-c.) Two plesiotypes, U.S.N.M. 105851a-b.

Occurrence.—Grayson County: Locs. 154 (these are from the zone that yielded the types, near the type locality), 152 (2 figured); the cotypes, "from 4 miles [sic] east of Whitesboro" (3 figured).

Range.—Templeton member.

Genus LISPODESTHES White, 1877

Type species: *Anchura nuptialis* White, from beds that are of lower Colorado age, 50 miles north of Camp Apache (=Fort Apache), 5 miles west of Mineral Springs, Ariz. (White, 1877, p. 191.)

Lispodesthes panda Stephenson, n. sp.

Plate 39, figures 1-6

In its general form and in the character of its expanded outer lip this species is similar to, and closely allied to, *Lispodesthes patula*. It is smaller, has a lower spire, and is covered with a thinner coating of callus. Shell small, with plump body and rather low spire; spiral angle about 47°. Protoconch not clearly uncovered but apparently low turbinate, with 1 or 1½ coils; in adults the protoconch is inwrapped in a mantle of callus. Suture closely appressed, sharply, but not deeply, impressed. Whorls 4, rather rapidly expanding, ornamented with spiral lirae that usually become completely covered with a mantle of callus in the adult stage. The body whorl bears about 15 low, narrow, primary lirae, those on the more inflated part of the shell being the strongest and most widely spaced; the fifth one from the top is the strongest. Secondary lirae may be introduced in the interspaces, and these increase in strength in the forward direction. Eight lirae are exposed on the penultimate whorl. The periphery and base of the body whorl are broadly rounded, and the base descends with moderate steepness. Growth lines sinuous, broadly convex in trend, forward on the base below and convex rearward on the part above the periphery. Aperture long-lanceolate, acutely angular at the rear, with a narrow anal channel incised in callus extending up the sides of the spire to, and 1.5 to 2 mm above, its tip, and with a moderately long, very narrow, strongly curved siphonal canal at the front. Outer lip of adults thick, dually expanded to form an upper long, narrow, upturned, pointed, sickle-shaped prong and a lower, much shorter, stubby, downward- and inward-turned projection; about halfway around the inflated part of the body whorl a pair of ribs arises, the upper and stronger rib continuing forward and out onto the upper prolongation of the lip to its tip and the lower rib diverging downward and extending as a weak ridge well out onto the lower prolongation; the rib that tra-

verses the upper prong is reflected on the inner surface as a narrow, sharply incised channel that extends from the inner surface of the body whorl to the tip. Inner lip very broadly excavated and, in the adult, forming a deposit of callus that spreads forward and around the outer surface of the shell. Callus also spreads backward from the outer lip over the outer surface of the shell; the layers of callus from the inner and outer lips eventually meet, thus completely concealing the sculpture over the entire surface.

Dimensions of the holotype: Height 18.2 mm; diameter exclusive of the expanded lip, about 8.5 mm; including this lip, 15 mm.

This species is a close relative of *Lispodesthes nuptialis* White (1877, p. 192), but it is larger and less slender, has a more inflated body whorl, appears to have a shorter and more strongly curved siphonal canal, and possesses a conspicuous hump of callus immediately back of the upper edge of the outer lip that is lacking in *nuptialis*.

Types.—Holotype, U.S.N.M. 105853; 4 figured paratypes, U.S.N.M. 105854a-d; 35 or more unfigured paratypes and a few fragments, U.S.N.M. 105855; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Locs. 200, 201 (types), 202.

Range.—Templeton member.

Lispodesthes patula Stephenson, n. sp.

Plate 39, figures 12-16

Shell of medium size, with an apical angle of about 50°; from the apex downward, the spiral angle decreases to about 35° on the larger whorls. On most shells the protoconch is either broken or worn away or is concealed by the outer coating of callus; as seen on one paratype it is a low smooth turbinate shell of 1 or 1½ turns. Suture closely appressed and slightly impressed. Whorls 4, very gently convex in lateral profile. In the presenile stage the shell is ornamented with numerous, low, narrow spiral lirae of irregular size and spacing; these number at least 25 on the body whorl. On the body whorl two of the lirae on the inflated part begin to enlarge as they approach the aperture, and become conspicuous as they pass out onto the expanded outer lip, one traversing the upper, and the other the lower, of the two projecting spurs. The periphery of the body whorl is broadly rounded, the base descends with moderate steepness, becoming broadly excavated below. Growth lines strongly sinuous on the body whorl. Aperture long, narrow-lanceolate, sinuous in trend; at the rear the aperture is acute, with a narrow anal canal deeply incised in thick callus, extending up the side of the spire to, and a little above, the apex. Anteriorly the aperture passes out into a low, narrow, strongly curved siphonal canal, which attains a length of 10 mm or more. In the adult the outer lip expands and forks, the upper prong curv-

ing regularly outward and upward in the form of a long-pointed spur and the lower prong passing downward and a little inward, forming a rather broad, dull-ending spur much shorter than the upper one. In the adult stage the mantle of the animal begins to fold back over the outer surface of the shell all around the aperture, depositing on the shell a layer of callus. As growth continues the mantle continues to spread, thickening the callus on the lips, covering the surface and, eventually, in the senile stage, completely concealing the surface sculpture.

Dimensions of the slightly incomplete holotype: Height 25+ mm; diameter, exclusive of the expanded lip, about 11 mm; including the lip 20 mm.

Compared with *Lispodesthes panda*, this species is larger, has a higher spire, plumper whorls, and a longer siphonal canal, and in the adult is covered with a thicker and more conspicuous layer of callus.

Types.—Holotype, U.S.N.M. 105856; 3 figured paratypes, U.S.N.M. 105857a-c; 100+ selected, unfigured paratypes, U.S.N.M. 105858; all from the Templeton member in a gully 300 feet north of a road at point 120 feet east of a T-road to the south, 0.65 mile south, 1 mile west of Star School, northeastern Grayson County.

Occurrence.—Cooke County: Loc. 99; Grayson County: locs. 114, 119, 120, 122, 126, 158, 163-165, 170-172, 173 (types); Fannin County: locs. 183, 193; Lamar County: loc. 229.

Range.—Lewisville member to Templeton member.

Family NYCTILOCHIDAE

Genus TRACHYTRITON Meek, 1864

Type species: *Buccinum vinculum* Hall and Meek, from the Pierre shale (Fort Pierre group of early reports) of the Upper Cretaceous series at the Great Band of the Missouri River, S. Dak. (Meek, 1864, pp. 22, 37.)

Trachytriton? sp.

Plate 41, figure 1

The one incomplete specimen here referred questionably to *Trachytriton* Meek presents insufficient characters on which to base a satisfactory determination of its generic relationships. It was found in the Templeton member in northeastern Grayson County (loc. 170). The shell is of medium size, with a spiral angle of about 35°. Sides of whorls evenly and moderately convex. Sutures rather deeply impressed. Body whorl evenly rounded from the suture above to the base, where it becomes broadly concave. Axial ribs narrow, non-prominent, separated by wider interspaces; on the sides of the whorls the axials are broadly concave in trend toward the front; on the body whorl, they die out about at the periphery. As preserved, the spiral ribs are numerous and narrow but are obscure; they number about 15 on the penultimate whorl. Aperture broad-lanceolate, with an acute angle at the rear; in front, the shell is partly broken away but shows the beginning of what appears to be a short, open slightly twisted

canal. Outer lip thin, broadly rounded. Inner lip broadly excavated and forming a thin wash of callus on the parietal wall. Columella apparently without folds. Dimensions: Height 21+ mm, diameter 13.2 mm. U.S.N.M. 105861.

Superfamily RACHIGLOSSA

Family SARGANIDAE

Genus HILLITES Stephenson, n. gen.

Type species: *Hillites multilirae* Stephenson. Named in honor of the late Robert T. Hill, pioneer geologist of Texas and the Americas.

The features determining the genus *Hillites* include a low, subdomelike spire, a subglobose form, a low turbiniate protoconch coiled about 1½ turns, an open, flaring umbilicus, a ridge of callus bordering the lower side of the shallow anal canal at the posterior angulation of the aperture, a deep, narrow, twisted siphonal canal, and a ridge of callus at the upper edge of this canal near the anterior end of the inner lip. The canal is formed by a sharp infolding of the peristome, the fold being orientated in such a way that the shell serves as the outer wall of the umbilicus. The outer surface of the shell is ornamented with spiral lirae and with numerous, closely packed, sinuous axial or growth ridges, which form quadrangular nodes at the intersections with the spiral ribs.

The genus is closely related to *Schizobasis* Wade, which Wade (1926, p. 176) hesitatingly placed in the family Turbinidae and which Wenz (1940, p. 723) included in the family Modulidae. In both *Turbo* and *Modulus* the anterior rim of the aperture is simple or only slightly deflected and presents nothing comparable to the sharply compressed and twisted siphonal fold of *Hillites* and *Schizobasis*. The two latter genera, together with *Sargana* Stephenson, whose apertural features are essentially similar, compose a compact family group, for which the name Sarganidae is already available (Stephenson, 1923, p. 377).

Turbinopsis Conrad (1860, p. 289), to which Cragin referred his species *T. septariana*, differs from *Hillites* in that its peristome is entire, having no attachment to the parietal wall and lacking a siphonal canal.

Turbo? *cookensis* Stanton, and *T.?* *gainsvillensis* Stanton (1947, p. 55), from the Pawpaw formation (Comanche series, Washita group), Cooke County, Tex., although incompletely preserved, exhibit features that suggest their generic identity with *Hillites*.

Hillites multilirae Stephenson, n. sp.

Plate 41, figures 10-17.

Shell of medium size, subglobose, with low, rounded, domelike spire. Protoconch low-turbiniate, smooth, coiled about 1½ times. Suture closely appressed, sharply but not deeply impressed. Whorls 3 in large

adults, rapidly expanding, broadly and regularly rounded in profile. Body whorl covered with numerous, closely spaced spiral ribs, numbering 14 in the holotype, increasing to 20 or more in some large adults; and with numerous, closely packed, sinuous axial or growth ridges, which become strongly oblique forward as they extend up over the upper surface of the whorl; the spiral ribs are dominant. The axials form low blunt, quadrangular nodes at the intersection with the spirals. On the inflated part the spirals are of sub-equal size, with very narrow interspaces; 2 spirals on the upper part of the body whorl and 3 or 4 low on the base are thicker than the others. Three to 8 spirals are exposed on the penultimate and antepenultimate whorls. New spirals may be introduced during growth either by intercalation or by addition at the base of the body whorl. The growth lines are sinuous, being gently convex forward on the base, gently concave forward on the inflated part of the body whorl, thence curving obliquely forward to the suture. Aperture rather broadly lanceolate, with an acute anal angulation at the rear, the anal channel bending over strongly against the body, and with a narrow, deep, twisted siphonal canal in front. Outer lip thin, arched nearly to a semicircle. Inner lip broadly excavated, forming a thin to moderately thick callus, spreading forward somewhat on the parietal wall, and below forming the inner wall of an openly flaring deep umbilicus; a rounded ridge of callus forms the lower border of the anal canal near its terminus, and a similar ridge borders the upper edge of the siphonal canal near the lower end of the inner lip. The fold of the peristome that forms the walls of the deep, twisted siphonal canal serves also as the outer wall of the umbilicus; the fold may be so closely compressed as to partly close the siphonal canal, only the forward portion of which may be presumed to have functioned as a channel for the siphon. The terminal part of the siphonal fold is partly broken or worn away in the holotype. A deeply incised spiral sulcus separates the outer, twisted wall of the umbilicus from the base of the body whorl. On some shells the inner surface of the umbilicus bears 5 or more rather weak spiral lirae.

Dimensions of the holotype: Height about 33 mm, diameter 25.5 mm. Large adults may attain a somewhat greater size.

The species is represented by many individuals, mostly from the type locality and nearby; they exhibit considerable individual variation in the number of spiral ribs and some variation in form, the spire being a little higher in some than in others. Compared with *Hillites septarianus* (Cragin), this species is similar in form but is ornamented with more numerous, more compactly crowded spiral lirae.

Types.—Holotype, U.S.N.M. 105862; 2 unfigured paratypes, U.S.N.M. 105863; all from the Lewisville member in a branch

north of the Chicago, Rock Island and Pacific Railroad near Dorothy Siding, about 1 mile west of the Dallas County line, in Tarrant County. One figured paratype, U.S.N.M. 105866; 5 unfigured paratypes, U.S.N.M. 105864; 33 unfigured paratypes, U.S.N.M. 105865; 1 unfigured paratype, U.S.N.M. 105869; 1 figured paratype, U.S.N.M. 105867; 1 figured paratype, U.S.N.M. 105868; 1 figured paratype, U.S.N.M. 105870.

Occurrence.—Tarrant County: Locs. 38 (figured paratype), 39, 41, 44 (holotype and 40 unfigured paratypes); Denton County: loc. 72; Grayson County: locs. 122, 131, 171; Fannin County: locs. 183 (1 paratype, figured), 191, 192 (1 paratype, figured); Lamar County: loc. 201 (2 paratypes, 1 figured).

Range.—Lewisville member to Templeton member.

Hillites septarianus (Cragin)

Plate 41, figures 6-9

1893. *Turbinopsis septariana* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 230, pl. 42, fig. 3.

The holotype of Cragin's *Turbinopsis septariana* is an internal mold of a low-spined umbilicate gastropod possessing the characters exhibited by the internal molds of *Hillites*. Weak impressions on the outer surface of the mold indicate the presence of 9 or 10 revolving ribs on the body whorl.

The shell characters of the species are best shown by several specimens possessing fewer and more widely spaced spiral ribs than *Hillites multilirae*, apparently corresponding in this respect to *H. septarianus*. These shells are like *H. multilirae* in form and apertural features and differ only in the paucity of their spiral ribs which number 10 to 12 on the different individuals, and in the more open spacing of the spirals. The thickness of the ribs and the width of the interspaces are variable both on the same and on different individuals.

Dimensions of the larger of the two illustrated specimens: Height 25+ mm, diameter 25 mm.

Types.—Holotype (Taff, original No. 154), an internal mold in the collection of the University of Texas, bearing a red ticket 43, from the Templeton member "4 miles [sic] east of Whitesboro, Grayson County." (See plastotype, U.S.N.M. 105872.) Two plesiotypes, U.S.N.M. 105871a-b.

Occurrence.—Grayson County: Locs. 170, 171; the holotype "from 4 miles [sic] east of Whitesboro"; Fannin County: loc. 192; Lamar County: loc. 201 (plesiotypes).

Range.—Lewisville member to Templeton member.

Family FUSINIDAE

Genus FUSINUS Rafinesque, 1815

Type species: *Murex colus* Linné Recent, in Indo-Pacific waters. (Rafinesque, 1815, p. 145.)

"*Fusinus*" *fuminis* Stephenson, n. sp.

Plate 41, figures 4, 5

Shell of medium size, with high spire and proportionately short body whorl. Spiral angle about 42°. Protoconch not clearly preserved. Suture moderately impressed. Whorls 6 or 7, with moderately convex sides. Upper part of each whorl slightly constricted but no well-defined anal band present. Body whorl

with a poorly defined, obtuse, peripheral angle and a steep, sharply constricted base. The upper part of the body whorl above the periphery, bears 11 thick, low, nearly direct axial ribs, which become somewhat constricted near the suture above; interspaces wide. About 9 axials present on the penultimate whorl. Two or 3 axials on each whorl are enlarged to form varices. Its spiral ribs are numerous fine threadlike ridges, which override the axials and which tend to alternate in size; on the base, the spirals appear to be a little coarser but are badly corroded. Growth lines strongly sinuous in trend, with a broad convexity toward the aperture on the base and the reverse on the upper part of each whorl. Aperture broadly lanceolate, with the angle at the rear approximating a right angle and the front passing into what appears to be a short, very narrow siphonal canal, but which is partly broken away. Outer lip strongly and regularly arched. Inner lip deeply and regularly excavated, forming only a very thin wash of callus on the parietal wall. Columella small, slender, smooth.

Dimensions of the incomplete holotype, the only available specimen: Height 15+ mm, diameter 8+ mm.

This species is tentatively assigned to the Recent *Fusinus* Rafinesque. More and better material would probably afford a basis for the erection of a new genus.

Type.—Holotype, the only available specimen, U.S.N.M. 105873; from a point near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201.

Range.—Templeton member.

"Fusinus" cornelianus Stephenson, n. sp.

Plate 41, figures 2, 3

Shell small, spire of medium height, about equal to length of aperture, subconical. Spiral angle about 48°. Protoconch not well preserved but apparently small, trochoid. Suture moderately impressed. Whorls 4, rapidly expanding, nearly flat on the sides. Body whorl with a subobtuse peripheral angle, below which the base is steep, gently convex above, excavated below; surface above the periphery bearing 9 or 10 weak, narrow spiral ribs of somewhat unequal strength and spacing. Similar spiral ribs cover the base below the periphery. One spiral at the periphery is larger than the others. The spiral ribbing continues rearward on the flanks of the earlier whorls nearly to the apex. Axial ribs are wanting. Growth lines gently sinuous in trend. Aperture broadly lanceolate, the angle at the rear less than a right angle, extending forward below in a moderately long, narrow siphonal canal, which is broken away in most of the available specimens. Outer lip broadly arched, inner lip broadly excavated. Columella apparently smooth.

Dimensions of the holotype: Height 11+ mm, diameter 5.2 mm.

The species does not appear to be closely allied to any described species in the Cretaceous of the Atlantic and Gulf Coastal Plain. Its generic relationships have not been satisfactorily determined.

Types.—Holotype, U.S.N.M. 105874; 25 selected, unfigured paratypes, U.S.N.M. 105875; numerous poorly preserved examples not removed from the matrix, U.S.N.M. 105876; all from a branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County.

Occurrence.—Grayson County: Locs. 139, 164 (types).

Range.—Templeton member.

Genus FASCIOLARIA Lamarck, 1799

Type species: *Murex tulipa* Linné, Recent, in the West Indies and off the southeast coast of the United States.

"Fasciolaria" sp.

Plate 41, figures 18, 19

One poorly preserved, incomplete shell, from the Templeton member in northeastern Grayson County (loc. 173), is provisionally referred to *Fasciolaria* Lamarck. Shell small, with spiral angle of about 65°. Protoconch not preserved. Suture of medium depth, narrowly channeled. Whorls about 3 (estimated), rapidly expanding, plumply rounded. Body whorl broadly rounded in profile from suture above to base below. Axial ribs weak and irregular except on the larger part of the body whorl, where they become stronger. Spiral ribs numerous, narrow. The body whorl bears 16 more or less distinctly noded primary spirals, the 3 uppermost ones of which are stronger than the others. A very small, obscurely noded secondary is present in each of the interspaces between the primary ribs. Aperture lanceolate, acutely angular at the rear; the shell is broken away at the front. Outer lip broadly arched; the shell is also broken away from the internal mold for several millimeters back from the outer lip, revealing the impressions on the mold of pronounced lirae, which are the internal expressions of the interspaces between the external primary ribs. This part of the mold also bears the impressions of several strong axial ribs. The inner lip forms a thin callus on the parietal wall. The columella appears to be nearly smooth. Dimensions of the incomplete shell: Height 13+ mm, diameter 8+ mm. U.S.N.M. 105877.

Genus BELLIFUSUS Stephenson, 1941

Type species: *Odontofusus curvicostatus* Wade, from the Coon Creek tongue of the Ripley formation (Upper Cretaceous), Coon Creek, McNairy County, Tenn. (Stephenson, 1941, p. 338.)

Bellifusus? parvilirae Stephenson, n. sp.

Plate 41, figures 30, 31

Shell of medium size, spire of medium height, body whorl a little longer than the height of the spire. Spiral angle about 52°. Protoconch broken away, but its internal mold indicates that it is strongly tilted and

partly enveloped by the earliest whorl of the main spire. Suture closely appressed, rather deeply impressed. Whorls 4, constricted above to form a steeply sloping, broadly excavated shoulder. Bordering the suture is a steeply sloping collar band that forms about the upper one-third of the shoulder slope. Body whorl broadly rounded below the shoulder, passing with graceful curvature into a broad excavation at the base. Inflated part of body whorl ornamented with 18 or 19 short, somewhat irregular, nonprominent axial ribs, which die out abruptly just above the shoulder angle and below more gradually about at the periphery; toward the aperture these axials become very irregular in size. On the penultimate whorl the axials number about 22 and are closely crowded. The whole surface is covered with fine, closely spaced, nonprominent to obscure spiral lirae, which are a little coarser low on the base than on the higher parts of the body whorl. The growth lines pass up over the body whorl with a broad convexity in trend forward toward the outer lip as far as the shoulder angle, where they curve obliquely forward and upward to the suture above. Aperture roughly lanceolate, with an acute angle at the rear, and passing anteriorly into a narrow siphonal canal, which is partly broken away in the holotype. Outer lip broadly and rather strongly arched, fullest above. Inner lip broadly but not deeply excavated, forming a thin callus, restricted in its spread forward on the parietal wall. Columella bearing one fairly prominent, narrow fold, above which is a second very weak fold; a narrow, low fold also borders the siphonal canal in front.

Dimensions of the incomplete holotype, the only available specimen: Height 37+ mm, diameter about 20 mm.

This species has a somewhat lower spire, a stockier profile, and more numerous axials than has the genotype, *Bellifusus curvicostatus* (Wade), from the Coon Creek tongue of the Ripley formation at Coon Creek, McNairy County, Tenn. The tilted protoconch may throw some doubt on the reference of the species to *Bellifusus*, which is described as having an untilted, smooth, trochoid protoconch. In form and sculpture the species bears a striking resemblance to *Aliofusus* Stephenson from the Nacatoch sand (Upper Cretaceous) of Texas, but the presence of a pronounced columellar fold rules it out of that genus.

Type.—Holotype, U.S.N.M. 105878; from a point near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201.

Range.—Templeton member.

Genus ALIOFUSUS Stephenson, 1941

Type species: *Aliofusus reaganii* Stephenson (1941, p. 336), from the Nacatoch sand (Upper Cretaceous), near Kaufman, Tex.

Aliofusus balaniformis Stephenson, n. sp.

Plate 41, figures 20-22

The species is represented by 5 incomplete shells, all from the same locality. Shell small, with spire about 0.35 and aperture 0.65 the height. Whorls 4 or 5, broadly convex on the side, with a narrow, slightly tumid collar band, becoming weakly shouldered on the body whorl of adults. Suture closely appressed, moderately impressed. Body whorl broadly rounded on the periphery, becoming broadly excavated low on the base. Axial ribs small, narrow, short, separated by much wider interspaces, numbering 15 on the body whorl of the holotype and 17 on the body whorl of one of the paratypes; the axials are situated high on the body whorl, do not cross the shoulder above, and die out near the periphery below. Spiral ornamentation is wanting on all but the lower part of the base, where 4 or 5 weak to obscure ribs are present. Aperture lanceolate, acutely angular at the rear, passing in front into a short, twisted, moderately open siphonal canal. Outer lip broadly arched. Inner lip broadly excavated, forming a thin callus on the parietal wall. Columella twisted, smooth, with the exception of a low rounded ridge or swell bordering the anterior edge of the siphonal canal.

Dimensions of the holotype, which is slightly incomplete at each end: Height 21+ mm, diameter 10.5+ mm.

Compared with the genotype, *Aliofusus reaganii*, this species is similar in form and in the features of its aperture but is smaller and much smoother. The axials are similar in their shape, position, and distribution but are smaller and shorter; spirals, which are present as fine revolving lines all over *A. reaganii*, are wanting on *A. balaniformis* except on the lower slope of the base, where a few obscure, relatively coarse ribs are present.

Types.—Holotype, U.S.N.M. 105879; 1 unfigured paratype, U.S.N.M. 105880; from near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson County. One figured paratype, U.S.N.M. 105881; 2 unfigured paratypes, U.S.N.M. 105882.

Occurrence.—Grayson County: Loc. 122 (holotype and 4 paratypes, 1 figured).

Range.—Lewisville member.

Family VOLUTIDAE

Genus CAROTA Stephenson, n. gen.

Type species: *Carota robusta* Stephenson.

Etymology: Latin *carota*, a carrot.

This medium to large volutid is characterized by its spire of medium height, relatively large, strongly tilted protoconch, elongated, gracefully curved body whorl, coarsely noded shoulder angle, a deep notch at the intersection of the shoulder angle with the outer lip, 2 or 3 coarse folds on the columella, and a relatively fine pattern of spiral ornamentation.

The species from Banquereau Bank, off the east coast of Nova Scotia, described by me (Stephenson, 1936, p. 402) under the name *Volutoderma? venusta*, appears to be a closely related species of this genus.

Carota differs from *Volutoderma* Gabb (1877, p. 289) in the presence of a strong shoulder notch in the outer lip and in other features, including a lower spire, a coarsely noded shoulder angle, and a more closely spaced pattern of spiral ornamentation. According to Stewart (1927, p. 409), *Volutoderma* is based on *Fusus averillii* Gabb, from the Chico group of California.

Volutoderma (Longoconcha) navarroensis (Shumard) is a much more slender shell and lacks a shoulder notch. (See Stephenson, 1941, p. 357.)

Rostellites dalli Stanton (1894, p. 156), from the "Pugnellus sandstone," Huerfano Park, Colo., is apparently a species of *Carota*, having a similar form and ornamentation and possessing a shoulder notch, as shown by growth lines on two of the type specimens.

Rostellinda Dall, proposed as a subgenus of *Volutoderma* Gabb, based on the species *Volutoderma (Rostellinda) stoliczkana* Dall (1907, p. 6), from the Trichinopoly group of India, is related to *Carota*, but it is broader in body below the shoulder, possesses a much shallower notch or sinus, which is near the suture, and is ornamented much more coarsely with spiral ribs (Stoliczka, 1868, p. 87, pl. 7, fig. 7).

Fulgoraria Schumacher (1817, p. 242) is a much more slender shell, having coarser sculpture and apparently lacking a shoulder notch.

Carota robusta Stephenson, n. sp.

Plate 42, figures 22-25

Shell large, robust, with spire of medium height and elongated body whorl. Spiral angle about 55° on the larger whorls, decreasing to 45° or less at the apex. Protoconch not well preserved but apparently a relatively large, turbinated, strongly twisted shell. Suture closely appressed, deeply impressed. Whorls 5 or 6. Body whorl with a relatively narrow, excavated shoulder, limited outwardly by a coarsely noded shoulder angle; anteriorly on adults the nodes pass into coarse, irregular growth lamellae. The nodes number 11 on the penultimate whorl. The shoulder bears 2 or 3 obscure, narrow spiral lirae. Periphery of body whorl very broadly rounded, bordered below by a broad, shallow excavation, which passes still lower into a long, gentle, slightly convex slope. On the holotype the whole of the surface below the shoulder is covered with numerous, small primary spiral ribs, with secondaries present between the primaries on the upper part of the basal slope and on most of the body to within 6 or 7 mm of the shoulder angle; on the figured paratype the spiral sculpture is obscure on the upper part of the body whorl. On the penultimate and earlier whorls the coarsely noded shoulder angle lies above the middle

of the exposed area, and the side below the angle is vertical; the latter area bears 5 or 6 narrow, irregular, nonprominent spiral lirae. The nodes on the shoulder angle form the upper ends of coarse, more or less irregular, nonprominent axial ribs, which die out at or a little below the periphery; toward the aperture on the body whorl they merge into coarse growth lamellae. The growth lines pass up over the elongated body with a broad gentle forward convexity until they reach the shoulder angle, where they bend sharply backward and then forward again on the shoulder above. Aperture elongated, with a deep notch or sinus at the intersection of the shoulder angle, and passing anteriorly into a long, slightly twisted siphonal canal of moderate width. Outer lip thin at the edge, very broadly arched below the shoulder notch. Inner lip forming a thin to moderately thick callus, which extends nearly the full length of the aperture and swells into a broad hump just below the upper end. The columella bears a group of three coarse, oblique folds that center slightly above the midheight of the opening. An elongate, narrow, shallow umbilical fissure borders the siphonal canal on its inner side; this is best seen on the figured paratype.

Dimensions of the incomplete holotype: Height 93+ mm, diameter 39 mm. The figured paratype, also incomplete, measures: Height 97.5+ mm, diameter 37.5 mm.

None of the few available shells is perfectly preserved. Both the holotype and the large figured paratype are worn and partly broken on the upper parts of their spires and at their anterior ends.

Types.—Holotype, U.S.N.M. 105883; 1 figured paratype, U.S.N.M. 105884; 1 unfigured paratype, U.S.N.M. 105885; all from Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar County.

Occurrence.—Grayson County: Loc. 164; Lamar County: loc 201 (holotype and 2 paratypes, 1 figured).

Range.—Templeton member.

Carota pendula Stephenson, n. sp.

Plate 42, figures 15-18

Shell of medium size, spire of medium height, spiral angle about 47°. Protoconch not preserved. Suture closely appressed, not deeply impressed. Whorls about 5. Body whorl elongated, with drooping, broadly excavated shoulder, obtusely subangulated shoulder margin, broadly rounded periphery, and very broadly excavated on the lower basal slope. The axial ribs of the holotype number 12 on the body whorl and 10 on the penultimate whorl; they form low rounded nodes on the shoulder angle, cross the shoulder above as gentle swells, and die out at or a little below the periphery. The axials appear on the penultimate and antepenultimate whorls as a row of nodes a little below the middle of the exposed area. The body whorl below the shoulder bears about 12 spiral ribs of subequal size

and spacing. Above the nodes the shoulder bears 4 or 5 much smaller, very obscure spirals. Aperture elongated, narrow, acutely angulated above and passing into a well-defined siphonal canal at the front. Outer lip very broadly arched, with a well-defined notch at the shoulder angle. Inner lip very broadly excavated, forming a rather thick callus on the parietal wall, ending above in a broadly rounded hump. Columella bearing 3 strong plications.

Dimensions of the incomplete holotype: Height 55+ mm., diameter 25.5 mm.

Compared with *Carota robusta*, the shoulder of this species droops much more steeply, the shoulder nodes are not so coarse and lie below instead of above the middle of the exposed area on the penultimate and earlier whorls, and the spiral ribs below the shoulder on the body whorl are coarser and appear to consist only of primaries.

Types.—Holotype, U.S.N.M. 105886; from the Templeton member on an east-west road near the head of a branch of Iron Ore Creek, 3 miles northeast of Sherman Junction, Grayson County. One figured paratype, U.S.N.M. 105887; 1 unfigured paratype, U.S.N.M. 105888.

Occurrence.—Tarrant County: Loc. 244; Grayson County: locs. 158, 160 (holotype), 164, 165, 171, ?172; Fannin County: loc. 183 (2 paratypes, 1 figured).

Range.—Lewisville member to Templeton member.

Carota? nodosa Stephenson, n. sp.

Plate 42, figures 19–21

Shell of medium size, with high spire. Spiral angle about 30°. Protoconch missing. Suture closely appressed, deeply impressed. Whorls about 4, moderately inflated, with a weak, narrow, steeply sloping shoulder below the suture. Body whorl elongated, very broadly rounded on the periphery, broadly excavated low on the base. The holotype bears about 9 axials on the body whorl, 10 on the penultimate and 11 or 12 on the antepenultimate whorl. The axial ribs are rather narrow, are separated by wider interspaces, and bear rounded nodes above at the shoulder; they bend forward on the shoulder and fade out before reaching the suture; below they die out at or a little below the periphery; from below upward they trend a little to the right of the vertical. Spiral lirae are present but obscure on the holotype; on the figured paratype they may be more clearly seen on parts of the shell. The body whorl is covered with narrow, closely spaced, somewhat irregular spiral ribs, which override the axials; the spirals are weak to obscure above the periphery but become stronger and a little coarser on the base below. The growth lines are broadly sinuous on the body whorl, being deflected slightly forward on the base and slightly rearward above the periphery. The aperture is elongate-sublanceolate, with almost a right angle at the rear, and with a moderately long, narrow, twisted siphonal canal in front. Outer lip

broadly arched, with a subobtuse angle at the intersection with the shoulder. Inner lip forming a thin wash of callus on the parietal wall, broadly excavated. Columella long, a little sinuous, bearing 3 strong folds.

Dimensions of the incomplete holotype: Height 48+ mm, diameter 18.2 mm.

The species is more slender and more finely and delicately ornamented than are the other species of *Carota* in the Woodbine formation.

Types.—Holotype, U.S.N.M. 105889; from a gully, 250 feet north of a road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson County. One paratype, U.S.N.M. 105890.

Occurrence.—Grayson County: Locs. 170 (holotype), 171 (paratype).

Range.—Templeton member.

Carota? biplicata Stephenson, n. sp.

Plate 42, figures 1–5

Shell of medium size, with rather low spire. Apical angle about 62°, decreasing to about 50° on the larger whorls of the spire below. Protoconch not preserved. Suture closely appressed, shallow. Whorls 5 or 6. Body whorl moderately elongated, with a steep, excavated shoulder limited outwardly by a noded, subobtuse shoulder angle; the nodes are moderately coarse, round-topped and form the blunt upper ends of axial ribs, which die out low on the base. The nodes are exposed on the side of the penultimate and earlier whorls and number about 11 on the body whorl, 10 on the penultimate whorl, and 9 on the antepenultimate whorl. The body whorl bears 10 or 11 weak spiral ribs on the base, with additional obscure ribs at higher and lower positions. The sharp-edged growth lines pass up over the body with gentle convexity in trend toward the aperture, turn obliquely back on the shoulder angle, thence sharply forward along the lower part of the shoulder excavation, thence turn upward and a little forward across the steep slope of the shoulder, and again turn sharply forward at the suture. Aperture elongated, with an acute angle at the rear and a moderately elongated twisted siphonal channel of medium width at the front. Outer lip thin at the edge, very broadly arched below the shoulder angle, and with a deep notch at the shoulder angle. Inner lip broadly excavated and forming a thin callus that spreads somewhat forward over the parietal wall. The columella is a little twisted and bears 2 folds slightly above its midheight, the upper one of which is considerably stronger than the lower one; these folds are best shown on the two paratypes from Lamar County.

Dimensions of the nearly complete holotype: Height 43+ mm, diameter 22.5 mm. A large adult may attain a height of 60 mm.

The species differs from *Carota robusta* in its smaller size, its proportionately lower spire, its weaker spiral ornamentation, and the presence of 2 instead of 3 strong folds on the columella.

Types.—Holotype, U.S.N.M. 105891; from a branch of Cornelius Creek, 3.35 miles north, 0.5 mile west of Bells, Grayson County. Two figured paratypes, U.S.N.M. 105893a-b; 2 unfigured paratypes, U.S.N.M. 105892.

Occurrence.—Grayson County: Locs. 163 (holotype), ?164, 165 (2 unfigured paratypes); Lamar County: loc. 201 (2 figured paratypes).

Range.—Templeton member.

Genus **PALEOPSEPHAEA** Wade, 1926

Type species: *Paleopsephaea mutabilis* Wade, from the Coon Creek tongue of the Ripley formation (Upper Cretaceous), Coon Creek, McNairy County, Tenn. (Wade, 1926, p. 123.)

The Woodbine species, here referred to *Paleopsephaea* Wade, appear to agree with that genus in all essential characters. They are, however, larger and more rugged in their development.

Paleopsephaea vadoana Stephenson, n. sp.

Plate 41, figures 27-29

Shell of medium size, robust, with high spire. Spiral angle about 40°. Protoconch not preserved. Suture closely appressed, rather deeply impressed. Whorls 6 or 7. Axial sculpture strong and coarse; spiral sculpture feeble and fine. Body whorl constricted below the suture, bearing 8 strong, round-crested, rather widely spaced subnodose axial ribs, which become abruptly depressed above, crossing the constriction as low, subdued swells and fading out downward on the base a short distance below the periphery. The axials continue well developed on the penultimate and earlier whorls, increasing in number posteriorly to a maximum of 12 or 13. The whole surface is covered with fine, obscure spiral lirae, which in the available material are partly erased by corrosion and wear; they are coarsest on the basal slope. Growth lines nearly direct where they pass up over the base, but they curve somewhat to the right and then to the left on the upper part of the whorl. Aperture lanceolate, with an acute angle at the rear, and passing into a somewhat elongated, slightly twisted siphonal canal at the front. Outer lip thin, broadly arched, with a rather broad, open backward deflection above at the intersection of the poorly defined shoulder. Inner lip very broadly excavated, forming a thin callus over the parietal wall. Columella bearing 3 well-defined columellar folds, the lower and middle ones stronger than the upper one.

Dimensions of the incomplete holotype: Height 50+ mm, diameter 23+ mm.

Compared with the genotype, *Paleopsephaea mutabilis* Wade, this species is less slender and the axial sculpture is more coarsely developed, but it appears to possess all the essential characters of Wade's genus.

Types.—Holotype, U.S.N.M. 105894; 1 paratype, figured, U.S.N.M. 105895; 5 unfigured paratypes, U.S.N.M. 105896; all from near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Grayson County: Loc. 171; Lamar County: loc. 201 (holotype and 6 unfigured paratypes), ?203.

Range.—Templeton member.

Paleopsephaea decorosa Stephenson, n. sp.

Plate 41, figures 23, 24

Shell of medium size, with high spire. Spiral angle about 28° on the larger whorls, increasing to about 40° at the apex. Protoconch not completely preserved but apparently high turbinate. Suture closely appressed, moderately impressed. Whorls 6, expanding gradually, gently convex on the side. Body whorl apparently about equal in length to the spire. Axial sculpture well developed; spiral sculpture obscurely present on some specimens, apparently absent on others. The body whorl of the holotype bears 13 slender axial ribs, which are strongest on the most inflated part, die out quickly below near the periphery, and reach the suture above in much reduced size. The penultimate whorl bears 15 axials, the antepenultimate whorl 19, and the next earlier whorl 17 axials. The spiral ribs are so obscure as to be practically wanting but are obscurely to weakly developed on some shells. The growth lines are broadly and gracefully convex in trend toward the aperture on the body whorl below the periphery but become gently concave in the same direction between the periphery and the suture above. Aperture elongate-lanceolate, with an acute angle at the rear and a narrow, moderately elongated siphonal canal at the front. Outer lip very broadly arched. Inner lip broadly excavated at the base of the body and forming a wash of callus of thin to medium thickness over the parietal wall. Columella with 3 strong plaits, the middle one of which is a little larger than the others.

Dimensions of the holotype, which is incomplete at both ends: Height 58+ mm, diameter 20+ mm.

Compared with *Paleopsephaea vadoana*, this species is more slender and has more numerous and much finer axial ribs.

Types.—Holotype, U.S.N.M. 105897; 7 unfigured paratypes, U.S.N.M. 105898; all from a branch, north of the Chicago, Rock Island and Pacific Railroad, 1 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Loc. 44.

Range.—Lewisville member.

Paleopsephaea patens Stephenson, n. sp.

Plate 41, figures 25, 26

In form and in the size and position of the three columellar folds this species is similar to *Paleopsephaea decorosa*. It differs from that species mainly in that the spire is a little more slender and the axial ribs are fewer and more widely spaced. The number of axials on successive whorls are as follows: Body whorl 10, penultimate whorl 10, antepenultimate whorl 13. Di-

mensions of the incomplete holotype: Height 53+ mm, diameter 20 mm.

Holotype.—U.S.N.M. 105899; from the Templeton member in the south bank of an east-west road, near the head of a northward-flowing branch of Iron Ore Creek, 3 miles north-east of Sherman Junction, Grayson County. Two paratypes, unfigured, U.S.N.M. 105900.

Occurrence.—Grayson County: Locs. 160 (holotype), 165 (2 paratypes, unfigured), 171–173; Fannin County: loc. 184; Lamar County: loc. ?206.

Range.—Lewisville member to Templeton member.

Paleopsephaea sinuosa Stephenson, n. sp.

Plate 42, figures 8–13

Shell of medium size, spire high. Spiral angle about 40°. Protoconch not preserved. Suture closely appressed, moderately impressed. Whorls 5 or 6, broadly convex on the sides, constricted above to form a sloping collar and shoulder below the suture. Axial ribs of medium strength on the penultimate and earlier whorls, becoming weak on the body whorl of adults and practically disappearing toward the aperture; axials 12 on the penultimate whorl of the holotype. Spiral sculpture obscure. Body whorl broadly rounded on the periphery, broadly excavated at the base. Growth lines sinuous, being broadly convex in trend toward the front on the basal slope, concave toward the front at the shoulder inflation, crossing the shoulder slope with a rather pronounced inclination toward the front and curving slightly back again just before reaching the suture. Aperture lanceolate, its length being about three-fifths the total height of the shell; angle at rear acute; siphonal canal at front narrow, long, and slightly twisted. Outer lip broadly convex above, becoming broadly concave below. Inner lip broadly excavated, forming a thin callus over the parietal wall and the lower portion of the columella. Columella slightly twisted, bearing 3 strong folds, the lower one strongest and the upper one weakest.

Dimensions of the incomplete holotype: Height 49+ mm, diameter 21 mm.

This species has weaker and more numerous axial ribs than *Paleopsephaea vadoana* and has a shorter spire and fewer axials than *P. decorosa*.

Types.—Holotype, U.S.N.M. 105901; 3 figured paratypes, U.S.N.M. 105902a–c; 7 unfigured paratypes, U.S.N.M. 105903; 7 unfigured paratypes, U.S.N.M. 105904; 1 figured paratype, U.S.N.M. 105905; 2 unfigured paratypes, U.S.N.M. 105906; all from the Lewisville member near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace Station), Grayson County.

Occurrence.—Grayson County: Locs. 122 (holotype, 20 paratypes, 4 figured), ?170, 173.

Range.—Lewisville member to Templeton member.

Paleopsephaea sp.

Plate 42, figure 14

One incomplete shell from the Lewisville member, near Dorothy Siding, Tarrant County (loc. 44, coll.

18218), is similar to *Paleopsephaea decorosa*, but the whorls are slightly more plump and the axial ribs are more numerous, sharper, and more closely crowded; the axials on the largest well-preserved whorl number 18, and on the next earlier whorl 17. Three well-developed folds are present on the columella. The incomplete shell measures: Height 27+ mm, diameter about 13 mm. U.S.N.M. 105907.

A still less complete specimen that appears to be the same species as the preceding was found in the Templeton member, 2.2 miles north of Sherman Junction, Grayson County (loc. 158). U.S.N.M. 105908.

Genus *PARVIVOLUTA* Wade, 1926

Type species: *Parvivoluta concinna* Wade (1926, p. 122), from the Coon Creek tongue of the Ripley formation (Upper Cretaceous) on Coon Creek, McNairy County, Tenn.

Parvivoluta? *venusta* Stephenson, n. sp.

Plate 43, figures 34, 35

Shell small, with spire of medium height. Spiral angle about 48°. Protoconch broken away. Suture deeply impressed, loosely appressed. Whorls 4, rapidly expanding, moderately convex on the sides. Body whorl about five-eighths the total height of the shell. Axial sculpture strongly dominant, the axial ribs numbering 16 both on the body whorl and on the penultimate whorl. Axials strong and subangular on the crests; they extend uninterrupted to the suture above and die out below on the lower slope of the base. Spirals very small and weak, being strongest on the lower part of the body whorl, scarcely discernible on the inflation above, and weakly present on the upper part of this whorl and on the exposed part of the penultimate whorl. The growth lines are gently sinuous, being slightly convex in trend on the base, slightly the reverse on the inflation, and bending only slightly forward as they approach the suture above. Aperture lanceolate, acutely angulated at the rear, passing in front into a short, rather wide open siphonal canal; the tip of the canal is broken away. Outer lip broadly and evenly arched, with simple interior edge. Inner lip moderately excavated above its midheight, forming a thin callus on the parietal wall. Columella nearly straight above, slightly twisted below, and bearing 3 weak folds, the middle one of which is slightly more prominent than the other two.

Dimensions of the slightly incomplete holotype: Height 7.3+ mm, diameter 3.9 mm.

This species is similar in form and ornamentation to the genotype, *Parvivoluta concinna* Wade, but has a plumper body whorl, a weaker development of spirals, slightly more direct axials, a straighter columella, and a more even development of its columellar plaits. Wade's species is described as having one well-developed fold with two lines or incipient folds behind it.

Type.—Holotype, U.S.N.M. 105909; from a branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin County.

Occurrence.—Fannin County: Loc. 183.

Range.—Lewisville member.

Genus **VOLUTOMORPHA** Gabb, 1877

Type species: *Volutilithes conradi* Gabb (1860, p. 300), from the Navesink marl (Upper Cretaceous), Crosswicks Creek, Monmouth County, N. J. (Gabb, 1877, p. 290.)

"*Volutomorpha*" *graysonensis* (Cragin)

Plate 43, figures 36, 37

1893. *Fusus graysonensis* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 224.

1951. "*Volutomorpha*" *graysonensis* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, figs. 6, 7 (following p. 163).

In the original description Cragin stated that the type material consisted of two specimens, each of which lacked a small portion of the shell at either extremity. One of these types is missing, and it apparently is the one on which the description of the surface ornamentation was based. In the collection of the University of Texas are two trays each labeled "*Fusus graysonensis* Cragin, one of the types." In the larger tray is an internal mold of a gastropod approximating in size the measurements given in the description; some shell substance adheres to the mold, but the details of ornamentation have been destroyed with the exception of a patch on the base in front of the aperture, which bears a series of small, closely spaced, somewhat irregular spiral ribs; in the same tray is a fragment of the basal portion of an internal mold that may or may not pertain to the same species. In the smaller tray is a vial containing a fragment of an internal mold of a small gastropod that obviously belongs to a different genus and cannot be the other of the two cotypes mentioned by Cragin. Cragin's description follows:

Medium-sized, spire elongate-conical, volutions apparently eight to ten in number, moderately convex, each ornamented with about sixteen transverse, acutely compressed ribs, which are much more prominent along the mid-region of the whorl-breadth than near the sutures, each rib gently curved with posteriorly presented convexity; lower part of body whorl with numerous, coarse and uneven, revolving, raised lines; spindle well produced; siphonal canal long and straight; inner lip of aperture, below, thrown into a strong fold parallel with the axis of the spindle and thus forming a deep, narrow channel occupied by a part of the callosity; outer lip simple.

"*Measurements*.—Height of spire (estimated), measured from upper extremity of aperture, 45 mm, total estimated height of shell 90 mm, breadth of body whorl 26 mm.

It appears to be safe to regard the one large specimen in the larger tray as one of the cotypes, the other one of which is lost. Recent preparation of this large specimen shows that it bears 3 well-developed folds on the columella, the two lower ones of which are the larger; the specimen therefore belongs to the Volutidae and is not properly assignable to *Fusinus* (= *Fusus*). The

incomplete mold is 66 mm high and 29 mm in diameter. This species somewhat resembles the original *Volutomorpha* Gabb in form, but its spire is higher and more slender; it possesses 3 fairly strong columellar folds instead of 1 strong and 2 weak folds, and the 3 folds occupy a position higher on the columella. Better material is needed to show the true generic relationships of this shell; it probably is not a *Volutomorpha*.

Types.—One of the original two cotypes is in the collection of the University of Texas. The label appears to be an original one and bears the number 153 (loc. 148). (See plastotype, U.S.N.M. 105910.) The whereabouts of the other cotype is not known. The types were collected "4 miles [less than 4 miles] east of Whitesboro, Tex."

Occurrence.—Grayson County, "4 miles [sic] east of Whitesboro" (Texas Univ. col.); Lamar County: Loc. 230.

Range.—Templeton member.

Genus **TOVULA** Stephenson, n. gen.

Type species: *Tovula microlirae* Stephenson.

Etymology: By anagram from *Voluta*. Gender, feminine.

This genus appears to belong in the family Volutidae. The genotype is a small, fusiform, rather plump shell having the spire and aperture of about equal length. Protoconch worn but apparently small, smooth, low-turbinate. Sutures deeply impressed. Surface covered with closely spaced microscopic spiral lirae. Growth lines broadly sinuous. Aperture lanceolate, sharply rounded at the rear, passing in front into a short, open siphonal canal. Outer lip thin, dentate on inner surface a little back of the edge. Inner lip forming a thick callus. Columella with 2 strong folds.

Tovula microlirae Stephenson, n. sp.

Plate 43, figures 42, 43

Shell small, with spire of medium height and with body whorl about equal in height to the height of the spire. Apical angle about 55°, increasing slightly on the larger whorls of the spire below. Protoconch considerably worn but apparently small, smooth, low-turbinate. Suture closely appressed, deeply impressed. Whorls 4 or 5. Sides of whorls of spire moderately inflated, regularly rounded in profile, with a slight suggestion of a narrow shoulder above. Body whorl broadly rounded on the periphery, becoming slightly excavated low on the base. The surface appears smooth to the naked eye but bears closely spaced, gently wavy microscopic spiral threads of somewhat irregular strength; these have been destroyed by corrosion over parts of the holotype. The growth lines are sinuous, being broadly convex in trend toward the aperture on the basal slope of the body whorl and broadly concave in the same direction on the side above the periphery. Aperture sublanceolate, sharply rounded at the rear, passing anteriorly into a short, rather wide siphonal canal. Outer lip thin, broadly arched, with a row of 7 or 8 teeth on the inner surface about 1 mm back from

the edge. Inner lip forming a rather thick callus extending a little forward on the parietal wall, broadly excavated centrally. A gentle swell borders the siphonal canal below, and above this swell are 2 strong columellar folds. Two folds are present also on the columella of the one small incomplete paratype. There is a suggestion of a narrow, shallow umbilical fissure.

Dimensions of the holotype: Height 13 mm, diameter 7.5 mm.

Type.—Holotype, U.S.N.M. 105911; from a bluff on tributary of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County. One paratype, unfigured, U.S.N.M. 105912.

Occurrence.—Grayson County: Locs. 164 (holotype), 165 (paratype unfigured).

Range.—Templeton member.

Tovula teres Stephenson, n. sp.

Plate 43, figures 40, 41

This species is similar in size and form to *Tovula microlirae*, but it is a little more inflated and more evenly rounded, its spire is not quite so high, its suture is less deeply impressed, there is no suggestion of a shoulder, and microscopic spiral lirae appear to be wanting. The columella bears 2 folds, the lower one on the holotype being broken away. The growth markings are rather coarse and irregular, some of them suggestive of incipient axial ribs. On both available specimens the anterior part of the shell is broken away, so that the nature of the siphonal canal is not determinable.

Dimensions of the holotype: Height 13+ mm, diameter 8 mm.

Types.—Holotype, U.S.N.M. 105913; 1 unfigured paratype, U.S.N.M. 105914; both from a gully 250 feet north of a road, 0.65 mile south, 1 mile west of Star School, northeastern Grayson County.

Occurrence.—Grayson County: Loc. 170.

Range.—Templeton member.

Superfamily TOXOGLOSSA

Family CANCELLARIDAE

Genus CAVEOLA Stephenson, 1941

Type species: *Cancellaria acuta* Wade (1926, p. 108), from the Coon Creek tongue of the Ripley formation (Upper Cretaceous), on Cook Creek, McNairy County, Tenn. (Stephenson, 1941, p. 363.)

Caveola pinguis Stephenson, n. sp.

Plate 42, figures 6, 7

Shell small, plump, with spire of medium height. Spiral angle about 60°. Body whorl nearly twice as long as the height of the spire. Protoconch small, smooth, high-turbinata, partly worn in the available specimens, apparently coiled about 1½ times. Suture deeply impressed. Whorls 3 or 4, plumply rounded on the sides. Body whorl broadly rounded on the periphery, moderately long below, strongly constricted

at the base. Body whorl ornamented with about 20 spiral ribs, which are coarsest and flattish-topped on the inflated part, smaller on the base and smallest on the outer surface of the canal. Six of the spirals are exposed on the penultimate whorl. The axial ribs are numerous, small, narrow, closely spaced and are overriden by the relatively coarser spirals. Growth lines only slightly sinuous where they pass up over the main part of the body whorl but bend strongly forward as they approach the suture above. Two well-developed varices are present on the holotype, one bordering the outer lip and the other on the body whorl less than half-way back from the lip. Aperture broadly and unevenly lanceolate, obtusely angular at the rear, passing into an open, slightly twisted canal in front. Outer lip very broadly arched; the lip is somewhat worn and broken, but there are obscure markings on the inner surface, suggestive of crenulations. Inner lip moderately excavated above the midheight, forming a very thin callus on the parietal wall. Columella with 3 rather thick but nonprominent folds, the lowest one bordering the twisted canal.

Dimensions of the holotype: Height 7.1 mm, diameter 4.4 mm.

Compared with the genotype, *Caveola acuta* (Wade), this species is much smaller and has plumper whorls, a lower spire, proportionately thicker and fewer spirals, aperture proportionately longer, and the canal not so widely gaping. The pattern of ornamentation, the three folds on the columella, one bordering the canal, and the probable presence of crenulations on the inner surface of the outer lip, all suggest generic relationship with *Caveola*.

Holotype.—U.S.N.M. 105915; from a point near old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201.

Range.—Templeton member.

Caveola bellsana Stephenson, n. sp.

Plate 42, figures 26–28

In size, form, and the features of the aperture this species is similar to *Caveola pinguis*. It differs mainly in the nature of the spiral and axial ribbing of the whorls. On *C. pinguis* the spiral ribs on the upper parts of the whorls are narrow and are separated by interspaces of equal or greater width; on *C. bellsana* the corresponding ribs are relatively broad, and are separated by very narrow, threadlike striae. The axial ribs on *C. bellsana* though small and numerous are coarser than those on *C. pinguis*, and, as on the latter, an occasional axial is enlarged to form a varix. The features of the aperture appear to be essentially identical in the two species. The termini of two columnar folds appear somewhat obscurely from beneath the matrix that partly fills the opening of *C. bellsana*, and the siphonal canal is short, twisted, and wide open. The inner edge

of the outer lip is not sufficiently uncovered to show the presence or absence of dentations, but impressions on an exposed portion of the internal mold of the holotype indicate their presence at certain stages.

Dimensions of the holotype: Height 8.4 mm, diameter 4.6 mm.

Types.—Holotype, U.S.N.M. 105916; 1 figured paratype, U.S.N.M. 105917; 2 unfigured paratypes, U.S.N.M. 105918; all from a bluff on a tributary of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson County.

Occurrence.—Grayson County: Loc. 165.

Range.—Templeton member.

Genus *PALADMETE* Gardner, 1916

Type species: *Trichotropis cancellaria* Conrad (1858, p. 333) from the Owl Creek formation (Upper Cretaceous), on Owl Creek, Tippah County, Miss. (Gardner, 1916, p. 412). The specimen figured by Gardner is from the Ripley formation, 2.5 miles south of Dumas, Miss., and is therefore not from the type locality of Conrad's species.

Paladmete? *turbiformis* Stephenson, n. sp.

Plate 43, figures 30, 31

Shell small, with spire more than half of the height of the shell. Spiral angle about 40°. Protoconch rather high turbate, with 2½ or 3 turns, the smallest one apparently partly submerged. Suture deeply impressed. Whorls, exclusive of the protoconch, 2 or 3, plumply rounded. Shoulder narrow and obscure. Body whorl plumply rounded, descending steeply to a constricted base. About 18 short axial ribs present on the body whorl and the same number on the penultimate whorl; these are subnodose at the shoulder angle, die out quickly below, and become smaller above as they cross the shoulder to the suture; the axials are badly corroded or worn on the earlier whorls, and the outer limit of the protoconch is difficult to determine. On the body whorl are 15 to 18 narrow, weak spiral ribs with slightly wider interspaces; the spirals are coarsest on the upper part of the whorl and finer and more closely spaced on the basal slope below. Growth lines nearly direct as they pass up over the body whorl, but they bend forward as they approach the suture above. Aperture broadly subovate, obtusely subangular at the rear, rather sharply rounded in front. Outer lip thin, arched, with a slight asymmetry at the intersection of the shoulder angle. Inner lip broadly excavated at the base of the parietal wall and forming a thin wash of callus over the wall. Columella apparently smooth.

Dimensions of the holotype: Height 5 mm, diameter 3 mm. The incomplete paratype measures: Height 6+ mm, diameter 3.8+ mm.

This species differs from other described species of *Paladmete* in details of sculpture and in its higher spire. The two available specimens may be juvenile and are

inadequate for a satisfactory determination of their generic relationships.

Types.—Holotype, U.S.N.M. 105919; 1 paratype, unfigured, U.S.N.M. 105920; both from a branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin County, Tex.

Occurrence.—Fannin County: Loc. 183.

Range.—Lewisville member.

Paladmete? sp.

Plate 43, figure 33

An incomplete external mold from the Lewisville member, Grayson County (loc. 117), indicates a gastropod with spire of moderate height, plump body whorl and sculpture suggestive of that of *Paladmete* Gardner. The axial ribs are narrow and are separated by somewhat wider interspaces. The spiral ribs on the body whorl consist of 12 or more narrow primaries separated by much wider interspaces, in the bottom of each of which is a small secondary; the secondaries are obscure on the upper part of the whorl and distinct on the basal slope. A strong spiral ridge closely parallels the suture, and the narrow shoulder is slightly excavated, features that are wanting on the typical *Paladmete*. U.S.N.M. 105921.

Paladmete? sp.

Plate 43, figure 32

The imprint of one fragment in ferruginous sandstone of the Dexter member, 1.4 miles northeast of Handley, Tarrant County (loc. 11, coll. 18979), pertains to a gastropod, possibly a *Paladmete* Gardner, having pronounced axial and spiral sculpture. The axial ribs are sharp-crested and are narrower than the interspaces; they extend well down over the basal slope as they do in *Paladmete*. The primary spirals number 12 or more, are narrow, strong, widely separated, and override the axials; one narrow, small, secondary spiral is present in each of the interspaces between the primaries. The imprint is too incomplete to justify giving it a specific name. The strong, sharp sculpture is in contrast to the much weaker sculpture of the unnamed species from collection 18966 (loc. 117). The fragment measures about 9 mm in the direction of height. U.S.N.M. 105922.

Paladmete? sp.

Three small incomplete internal molds from the Lewisville member near Dorothy Siding, Tarrant County (loc. 50), have the general form of *Paladmete* Gardner but are inadequate for specific determination. Compared with *P.?* *turbiformis*, the suture is more deeply impressed, the whorls expand more rapidly, and the body whorl is more distinctly shouldered. Spiral and axial markings are faintly impressed on the molds. The diameter of the largest specimen is 4.3 mm. U.S.N.M. 105923.

Genus *CANCELLARIA* Lamarck, 1799

Type species: *Voluta reticulata* Linné, Recent, in the waters off Florida and the West Indies.

Cancellaria? sp.

Plate 43, figures 28, 29

One small, nearly complete shell, probably juvenile, from the Templeton member in a gully 300 feet north of a road, at a point 120 feet east of a T-road to the south, 0.65 mile south, 1 mile west, of Star School, north-eastern Grayson County (loc. 173), is questionably referred to *Cancellaria* Lamarck. Shell small, with spiral angle of 62°. Protoconch corroded but apparently low turbinate, coiled about 1½ times. Suture deeply impressed. Whorls 2, plumply rounded. Body whorl broadly rounded on the periphery and base, turning into the suture above to form a narrow, rounded shoulder. Axial ribs narrow, irregular, closely spaced; they bend forward on the shoulder and extend well down over the base below. Spiral ribs narrow, non-prominent, separated by narrower grooves numbering 16 or 17 on the body whorl; 5 or 6 spirals exposed on the sides of the penultimate whorl. Aperture elongated, of medium width, with posterior angle a little less than a right angle, and passing anteriorly into a short, wide-open, twisted siphonal canal. Outer lip broadly arched, with a faint obtuse subangulation at the shoulder intersection. Inner lip rather deeply concave, forming a thin wash of callus on the parietal wall. Columella twisted and bearing 3 folds, the middle and upper ones prominent and about equal, the lower one weak and closely bordering the siphonal canal. Dimensions: Height 4.5 mm, diameter 3 mm. U.S.N.M. 105924.

Cancellaria? sp.

Plate 43, figures 38, 39

An incomplete shell from the Templeton member 1.85 miles east of Sadler, Grayson County (loc. 167), appears to be closely allied to *Cancellaria* Lamarck. Shell of medium size with spiral angle of about 57°. Protoconch poorly preserved, apparently rather high-turbinate. Whorls 4, plumply rounded. Suture deeply impressed. Body whorl with greatest inflation above midheight, ending above in an ill-defined shoulder. Periphery and base evenly rounded. Axial ribs numerous, narrow, of medium prominence, nearly direct except on the shoulder where they bend toward the front; they end below at the periphery; two or more of the axials are enlarged to form varices. Spiral ribs narrow, nonprominent, overriding the axials, separated by equal or narrower interspaces; they number 18 or 19 on the body whorl. Aperture lanceolate, of medium width, acutely angular at the rear, passing into a twisted siphonal canal of medium width at the front. Outer lip broadly arched. Inner lip broadly

excavated. Columella bearing 3 well-developed folds, the lowest one bordering the siphonal canal.

Dimensions: Height about 11 mm, diameter 5.5+ mm. U.S.N.M. 105925.

Subclass EUTHYNEURA

Order OPISTHOBRANCHIA

Suborder TECTIBRANCHIATA

Family ACTEONIDAE

Genus *FICTOACTEON* Stephenson, n. gen.

Type species: *Fictoacteon saxanus* Stephenson.

Etymology: A feigned or fictitious *Acteon*.

In form and in the character of the spiral ornamentation this genus is essentially like the typical *Acteon tornatilis* Gmelin, a Recent species inhabiting European marine waters. It differs from that species in the apparent absence of a columellar fold; a fold if present must be well back from the aperture. On *A. tornatilis* a fold is a conspicuous feature, reaching the edge of the aperture low on the columella.

On several species included in *Acteon* by Wade (1926, pp. 101-103), a single columellar fold is in view from the aperture but does not reach the edge of the lip; this fold is higher on the columella than is the fold on *A. tornatilis*. On all of these except one, *Acteon conicus*, the sculpture is conspicuously punctate.

Fictoacteon saxanus Stephenson, n. sp.

Plate 43, figures 26, 27

Shell of medium size, lanceolate in profile, spiral angle about 55°. Protoconch not well preserved but apparently low-turbinate, smooth, coiled about twice; tip not clearly seen. Suture moderately impressed, closely appressed. Whorls 4, broadly convex on the side. Body whorl elongate, broadly rounded in profile from suture to base. Main surface of body whorl covered with 33 or more flat, low spiral ribs of differing width, much wider than the narrow, groovelike, feebly punctate interspaces; the second and third interspaces (second and fourth on the body whorl) below the suture are wider than those on the main surface, and the same is true of a group of 4 or 5 interspaces well down on the base; new interspaces may be added by intercalation as the shell increases in size; 10 spirals appear on the widest part of the exposed flank of the penultimate whorl and only 5 or 6 on the corresponding part of the antepenultimate whorl. The spirals tend to fade out on the earlier whorls. The trend of the growth lines is very gently convex toward the aperture. Aperture long, lanceolate, about seven-tenths the total height of the shell, sharply angular at the rear and narrowly rounded at the front. Outer lip thin and broadly curved. Inner lip broadly excavated below; parietal wall apparently devoid of callus; lower

part of lip bordered in front by a narrow, weak, umbilical fissure. The columella appears to be smooth; if a fold is present, it does not reach the aperture.

Dimensions of the holotype: Height 16.2 mm, diameter about 8 mm.

Compared with *Fictoaeteon imlayi*, this species has a more slender profile, with no suggestion of a shoulder, and the spiral ribs are broader and cover the surface more completely.

Type.—Holotype, U.S.N.M. 105926; from a branch, north of the old Keller road, 1.4 miles west of Grapevine, Tarrant County.

Occurrence.—Tarrant County: Loc. 49.

Range.—Lewisville member.

Fictoaeteon alveolanus Stephenson, n. sp.

Plate 43, figures 22, 23

Shell small, with low spire; apical angle 95°, decreasing to a spiral angle of about 83° on the larger whorls below. Height of spire about 0.25 the total height of the shell. Protoconch smooth-turbinate, coiled 1½ or 2 times. Suture narrowly channeled, moderately impressed. Whorls 4, evenly rounded on the side. Body whorl large, broadly rounded from suture to base, curving in a little more strongly to the suture above, but scarcely shouldered. Surface ornamented with numerous low, flat-topped ribs separated by incised punctate lines of irregular spacing both on the same and on different individuals. As growth proceeds new lines are added by intercalation between the more widely spaced ones. Aperture elongated, acutely angular at the rear, sharply rounded at the front. Outer lip broadly arched. Inner lip with little or no callus on the parietal wall and forming a thin, sharp-edged flange bordering a shallow umbilical fissure below. Columella apparently smooth.

Dimensions of the holotype: Height 11 mm, diameter 7.4 mm.

Types.—Holotype: U.S.N.M. 105927; 12 paratypes unfigured, U.S.N.M. 105928; all from a gully south of a barn, 0.5 mile south, 0.75 mile west of Star School, northeastern Grayson County.

Occurrence.—Grayson County: Locs. 165, 167, 171 (types).

Range.—Templeton member.

Fictoaeteon imlayi Stephenson, n. sp.

Plate 43, figures 24, 25

Shell of medium size, with a moderately plump body whorl and a spiral angle of about 65°. Protoconch not clearly preserved. Suture sharply and moderately impressed. Whorls 4, gently convex on the sides. Body whorl large, with aperture twice as long as the spire is high. A narrow, steep, poorly defined shoulder is limited below by a rounded, obtuse subangle, from which the surface rounds broadly down to the base. The shoulder is traversed a little above the center by a distinct spiral groove, which is paralleled above by 1

and below by 2 or 3 fine, incised lines; the groove can be traced well back toward the apex. A spiral band about 1.5 mm. wide, including the shoulder angle and a narrow area below it, is nearly smooth, presenting only a few more or less obscure lines. The rest of the body whorl below this smooth band is covered with numerous subued, flat-topped spiral ridges of irregular width, separated by incised lines of irregular width and depth. With the exception of the shoulder groove, the exposed portions of the penultimate and earlier whorls appear to be nearly smooth. The growth lines extend up over the body whorl, with only a broad, gentle convexity in trend toward the aperture. Aperture long and roughly lanceolate, with a sharply acute angle at the rear and with a sharply rounded, almost angular terminus in front. Outer lip thin and broadly curved. Inner lip deeply and rather broadly excavated low on the base; parietal wall without callus; lower part of lip bordered in front by a moderately pronounced umbilical fissure. The columella is slightly twisted and gives the impression of a low swell near the base, but no true fold can be seen and if present does not reach the aperture.

Compared with *Fictoaeteon saaxanus* this species has a lower spire, a plumper body, and the anterior margin of the aperture is more sharply rounded.

Dimensions of the holotype: Height 13.5 mm, diameter 7.8 mm.

Type.—Holotype, U.S.N.M. 105931; from a branch north of the Chicago, Rock Island & Pacific Railroad, 1 mile west of the Dallas County line, Tarrant County. Named in honor of Ralph W. Imlay, of the U. S. Geological Survey.

Occurrence.—Tarrant County: Loc. 44.

Range.—Lewisville member.

Fictoaeteon humilispira Stephenson, n. sp.

Plate 43, figures 20, 21

Shell small, with low spire and proportionately very large ovate body whorl; spiral angle about 110°. Height of spire less than one-fifth the total height of shell. Protoconch partly broken away in the holotype; apparently twisted and partly sunken at the tip on one of the paratypes. Suture slightly impressed, narrowly channeled. Whorls 3, very rapidly expanding. Body whorl with a narrow, unangulated shoulder, which passes in a regular, sharp curve into the surface below. Profile below the shoulder broadly curved to the anterior terminus of the shell. Surface of body whorl ornamented with numerous incised punctate lines that are somewhat unevenly spaced and that increase in number toward the aperture by the occasional intercalation of a new line between two of the older ones; these lines are of about equal strength except low on the base, where several of them are small and closely spaced; a maximum of 4 lines appears on the exposed part of the penultimate whorl. Aperture long and wide open, with an acute angle at the rear and a sharply rounded anterior

margin. Outer lip thin, broadly arched centrally, curving more sharply at each end. Inner lip without callus on the parietal wall, sinuous in profile, bulging convexly into the aperture above and rather deeply and evenly excavated below. Umbilical fissure moderately deep and gaping. Columellar fold, if present on the holotype, does not reach the aperture.

Dimensions of the holotype: Height 4.9 mm, diameter 3.6 mm. The largest shell referred to this species measures: Height 9.2 mm, diameter 7 mm.

Most of the paratypes are small and imperfectly preserved. Compared with *Fictoacteon imlayi*, *F. saxanus*, and *F. alveolanus*, the spire of this species is very low, a feature that might justify the erection of a new genus to contain it.

Types.—Holotype, U.S.N.M. 105932; 2 unfigured paratypes, U.S.N.M. 105933; 19 unfigured paratypes, U.S.N.M. 105934; all from a locality 2.8 miles east of Whitesboro, Grayson County.

Occurrence.—Grayson County: Loc. 154 (holotype and 21 unfigured paratypes), 160, 165, 170.

Range.—Templeton member.

Fictoacteon paucistriae Stephenson, n. sp.

Plate 43, figures 18, 19

Shell small, with low spire; spiral angle about 100°. Protoconch low-turbinate, coiled 1½ or 2 times. Suture moderately impressed, narrowly channeled. Whorls 3, rapidly expanding. Body whorl large, its height being about seven-tenths the total height of the shell. The body whorl presents a narrow sloping shoulder above, and rounds down broadly from the shoulder to the anterior terminus below. The body whorl of the holotype is ornamented with about 20 feebly and finely punctate, narrow, spiral striae of very uneven strength and spacing on its different parts; 5 striae on the shoulder form a closely spaced group, of which one below the suture is wider and deeper than the others; 7 on the inflated part of the shell are widely spaced; and the remaining 7 on the lower part of the base are more closely spaced. The spaces between the striae are smooth. On some shells the striae are weak to obscure, especially on the inflated area. Aperture elongate, of medium width, acutely angular at the rear, sharply rounded at the front. Outer lip broadly arched. Inner lip deeply excavated below the mid-height; callus is thin or wanting on the parietal wall. The columella is smooth and is bordered below by a narrow, shallow umbilical fissure.

Dimensions of the holotype: Height 8.3 mm, diameter 6.5 mm.

This species has fewer and more widely spaced spiral striae than any of the other species here described and a lower spire than all except *F. humilispira*. The holotype is gracefully ornamented with patterns of secondary dendritic manganese.

Types.—Holotype, U.S.N.M. 105929; 9 unfigured paratypes, U.S.N.M. 105930; all from a gully south of a barn, 0.5 mile

south, 0.75 mile west of Star School, northeastern Grayson County.

Occurrence.—Grayson County: Locs. 170, 171 (types).

Range.—Templeton member.

Fictoacteon? sp.

One small, worn specimen is similar in form to *Fictoacteon* but is badly corroded and appears to have a fairly well-developed fold low on the columella. The only evidence of spiral sculpture is afforded by a few very obscure lines. This specimen came from the Templeton member on an east-west road at the head of a northward-flowing branch of Iron Ore Creek, 3 miles northeast of Sherman Junction, Grayson County (loc. 160). U.S.N.M. 105935.

Genus *ACTEONELLA* D'Orbigny, 1843

Type species: *Acteonella laevis* (Sowerby) = *Volvaria laevis* Sowerby, from the Cretaceous at Gosau, Austria. (D'Orbigny, 1842-1843, tome 2, p. 107.)

Acteonella? sp.

One small imperfectly preserved internal mold in a limonitic concretion in the Dexter member, at a locality 1.7 miles south by west of Bartonville, 4.1 miles east-southeast of Smoots, Denton County (loc. 59), is questionably referred to *Acteonella* D'Orbigny. The spire is low and the body whorl long and subcylindrical. Although the external mold is not available, the rather strong growth lines are impressed upon the internal mold; no trace of spiral sculpture can be seen associated with the growth lines. The aperture is elongated, acutely angular at the rear, widening anteriorly, and sharply rounded at the anterior margin.

Dimensions: Height 10 mm, diameter about 6 mm. U.S.N.M. 105936.

Genus *PIRSILA* Stephenson, n. gen.

Type species: *Pirsila tensa* Stephenson.

Etymology: By anagram from the Latin *liparis*, a sea snail. Gender, feminine.

In form and in apertural features this new genus agrees essentially with *Acteon* Monfort, but the shell is smooth, all four of the species referred to it being devoid of spiral lirae. The true *Acteons* possess spiral lirae. A well-developed, strongly twisted fold is present near the base of the columella on all the shells. The protoconch, as seen incompletely preserved on some of the shells, is smooth and simple except that the tip appears to dip inward and downward; the junction of the protoconch with the beginning of the main shell is not easily distinguishable on the available specimens.

Pirsila tensa Stephenson, n. sp.

Plate 43, figures 1, 2

Shell small, with spire of medium slenderness. Spiral angle about 26° on the larger whorls of adults, increas-

ing to about 35° near the apex. Protoconch small, smooth, turbinata, coiled about 1½ times, apparently twisted inward at the tip. Whorls 5 in the holotype, gently convex on the sides, fullest above midheight. Suture closely appressed, moderately impressed, occupying a depression widely obtuse in cross section. Body whorl noticeably flattened on the side. Periphery broadly rounded, steepening low on the base. Aperture narrowly subovate, acutely angular at the rear, narrowly rounded at the front. Outer lip very broadly arched. Inner lip forming a thin callus over the parietal wall, thickening to a strong inwardly curving fold just below the parietal wall. Umbilical fissure small, nearly closed.

Dimensions of the holotype: Height with protoconch missing 11.8 mm, diameter 5.7 mm.

This species differs from *Pirsila simpla* in having a more elevated spire and sharper apical terminus. Allowance is made for some variation in form among the shells assigned to this species.

Types.—Holotype, U.S.N.M. 105937; 1 unfigured paratype, U.S.N.M. 105938; both from a branch, north of the Chicago, Rock Island and Pacific Railroad, 1 mile west of the Dallas County line, in Tarrant County.

Occurrence.—Tarrant County: Locs. 35, 44, (types); Denton County: loc. 76; Fannin County: locs. 179, 183.

Range.—Lewisville member.

***Pirsila simpla* Stephenson, n. sp.**

Plate 43, figures 3-5

Shell rather small, with spire of medium height. Spiral angle about 40°. Protoconch not well preserved. Whorls 5 in the holotype, gently convex on the sides. Suture closely appressed, moderately impressed. Body whorl broadly and regularly convex from suture above to base below. Aperture narrowly subovate, acutely angular at the rear, sharply rounded in front. Outer lip broadly arched. Inner lip forming a thin callus on the parietal wall, becoming thick below, with the upper end of the thickened portion turning sharply inward to form a pronounced fold. Umbilical fissure narrow.

Dimensions of the holotype: Height 12 mm, diameter 6 mm.

The spire of this species is intermediate in height between that of *Pirsila tensa* and *P. decora*.

Types.—Holotype, U.S.N.M. 105939; from the Lewisville member in a borrow pit, south of the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant County. One figured paratype, U.S.N.M. 105940.

Occurrence.—Tarrant County: Loc. 50 (holotype); Grayson County: locs. 160 (paratype), 171.

Range.—Lewisville member to Templeton member.

***Pirsila decora* Stephenson, n. sp.**

Plate 43, figures 9-11

Shell, small, with spire intermediate in height between that of *Pirsila simpla* and *P. obtusa*. Spiral

angle about 40°, widening to about 60° at the apex. Protoconch rather low-turbinata, tip broken away. Suture closely appressed, moderately impressed. Whorls 3 or 4. Surface smooth. Periphery and base broadly rounded. Aperture elongate, acutely angular at the rear, narrowly rounded in front. Outer lip broadly arched. Inner lip broadly excavated, forming a thin callus over the parietal wall. Margin below thickened and bent inward, becoming cemented against the parietal wall. Columella with 1 rather small fold. Umbilical fissure small.

Dimensions of the holotype: Height 10.2 mm, diameter 5.3 mm.

A broken surface on the side of the body whorl of the paratype reveals the imprints of about 9 narrow, internal spiral ribs. It would seem that this ribbing should be a generic character present on all the shells referred to the genus, but this is the only available shell revealing the internal characters of the body whorl.

In this species the apex of the spire is less blunt than that of *Pirsila obtusa*.

Types.—Holotype, U.S.N.M. 105941; from the Lewisville member on Timber Creek, 3 miles west by south of Lewisville, Denton County. One figured paratype, U.S.N.M. 105942.

Occurrence.—Denton County: Locs. 73 (holotype), 76 (paratype, unfigured); Grayson County: loc. 170.

Range.—Lewisville member to Templeton member.

***Pirsila obtusa* Stephenson, n. sp.**

Plate 43, figures 16, 17

Shell larger than the other species here described, bluntly terminated at the apical end. Protoconch small, smooth, tilted in a little at the tip. Whorls 5. Spiral angle on the whorls near the apex about 70°, decreasing to about 40° on the large whorls below. The earliest whorls expand rapidly. Suture closely appressed, occupying a depression, the lower limb of which is steep, facing upward, and the upper limb gently inclined downward. Surface smooth with the exception of growth lines. Periphery and base of body whorl very broadly rounded. Growth lines nearly vertical in trend, with, however, a very gentle convexity toward the aperture. Aperture elongate, acutely angular at the rear, rather sharply rounded at the front. Outer lip broadly arched. Inner lip broadly excavated, forming a thin callus over the parietal wall. Columella with a strong fold below, separated from the parietal wall by a narrow channel. Umbilical fissure nearly closed. Only the holotype and one other poorly preserved example are available.

Dimensions of the holotype: Height 18.5 mm, diameter about 10 mm.

Types.—Holotype, U.S.N.M. 105943; one unfigured paratype, an incomplete internal mold, U.S.N.M. 105944; both from near Old Slate Shoals, Red River, 8 miles east of Arthur City, Lamar County.

Occurrence.—Lamar County: Loc. 201 (holotype and paratype).

Range.—Templeton member.

Unidentified species of *Pirsila*

One small, partly corroded, apparently smooth shell, from the Lewisville member, near the Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line in Tarrant County (loc. 46), appears to be a *Pirsila*. The aperture is a little longer than the height of the spire, and the columellar fold is weakly developed. The shell is about 3.8 mm high. U.S.N.M. 105945.

A somewhat larger, incomplete shell from the Templeton member, 3.3 miles N. 16° W. of Bells, Grayson County (loc. 165), may belong to the same species as the preceding. It measures: Height 5+ mm, diameter 3.4 mm. U.S.N.M. 105946.

The spires of young shells from the Lewisville member, on Sheep Creek, Fannin County (loc. 184, coll. 18256), U.S.N.M., 105947 (figured), and 2 miles S. 50° W. of Ambrose, Grayson County (loc. 135), U.S.N.M. 105948, appear to be proportionately too low for either *Pirsila tensa* or *P. simpla* and too high for *P. decora*. The species appears to be an intermediate form between the two latter species. It possesses the characteristic columellar fold of the genus. The figured specimen (pl. 43, figs. 12, 13) measures: Height: 3.5 mm, thickness 2 mm.

Family RINGICULIDAE

Genus RINGICULA Deshayes, 1838

Type species: *Auricula ringens* Lamarck, from the Eocene of the Paris Basin.

***Ringicula arlingtonensis* Stephenson, n. sp.**

Plate 43, figures 6-8

Shell small, with a low acute spire. Spiral angle about 62° in the holotype, but this angle is variable, being as much as 70° on some individuals. Protoconch small, smooth, high-turbinate. Suture sharply, but not deeply, impressed. Whorls 3 or 4, rapidly expanding, flattish to gently convex on the side. Body whorl proportionately large, plumply rounded in profile, becoming steep on the lower base, smooth with the exception of 2 to 3 lightly impressed, fine spiral grooves on the lower half of the surface; where present, the lower 3 to 5 of these grooves are very small and closely spaced. Aperture subcrescentic, acutely angular at the rear, with the anal canal extending up across the penultimate whorl to the next suture above in front of the extended thickened lip; the anterior end of the aperture is sharply rounded, with a short, narrow siphonal canal or notch at the left, curving back under the anterior columellar fold. Outer lip thin in the young stages, thickening in the adult to a prominent varixlike ridge,

which is striated with growth lines and which is produced above across the penultimate whorl. The ridge serves as a base for the anal canal, which traverses its front side. Inner surface of shell near the outer lip feebly crenulated. Inner lip forming a heavy and irregular callus and bearing 3 prominent, narrow folds, the uppermost one on the parietal wall. The lower fold borders the siphonal canal, forming its upper bounding wall; the middle fold is the largest and most prominent of the three; and the upper fold is the least prominent. The three folds are separated by deep, moderately wide channels. Above the third fold the callus extends as a more or less irregular mass to the outer edge of the anal canal. The callus is loosely attached to the parietal wall and is easily damaged or peeled off in the process of removing the shell from its matrix.

Dimensions of the holotype: Height 5.5 mm, diameter 3.7 mm.

This species is distinguished from most other species of *Ringicula* from higher positions in the Upper Cretaceous of the Atlantic and Gulf Coastal Plain by the paucity of its spiral ornamentation; *R. clarki* Gardner, from the Monmouth formation of Maryland (1916, p. 400), is feebly sculptured, but it is much larger and differs in the details of its apertural features.

Types.—Holotype, U.S.N.M. 105949; 1 figured paratype, U.S.N.M. 105950; 8 unfigured paratypes, U.S.N.M. 105951; all from the Lewisville member on Johnson Creek, 2 miles northeast of Arlington, Tarrant County.

Occurrence.—Tarrant County: Locs. 34 (types), 46; Grayson County: locs. 162, 164, 165, 167.

Range.—Lewisville member to Templeton member.

Family ACTEOCINIDAE

Genus CYLICHNA Lovén, 1846

Type species: *Bulla cylindracea* Pennant, Recent, seas of Europe.

***Cylichna?* sp.**

The genus *Cylichna* Lovén is questionably represented by one small, incomplete specimen from the Templeton member, 2.8 miles east of Whitesboro, Grayson County (loc. 154, coll. 14092). The shell is involute, subcylindrical, the sides converging slightly from below upward and the apex somewhat submerged. The surface is covered with very fine, almost obscure, revolving lines, and short, very fine axial lines are present on the upper part of the whorl. Presence of columellar fold not determined. Dimensions: Height 3+ mm, diameter about 1.9 mm. U.S.N.M. 105952.

Order PULMONATA

Suborder BASOMMATOPHORA

Family AURICULIDAE

Genus RHYTIPHORUS Meek, 1877

Type species: *Melampus priscus* Meek, from the brackish-water carbonaceous beds at the mouth of Sulphur Creek on Bear

River, southwestern Wyoming. (Meek, 1877, p. 175.) The beds exposed at this place are in the Bear River formation (basal Upper Cretaceous) near its type locality.

Rhytiphorus? sp.

Plate 43, figures 14, 15

Four incomplete, very imperfect ferruginous internal molds, probably referable to *Rhytiphorus* Meek, were obtained from the Dexter member, 2.4 miles west by north of Retta, Tarrant County (loc. 12). The spire is low and the body whorl is long, approaching cone-shape, the sides, however, being very broadly rounded in profile.

One of the molds furnishes fairly satisfactory evidence of the presence of a basal columellar fold, but no sign of a weaker fold higher up on the columella can be detected. Axial folds such as are present on the upper part of the body whorl of Meek's species *Rhytiphorus priscus* are not reflected on these internal molds. The best-preserved specimen measures: Height 19+ mm, diameter 10+ mm. The largest specimen is more than 18 mm in diameter. U.S.N.M. 105954; one figured example, U.S.N.M. 105953.

Class CEPHALOPODA

Subclass TETRABRANCHIATA

Order AMMONOIDEA

Suborder EXTRASIPHONATA

Family HAMITIDAE

Genus HAMITES Parkinson, 1811

Type species: *Hamites attenuatus* Sowerby, from the lower Gault (Albian) of the Paris Basin, France.

Hamites? sp.

One small fragment of a *Hamites*-like form was found in the Templeton member in dark shale in gullies south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson County (loc. 154, coll. 14560). It is a somewhat compressed, nearly straight conch measuring: Length 7 mm, short diameter 2.8 mm, long diameter 4 mm. In a linear distance of 5 mm it bears 8 narrow, sharply raised ribs of uniform size and spacing; the ribs, which presumably passed completely around the conch, are broken away along one edge. U.S.N.M. 105955.

Family TURRILITIDAE

Genus TURRILITES Lamarck, 1801, *sensu lato*

Type species: *Turrillites costatus* Lamarck, from the upper Cenomanian, Mountain of Sainte Catherine, near Rouen, France. (Lamarck, 1801, p. 102.)

Turrillites dearingi Stephenson, n. sp.

Plate 44, figures 6-8

Shell small for the genus, spirally coiled, sinistral, spiral angle about 21°. Coils closely appressed with the line of contact deeply impressed. Sides of volu-

tions rather strongly convex. Sides ornamented with three rows of prominent conical nodes. On the larger volutions the nodes in each row number 16 to 18, the successive nodes in the 3 rows being alined with each other upward and obliquely forward. The nodes in the lowest row are the smallest and crowd the line of contact with the volution below. The nodes in the upper row which lies a little above the middle of the volution and parallels the upper line of contact are the largest; some of the nodes in this row show a slight tendency to vertical elongation. The slope between the upper row of nodes and the line of contact above is smooth and steep. The base of the spire is flat or very broadly excavated. The sutures are too obscurely preserved for description.

Dimensions of the holotype: Height of the incomplete spire 55+ mm, greatest diameter of spire about 30 mm. The incomplete paratype measures: Height 74+ mm, greatest diameter 35 mm.

Compared with *Turrillites bosquensis* Adkins (1920a, p. 76, pl. 3, fig. 5), from the Grayson marl (Del Rio) in McLennan County, Tex., the spire of this species is more slender, the volutions bear 3 instead of 4 rows of nodes, and the nodes are more prominent and more numerous.

Types.—Holotype, U.S.N.M. 105956; 1 paratype in the private collection of James P. Conlin, his specimen No. 4134 (plastotype, U.S.N.M. 105957); both from a small tributary of Big Bear Creek, 1.5 miles east of Euless, 0.2 mile north of State Highway 183, Tarrant County (Conlin's orig. loc. no. T-10-Kwb). The holotype was donated to the U. S. National Museum by Mr. Conlin.

Occurrence.—Tarrant County: Loc. 55 (holotype). One paratype from same locality in Conlin's private collection at Fort Worth, Tex.

Range.—Lewisville member.

Family DESMOCERATIDAE

Genus DESMOCERAS Zittel, 1884

Type species: *Ammonites latidorsatus* Michelin, from the lower Gault (Albian) of France. (Zittel, 1884, p. 465.)

Questionably identified specimens of *Desmoceras*

Two small internal molds from the Templeton member in gullies south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson County (loc. 154, colls. 14092, 14560 (figured)), are questionably referred to the genus *Desmoceras*. Part of the living chamber of the larger specimen (pl. 45, figs. 1, 2) is represented in a crushed and broken condition. The shell is smooth, having neither nodes nor ribs. The maximum radius, center to venter, is 6.3 mm and the corresponding transverse diameter of the volution about 5 mm. The venter is rounded and the flanks slightly flattened, converging slightly inward. The shell is involute and the umbilicus narrow and deep. The ventral lobe is about as broad as deep, has 1 moderately strong digitation on each side, and terminates rearward in 2 short prongs

separated by a broad, short ventral saddle with a broad, shallow anterior concavity. The superior lateral saddle is rather narrow, bipartite, and is moderately broken by small digitations; the first lateral lobe is broader than the superior saddle and terminates with tripartite digitations; the remaining 5 saddles and lobes to the line of involution are much smaller, becoming increasingly simple, those on the steep umbilical slope being very small and entire. U.S.N.M. 105958 and 105959.

A fragment of a young, smooth, plump shell (pl. 45, figs. 3, 4), having sutures similar to those of the preceding species and referred questionably to *Desmoceras*, was found in the Templeton member at Golden Bluff on Red River, 3 miles east of Arthur City, Lamar County (loc. 203). The shell is involute and the umbilicus deep. The maximum dorsoventral diameter as preserved is 3.5 mm, and the corresponding transverse diameter is 6.2 mm. The venter is very broadly rounded and the conch rapidly expanding; the flanks are slightly flattened and converge inward. The ventral lobe is broad, a little longer than wide, has 2 or 3 digitations on the side, and terminates in 2 digitations that are separated by a broad, short, weakly tripartite saddle. The superior lateral saddle is narrower than the ventral lobe, is bipartite, and moderately digitate; the first lateral lobe is about as broad and deep as the ventral lobe and ends in tripartite digitations. The 5 additional saddles and separating lobes to the line of involution are much smaller and become increasingly simple, the last 4 saddles being entire. U.S.N.M. 105960.

Family "HOPLITIDAE" (Hoplites preoccupied)

Genus EUHOPLITES Spath, 1925

Type species: *Euhoplites truncatus* Spath, from the middle Albian of England. (Spath, 1925, pt. 2, p. 82; 1928; pt. 6, pp. 257-261; 1930, pt. 7, pl. 25, figs. 1-4.)

Euhoplites? sp.

Plate 45, figures 5, 6

A fragment of the living chamber of a small ammonite, from the Lewisville member, on Timber Creek about 2.25 miles south-southwest of Lewisville, Denton County (loc. 81, coll. 19501), appears to belong to a smooth species in the hoplitid group. It has nearly flat flanks, diverging only slightly inward from the relatively broad venter, which is rounded on the edges and is traversed centrally by a rather broad, shallow depression. The growth lines are strongly sigmoidal on the flanks and swing well forward on the venter. The width of the venter increases from about 4.5 mm to 5.5 mm in a distance of 17 mm. The transverse dimension of the shell midway of the flank is about 6.3 mm. U.S.N.M. 105961.

Family ACANTHOCERATIDAE

Genus ACANTHOCERAS Neumayr, 1875, sensu lato

Type species: *Ammonites rhotomagensis* DeFrance (in Brongniart), from the upper Cenomanian, Rouen, France. (Neumayr, 1875, p. 929.)

The species here referred to *Acanthoceras* Neumayr have straight or only slightly curved, rather widely separated, radial ribs generally alternating in size, two pairs of ventrolateral tubercles on each rib, and a median row of subdued tubercles present on the venter of younger stages, but dying out on later stages. On different species the nodes of the ventral pairs may differ in strength of development. On some the outer node of each pair, and on others the inner node, is the stronger, or one node of each pair may be so reduced as to be practically wanting. The ribs that reach the shoulder of the umbilicus are generally longitudinally raised at their inner ends. In cross section the volutions are subquadrate in the early and medial stages of individual growth but may become subovate to subcircular in the later stages. In degree of coiling a given volution may enclose one-fourth to one-half of the preceding volution.

Adkins (1928, p. 241) described the species *Metacalycoceras? tarrantense*, but there appears to be no essential generic difference between this species and the one he named *Acanthoceras wintoni* (1928, p. 243). *Metacalycoceras* Spath (1926b, p. 83) is based on a specimen figured by D'Orbigny (1840-1841, tome 1, pp. 340-345, in part, pl. 103) under the name *Ammonites mantelli* Sowerby (not *Ammonites navicularis*, as stated by Spath), which, at the stage figured, is plumply rounded in the cross section of the volution and lacks tubercles on the venter. Because *Acanthoceras tarrantense* is subquadrate in cross section and possesses 5 rows of ventral nodes, the reason for assigning it even tentatively to *Metacalycoceras* is not apparent.

Acanthoceras tarrantense (Adkins)

Plate 45, figures 9, 10; plate 46, figures 2-4

- ?1926. *Acanthoceras rotomagense* (DeFrance). Scott, Am. Assoc. Petroleum Geologists Bull., vol. 10, no. 6, pl. 22, fig. 1 only (opp. p. 617); no text description. (Fig. 2 is not identifiable from the illustration alone.)
1928. *Metacalycoceras? tarrantense* Adkins, Texas Univ. Bull. 2838, p. 241, pl. 28, fig. 3; pl. 29, fig. 1.
- ?1942. *Acanthoceras inaequiplicatum* (Shumard). Moreman, Jour. Paleontology, vol. 16, no. 2, p. 201, pl. 32, fig. 2. (Not Shumard.)
1951. *Acanthoceras tarrantense* (Adkins). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, fig. 2 (following p. 163).

Shell large, moderately plump, involute, each volution enclosing about one-third of the preceding volution. The venter is truncated. The cross sections of the volutions are subquadrate in the early and medial

stages but tend to become subovate to subcircular in adults. At a shell diameter of 50 mm a volution may bear as few as 15 radial ribs, but the number may increase to as many as 23 in large adults. The ribs are straight or only slightly curved and tend to alternate in size, those that reach the umbilical shoulder being raised toward their inner ends to form a moderately prominent, radially elongated tubercle; the ribs cross the venter as a gentle swell. A peculiarity of the shell is that a rib that is prominent at the umbilical shoulder on one flank, may become the intermediate nonprominent rib on the opposite flank. In the young and medial stages each rib bears 5 ventral tubercles, one at the center of the venter and a pair on each ventral angle; the former is subdued and becomes weaker from the earlier to the later stages, disappearing at a shell diameter of something less than 100 mm; in each pair of tubercles the one nearest the venter is prominent and slightly elongated, and the other one is subconical and somewhat less prominent; both become progressively more subdued in the later stages, but one or both are recognizable at the largest size attained by the shell. The ribs increase in size with increase in age and on the body whorl of large adults are quite prominent and cross the venter with as much strength as on the sides.

The ventral lobe of the suture is elongate, rather finely and irregularly digitate on the sides, and terminates in two long parallel lobules, separated by a proportionately small ventral saddle; this saddle is about two-fifths as high as the lobe is deep and its termination is squarish and trifid, the separating indentations being shallow. The first lateral saddle is broad, slightly asymmetrical, and nearly as high as the ventral lobe is deep; it is bipartite, the separating sublobe extending about halfway to the base; each subsaddle is divided by 3 or 4 short lobules. The first lateral lobe is much smaller than the ventral lobe, is a little deeper than wide, and is rendered tripartite by lobules of medium length. The second lateral saddle is much smaller than the first lateral lobe and is bipartite. The second lateral lobe is still smaller and is near the umbilical shoulder. The third lateral saddle and the third lateral lobe are progressively still smaller and are on the umbilical slope; these inner lobes and saddles are not very clearly preserved in the available material.

Dimensions of a half-grown plesiotype (pl. 46, figs. 3, 4): Maximum diameter 108 mm, maximum radius from center to venter 70 mm; maximum dorsoventral diameter 45 mm and corresponding transverse diameter 52 mm (approximate). Adult shells attain a diameter of 200 mm or more.

Compared with *Acanthoceras wintoni* Adkins, the volutions in the younger stages of this species are much plumper, the pairs of ventral tubercles are more strongly developed and more nearly equal in size, and the tubercle of each pair nearest the venter is less elon-

gated parallel to the venter. In other features the two species appear to be essentially alike, with the exception of certain minor differences, as for example in the details of the pattern of the suture. In the later stages of the adult shells, in which the nodes have practically disappeared and the cross section of the volution has become more rounded, it is scarcely possible to distinguish the two species, at least with the poorly preserved material available.

Moreman (1942, p. 201, pl. 32, fig. 2) considered the specimen figured by Scott under the name *Acanthoceras rotomagense* (Defrance) to be the same as the one from "Garnets [Garretts?] Bluff, on Red River, Fannin County" that Shumard (1860b, p. 591) described under the name *Ammonites inaequipliatus*. Garretts Bluff is on Red River, 12 miles west of Arthur City, in the present Lamar County. Shumard records 25 to 28 ribs to the volution, whereas most of the available specimens of *Acanthoceras tarrantense* have fewer than 20 ribs and none has more than 23 ribs. Scott's figured specimen has only 18 or 19 ribs. Shumard indicates only 2 ventral nodes, one on each shoulder, but the present species has 5 including a medial one; his description of the rib spacing does not tally with that of *A. tarrantense*, on which the spaces are all wider than the ribs; his description of the suture pattern does not seem to apply to that of *A. tarrantense*, but the terms used are difficult to interpret. In view of these discrepancies, Moreman was not justified in setting up Scott's figured specimen as the neotype of *Ammonites inaequipliatus*.

The available material of the present species in the U. S. National Museum includes about 30 specimens, small and large, mostly in a poor to very poor state of preservation, owing to corrosion and compression; all came from the type locality or points near it and may be considered topotypes. A few of the smaller specimens show the features of the shell fairly well preserved, the half-grown shell shown in the illustration being one of the best, but the last volution of all the larger shells, is more or less corroded and distorted. The progressive increase in the size of the ribs is well shown on many of the large shells.

Types.—Holotype, collection of the Bureau of Economic Geology, Austin, Tex., no. 2424, recorded as from "2 miles [not more than 1.5 miles] east of Tarrant Station, Tarrant County." Plesiotype, U.S.N.M. 105962.

Occurrence.—Tarrant County: Locs. 38 (includes plesiotype), 39, 42, 44, 50, 215a; the holotype as stated above.

Range.—Lewisville member.

Acanthoceras tarrantense nitidum Stephenson, n. var.

Plate 50, figures 5, 6

This varietal form is represented by two incomplete individuals that resemble *Acanthoceras tarrantense* in form, type of ornamentation, and suture pattern. They differ from the typical *A. tarrantense* in that the cross

section of the volution is more plumply rounded, especially in the early and medial stages, the ribs and nodes are smaller and less prominent, and the venter rounds off at an earlier stage. Most of the body chamber is represented on the holotype by the internal mold, only a minor anterior portion of which is broken away. On the body chamber the ribs are prominent and cross the venter without diminution in strength. The dimensions of the holotype are: Maximum diameter as preserved 167 mm; maximum measurable radius, center to dorsum, 102 mm; maximum dorsoventral diameter of volution about 65 mm and corresponding transverse diameter about 68 mm.

Types.—Holotype, U.S.N.M. 105964; from 9 miles north of Arlington (probably within 3 miles of Euless), Tarrant County. One paratype, unfigured, U.S.N.M. 105965.

Occurrence.—Tarrant County: Loc. 36 (holotype); Denton County: loc. 92 (paratype, unfigured).

Range.—Lewisville member.

Acanthoceras wintoni Adkins

Plate 45, figures 7, 8; plate 46, figure 1; plate 47, figures 1, 2

1893. *Buchiceras inaequiplacatus* Shumard (probably in part). Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 233. (Not *Ammonites inaequiplacatus* Shumard.)

?1926. *Acanthoceras rotomagense* (Defrance). Scott (probably in part), Am. Assoc. Petroleum Geologists Bull., vol. 10, no. 6, p. 617 (no description), pl. 22, fig. 2 (?).

1927. *Acanthoceras* aff. *rotomagense* (Defrance). Moreman, Jour. Paleontology, vol. 1, no. 1, p. 92, pl. 13, fig. 1.

1928. *Acanthoceras wintoni* Adkins, Texas Univ. Bull. 2838, p. 243, pl. 25, figs. 2, 3.

1942. *Acanthoceras wintoni* Adkins. Moreman, Jour. Paleontology, vol. 16, no. 2, p. 202.

1951. *Acanthoceras wintoni* Adkins. Adkins and Lozo, Fossils Science Series 4 (Dallas), pl. 2, fig. 1 (following p. 163).

Shell large, involute, somewhat compressed laterally in the young and medial stages, becoming individually variable in the cross section of the adult shells, which appear to range from plump to compressed; however, all of the larger shells have suffered mechanical pressure, which may have either increased or decreased the apparent plumpness of the last volution. Each volution encloses half or less than half of the preceding volution. The venter is truncated, and the sides are broadly convex. The ribs are radial, straight, or slightly curved, tend to alternate in size, cross the venter as gentle swells, and range in number from 15 to 20 on different individuals. The holotype bears 19 or 20 ribs and the plesiotype 18 ribs. Most of the ribs that reach the edge of the umbilical slope bear a radially elongated tubercle at the inner end. The ribs increase in prominence on the later stages of growth and on large shells cross the venter in strength equal to that on the flanks. As in *Acanthoceras tarrantense*, a prominent rib on one flank may or may not become a nonprominent one as it passes over onto the other flank. On the young and medial stages each rib bears 5 ventral tuber-

cles, a medial one and a pair on each ventral angle. The medial one is comparatively weak and becomes progressively weaker and finally disappears on large adult shells. In each pair, the tubercle nearest the center of the venter is prominent and strikingly elongated transversely to the rib; it becomes weaker in the later stages but remains recognizable to the aperture of the largest shells. The other tubercle of the pair is nonprominent, conical, or only slightly elongated transversely and becomes progressively weaker toward the aperture, generally fading out at a shell diameter of 100 mm or less. The suture appears to be essentially like that of *Acanthoceras tarrantense*.

Dimensions of the holotype: Diameter 108 mm; maximum measurable radius from center to venter 65 mm; dorsoventral diameter about 45 mm; corresponding transverse diameter about 48 mm. Dimensions of the plesiotype, which is nearly half-grown and whose body chamber is partly broken away: Diameter 92+ mm; maximum measurable radius from center of umbilicus to venter 54 mm; dorsoventral diameter 36 mm; corresponding transverse diameter 38 mm. Fragments of large shells indicate that adults may attain a diameter of 200 mm or more.

This species is readily distinguishable from *Acanthoceras tarrantense* by the greater compression of its flanks, by the greater elongation of its shoulder node nearest the center of the venter, and by the weaker development of the node farthest from the center. In the later stages of adult shells the two species can scarcely be told apart. The two species are associated together at the type locality and at other localities nearby.

Types.—Holotype, collection of the Bureau of Economic Geology, Austin, Tex., no. 2426, recorded as from [Big] Bear Creek, 3 miles northeast of Tarrant Station, Tarrant County, near the Dallas County line (see plastotype, U.S.N.M. 105967); another specimen from Big Bear Creek in the Bureau collection, labelled *Buchiceras inaequiplacatus*, Shumard (orig. no. 51) collected by S. Leverett in 1892, may be considered a topotype. Plesiotype, U.S.N.M. 105966.

Occurrence.—Tarrant County: Locs. 36, 38, 39, 40 (includes plesiotype), 41, 42, 44, 46, 48, 52, 215; the holotype and topotype in the Texas Bureau of Economic Geology, from Big Bear Creek near Dallas County line. Denton County: Locs. 786, 92.

Range.—Lewisville member.

Acanthoceras adkinsi Stephenson, n. sp.

Plate 47, figures 3, 4

Shell of medium size (the holotype is preserved in the form of an internal mold), with living chamber missing; adults probably attain fairly large size. A given volution encloses less than one-half of the preceding volution. Sides compressed, broadly convex in profile. Venter truncated, of moderate width. The ribs are of weak to medium strength, are narrower than the interspaces, and number 23 at a shell diameter of 83 mm; they are radial, straight to slightly curved, and tend to alternate in size; some of the ribs that reach

the umbilical shoulder are slightly raised radially toward their inner ends, but this is not a conspicuous feature; the ribs cross the venter as fairly pronounced swells. Each rib bears 5 ventral nodes, a medial weak one and a pair on each ventral angle; in each pair the node nearest the center is strong and conical or only slightly elongated; the more distant node of the pair is weak; the latter node and the medial node grow progressively weaker on ribs successively nearer the aperture. The suture is not very clearly preserved, but its pattern appears to be essentially like that of *Acanthoceras tarrantense* and *A. wintoni*; it may, however, be a little more finely digitate.

Dimensions of the holotype: Diameter 83 mm; maximum radius from center to venter 50 mm; maximum dorsoventral diameter as preserved about 34 mm; corresponding transverse diameter about 34 mm.

In form this species is similar to *Acanthoceras wintoni*, but the ribs and nodes are more numerous and more weakly developed, and the node nearest the medial line of the venter in each pair of ventral nodes is conical or only slightly elongated transverse to the rib.

Types.—Holotype, U.S.N.M. 105968; 1 paratype, unfigured, U.S.N.M. 105969; both from a branch north of Chicago, Rock Island and Pacific Railroad, 1 mile west of Dallas County line, in Tarrant County. Honoring W. S. Adkins.

Occurrence.—Tarrant County: Loc. 44 (holotype and paratype).

Range.—Lewisville member.

Acanthoceras? eulessanum Stephenson, n. sp.

Plate 47, figure 5; plate 48, figures 3, 4

Shell large, inflated, moderately involute, each volution enclosing about one-fourth of the preceding volution; living chamber broken away. Venter truncated. Cross section of volution subquadrate. At a shell diameter of 125 mm, a volution bears 14 straight or only slightly curved, rather prominent distant ribs; in the early stages the ribs tend to alternate in size, but in the medial and later stages they become progressively more nearly equal. Inwardly each rib that reaches the umbilical shoulders extends, with diminishing strength, down the umbilical slope to the line of involution, and at the umbilical shoulder each of these ribs bears a tubercle which may be weak or prominent and may be conical or slightly elongated in the radial direction. Each rib where it crosses the truncated venter is broken into two rather weak parallel subribs. A pair of tubercles is present on each rib at the ventral angle; the lateral tubercle of each pair is prominent and tends to point horizontally away from the venter, and the other one is less prominent and is elongated parallel to the venter. On the median line of the venter is a row of small conical or slightly elongated tubercles, one on each subrib and one on a low, narrow transverse swell which is present in some of the interspaces between the pairs of ventral subribs; this transverse swell

may have a weak tubercle at each ventral angle. The suture is very faintly revealed on the one available specimen, but the pattern appears to be essentially like that of *Acanthoceras*.

Dimensions of the incomplete holotype: Diameter 135 mm; maximum radius from center to venter 82 mm; dorsoventral diameter of volution 52 mm; corresponding transverse diameter about 65 mm.

This species is closely related to *Acanthoceras lonsdalei* Adkins (1928, p. 244, pl. 26, fig. 5; pl. 27, fig. 3), from the basal flaggy member of the Eagle Ford shale near the Belton-Temple road, about 4 miles west of Temple, Bell County, Tex. Compared with that species, *A.? eulessanum* possesses a flatter venter, a more pronounced subquadrate cross section of the volution, and fewer and weaker medial ventral nodes. The outer node of each pair of nodes at the ventral angle is more elongated and these outer nodes are connected across the venter by a pair of subribs instead of a single rib. Inasmuch as *A.? eulessanum* occurs in a zone in the upper part of the Woodbine formation (Tarrant unit of Moreman), and *A. lonsdalei* is from the basal flaggy beds of the overlying Eagle Ford shale, the former may be ancestral to the latter. (See plastotype of holotype of *A. lonsdalei*, U.S.N.M. 106013.)

I have not seen the type of *Acanthoceras stephensoni* Adkins, also from the flaggy basal beds of the Eagle Ford shale in Bell County, but it appears to be closely related to *A.? eulessanum*. However, the outer node of each pair of ventral nodes is described as being conical, and there is no mention of a pair of subribs connecting these nodes across the venter. The medial ventral nodes are also described as elongated, whereas in *A.? eulessanum* they are essentially conical.

Acanthoceras? eulessanum is closely related to *A. cunningtoni* (Sharpe) from the Grey Chalk (Cenomanian) of England (Sharpe, 1854, pt. 2, p. 35, pl. 15, fig. 2). It differs from this species in having more ribs at corresponding stages of growth. *Acanthoceras meridionale* (Stoliczka), and *A. cunningtoni cornutum* Kossmat, from the Ootatoor group (Cenomanian) of India (Stoliczka, 1864, pt. 3, p. 76, pl. 41, figs. 1a-c; Kossmat, 1897, pt. 2, p. 18 [125], pl. 5 [16], figs. 1a-c), are related species.

Types.—Holotype, U.S.N.M. 105970; from 9 miles north of Arlington (within 3 miles of Eules), Tarrant County. The assemblage of species from this locality is a typical fauna of the Tarrant unit of Moreman.

Occurrence.—Tarrant County: Loc. 36 (type); Cook County: loc. 799.

Range.—Lewisville member.

Acanthoceras hazzardi Stephenson, n. sp.

Plate 48, figures 1, 2; plate 49, figure 4

Holotype of medium size (probably a young stage), involute, the body chamber embracing about one-

fourth of the preceding volution. Probably a little more than half the body chamber is preserved on the right side. Venter broad, with a central gentle, slightly undulating, longitudinal swell. Volutions subsquarish in cross section. On the largest volution of the holotype the radial ribs number 14, and 10 are present on the next preceding volution. The ribs trend nearly directly across the flanks, showing only a slight sinuosity. Surmounting the umbilical slope each rib bears a moderately prominent tubercle elongated in the radial direction; each rib bears a strong tubercle at each ventral angle, these tubercles being elongated transverse to the direction of the rib; between the tubercles on the flanks the ribs are weak, and inward they die out downward on the umbilical slope; they are scarcely detectable across the venter except for a feeble swell at the center; the strong tubercles at the ventral angles become progressively stronger toward the aperture and are quite prominent on the late adult stage; these nodes tend to point outward at right angles to the plane of coiling. In a favorable light two additional rows of very feeble ventral tubercles can barely be detected on either side of the central swell; apparently each of these represents the inner one of a pair of ventral nodes. Traced backward toward the apex the tubercles bordering the umbilical slope become progressively weaker, the shell surface becoming nearly smooth at the earliest observable stage.

In the adult stage the ventral lobe of the suture is of moderate width and depth, is rather finely digitate, and is divided by a short, squarish tripartite ventral saddle. The superior lateral saddle is broad and is rendered bifid by a short, digitate sublobe; the outer of the two subsaddles is divided by a still smaller lobe, and each of its subsaddles is again divided by a tiny lobule; the inner of the two subsaddles is bifid, but only the outer of its parts is bifid. The first lateral lobe is digitate and is not as large as the ventral lobe. The second lateral saddle is smaller and simpler than the first, and the second lateral lobe is digitate and very much smaller than the first. Two small additional bifid saddles, separated by a small bifid lobe, are present between the second lateral lobe and the line of involution.

Dimensions of the holotype: Maximum diameter 93.5 mm, maximum radius center to venter 57 mm, maximum dorsoventral diameter about 40 mm. The incomplete paratype exceeded 130 mm in maximum diameter.

The paratype is a fragment of a large individual including a considerable part of the living chamber and two septal chambers; it is badly worn and is in itself specifically indeterminate. It was found by Roy T. Hazzard, loose at the mouth of a small branch about half a mile northeast of the locality of the holotype and must have come from about the same stratigraphic posi-

tion. Although incomplete, it bears large tubercles at the ventral angles and appears to be a worn example of the species to which the holotype belongs. One small incomplete specimen from Tarrant County (loc. 34, coll. 476) closely resembles *Acanthoceras hazzardi* in form and ornamentation, except that the ribs are more prominent and the outer node of each pair of nodes at the ventral angle is stronger; the specimen is considered a variant of *A. hazzardi*. Maximum diameter as preserved 57 mm.

This species resembles *Acanthoceras? eulesanum* in general form and in the prominence of the outer row of tubercles at the ventral angles; it differs from that species in the exceedingly weak development of the ventral tubercles intermediate between the prominent tubercles at the ventral angles.

Acanthoceras amphibolum Morrow (1935, p. 470, pl. 49, figs. 1-4, 6; pl. 51, figs. 3, 4) from the upper part of the Graneros shale, south bank of Smoky Hill River, south of Wilson, Ellsworth County, Kans., is a fairly close analogue of *A. hazzardi*. It differs in that it is plumper in cross section, has a flatter venter, and more numerous ribs. The upper part of the Graneros shale is probably about the same age as the upper part of the Lewisville member of the Woodbine formation.

An unnamed specimen from the Belle Fourche shale (U.S.G.S. coll. 12062), Black Hills rim, Wyo., is closely related to both *Acanthoceras hazzardi* and *A. amphibolum*.

Types.—Holotypes, U.S.N.M. 105971; from a headwater branch of Walnut Creek, 0.3 mile north of Gordonville, Grayson County. One paratype, U.S.N.M. 105972; questionable example, U.S.N.M. 105973. Named in honor of Roy T. Hazzard, chief geologist, Gulf Refining Company, Shreveport, La.

Occurrence.—Tarrant County: Loc. ?34; Grayson County: locs. 124 (paratype), 125 (holotype), ?126.

Range.—Lewisville member.

Acanthoceras cuspidum Stephenson, n. sp.

Plate 50, figures 1-4

This species is based on four small shells, three of which are from the type locality; they probably represent young stages of a much larger species. Most of the body whorl is preserved in each of the figured specimens, indicating that they are not the small inner volutions of larger examples. The two figured shells were found by Roy T. Hazzard in a small septarian concretion in close association with six young examples of *Metoicoceras latoventer*. The two are cut by several calcite veins which distort the shells and give to them a slightly scaphoid form.

Shell small, involute, the body whorl embracing not more than one-fourth of the preceding volution. Volution squarish in cross section. The ribs are rather weak, and number 14 or 15 on the largest volution of the holotype. They cross the flanks with a slight for-

ward inclination and are represented across the venter by gentle swells. One or 2 ribs, which do not reach the umbilical shoulder, are added by intercalation. Each complete rib bears 5 ventral nodes and 1 node on each umbilical shoulder. The latter are of moderate size, are either cone-shaped or are slightly elongated in the radial direction, and increase regularly in size toward the aperture; traced backward toward the apex these nodes become progressively weaker and disappear before reaching the earliest stage observable in the umbilical depression. Across the venter each rib bears a central tubercle and a pair of tubercles on each ventral angle. The central tubercle is low and is elongated transverse to the rib; the inner tubercle of each pair is more prominent than the central one and is slightly elongated transverse to the rib; the outer member of each pair is the most prominent, is cone-shaped, and is directed outward nearly at right angles to the plane of the volutions. The tubercles increase regularly in size from rib to rib in the forward direction, and their prominence is such as to render the shell conspicuously spinose in appearance. The tubercles of the outer ventral row continue well developed backward toward the apex and are present nearly to the earliest stage observable in the umbilical depression.

The digitations on the larger of the sutures are numerous and are rounded at their ends. The ventral lobe is rather deep and broad and is divided by a squarish-topped, slightly bifid ventral saddle that is about two-fifths as high as the lobe is deep. The superior lateral saddle is broad, and a short sublobe divides it into two subsaddles, each of which is trifid; the outer sublobe is a little broader than the inner one. The first lateral lobe is narrower than the ventral lobe and a little more than half as deep. The second lateral saddle is much smaller and simpler than the first and is not clearly bifid; it is divided into minor saddles by several lobules. Two small, short additional saddles divided by a shallow lobe are visible to the line of involution. The sutures on the two examples show minor individual differences.

Approximate maximum dimensions of the holotype, the larger of the two specimens figured: Diameter 32.5 mm, radius from center to venter 18 mm, dorsoventral diameter 12 mm, transverse diameter 12 mm.

This species is conspicuously more spinose than any previously described American acanthoceratid species.

Types.—Holotype, U.S.N.M. 105974; 1 paratype, figured, U.S.N.M. 105975; 1 paratype, unfigured, U.S.N.M. 105976; all from gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson County.

Occurrence.—Grayson County: Locs. 154 (holotype and 1 figured paratype, coll. 18971; 1 unfigured paratype, coll. 14092), 167.

Range.—Templeton member.

Acanthoceras barcusi Jones

Plate 44, figures 9–11

1938. *Acanthoceras barcusi* Jones, Geol. Soc. America Bull., vol. 49, no. 1, p. 117, pl. 6, figs. 2, 3, 8, 9.

1951. *Acanthoceras barcusi* Jones. Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, fig. 4 (following p. 163).

Shell of medium size, involute, each of the later volutions embracing less than half of the preceding one, subquadrate to subcircular in cross section. Ribs strong, round-crested, narrower than the interspaces, alternating in length, every other one reaching and extending part way down the steep umbilical shoulder. The shorter ribs vary somewhat in length, some of them extending farther inward than others, but all the ribs cross the venter in about equal strength. In the early and medial stages each rib that reaches the umbilical shoulder bears 7 nodes, and the intermediate shorter ribs bear 5 nodes. The ventral nodes include a medial node and a pair of rather widely separated nodes on each ventral angle. The medial node is blunt, round-topped and of medium strength; the inner node of each ventral pair is slightly stronger and slightly elongated transverse to the length of the rib; and the outer one of each pair is conical and relatively weak. The ventral nodes become progressively weaker and fade out on the later stages. The nodes on the umbilical shoulder are strong, conical on the earlier stages, becoming radially elongated on the later stages; they increase their strength on the later stages.

On the one available shell (plesiotype in Conlin's private collection) the sutures are not completely uncovered. The ventral lobe is deep and rather strongly digitate, the ventral saddle is short and is divided by 2 or 3 small lobules. The superior lateral saddle is broad, is divided by a short dentate sublobe and each subsaddle is further divided by several lobules. The first lateral lobe is much smaller than the ventral lobe.

Dimensions of the plesiotype: Diameter 61 mm, maximum radius from center to venter 36 mm, maximum dorsoventral diameter about 22 mm, corresponding transverse diameter about 25 mm.

The one specimen available to me is smaller than the holotype, but appears to be identical with it. Inasmuch as both specimens came from eastern Tarrant County, this one is probably essentially a topotype. The side of the shell shown in the illustration includes most of the living chamber.

Types.—Holotype, Michigan Univ., no. 16543; 1 paratype, Michigan Univ., no. 16838. One plesiotype, private collection of James P. Colin, Fort Worth, Tex., no. 4136. (See plastotype of plesiotype, U.S.N.M. 105977.)

Occurrence.—Tarrant County: Banks and bed of a small stream tributary to Big Bear Creek, 1.5 miles east of Euless, 0.2 mile north of State Highway 183 (Conlin's orig. loc. no. T-10-Kwb.).

Range.—Lewisville member.

Unidentified specimens of *Acanthoceras*

A fragment of a large specimen of *Acanthoceras*? from the Lewisville member on Timber Creek, Denton County (loc. 72, coll. 475), is specifically indeterminate; it includes parts of the last two sutures and the earlier part of the body chamber. Fragments of shell adhering to the internal mold are as much as 3 mm thick. The ribs pass prominently and rather uniformly over the venter; they are rounded on the crest and are narrower than the interspaces. U.S.N.M. 105978.

A fragment of the internal mold of a specimen of *Acanthoceras* (pl. 46, figs. 5,6), from the Templeton member in gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson County (loc. 154, coll. 17163), at approximately the larger end of the volution, measures in dorsoventral diameter 18.8 mm and in the corresponding transverse diameter 20 mm. The flanks are slightly flattened. The ribs tend to alternate in size, those that reach the umbilicus having well-developed nodes at the shoulder. Each rib bears 5 ventral conical nodes, of which the medial one is of moderate strength, the lateral one of each pair on the ventral angle is weak, and the one nearest the medial line rather strong. The specimen possesses the same type of nodes as those on *Acanthoceras barcusi* Jones, but appears to be less plump and a little more openly coiled. U.S.N.M. 105979.

A ferruginous internal mold representing a fragment of an early stage of an *Acanthoceras*-like ammonite was found in the Lewisville member in a headwater branch of Walnut Creek, 0.5 mile north of Gordonville, Grayson County (loc. 126, coll. 18976.) The specimen is plump, the maximum transverse diameter being about 4 mm. There is a median row of conical nodes and a pair of conical nodes on each lateral rib at the ventral angles. The node of each pair nearest the medial row is the larger. The plumpness of the conch at this early stage suggests the possibility that it may pertain to *Acanthoceras? eullesanum*. U.S.N.M. 105981.

At the same locality as the preceding (126) was found a distorted ferruginous internal mold of a small *Acanthoceras*-like ammonite having a conspicuously strong medial row of ventral nodes and a pair of smaller nodes on each ventral angle. The medial nodes are elongated in the linear direction of the venter, and the node of each pair nearest the medial node is slightly elongated. The maximum shell diameter is about 28 mm. U.S.N.M. 105982.

Incomplete, mechanically compressed external and internal molds of a large ammonite, with thin fragments of shell substance adhering (pl. 49, figs. 1, 2), found in the Templeton member in dark shale on land of Charles Price, about 3.5 miles east-southeast of Arthur City, Lamar County (loc. 204), appear to be a species of *Acanthoceras*. The molds are too incomplete for accurate measurement, but the shell diameter must have

exceeded 150 mm. The molds indicate a strongly ribbed species, the ribs being of about equal strength near the venter; inward every other rib reaches the umbilical shoulder in strength, while the intermediate ones die out before reaching the shoulder. The ventral angle bears a row of prominent conical nodes on each rib. The strong ribs bear relatively weak conical nodes at the umbilical shoulder; outward from the shoulder, about one-third the distance to the venter, each strong rib swells into a node that on the younger stages appears to be conical but on the larger later stages becomes elongated, canoe-shaped; each of the intermediate ribs bears an elongated node similar to the preceding, but much weaker and a little farther out from the shoulder. The internal mold bears obscure impressions of sutures, the traces of which cannot be readily followed. U.S.N.M. 105980.

Genus **MAMMITES** Laube and Bruder, 1887

Type species: *Ammonites nodosoides* Schlotheim (in Schlüter, 1871-1872, p. 19), from the south rim of the Westphalian Cretaceous basin, in the lower Turonian. (See Laube and Bruder, 1887, p. 229.)

Mammites? bellsanus Stephenson, n. sp.

Plate 49, figure 3; plate 51, figures 8-11

Shell of medium size for the genus, plump, involute, each volution enclosing about half of the preceding one. The volutions are subquadrate in cross section in all except the early stages. Surface ornamented with ribs and nodes. At a diameter of 95 mm the ribs number 19; of these, 10 strong primary ribs reach the umbilical shoulder; in each interspace between the primary ribs is a short, weak secondary rib that fades out before reaching the shoulder. The ribs pass nearly directly out across the flanks. Each primary rib bears a radially elongated, rather prominent node on the umbilical shoulder. At the ventral angles each of the ribs bears a moderately prominent node elongated transverse to its linear direction, and each of these nodes is paired by a lateral conical node a few millimeters to a maximum observed distance of 15 mm inward on the flank. Both nodes of this pair continue well developed to the largest stage observed (diameter 140 mm), the lateral node increasing proportionately in size but not attaining the conspicuous prominence present on some species of *Mammites*. The venter is flat, of moderate width, and lacks a row of medial nodes at all stages; there is, however, a broad gentle swell in the area separating the two pairs of ventral nodes. The sutures are similar in number and pattern of lobes and saddles to those of *Acanthoceras*, but the lobes are deeper and more sharply and intricately digitate, and the saddles are cut by more numerous and deeper sublobes and lobules.

The specimen chosen as holotype is of medium size, with most of the body chamber missing; it is somewhat

misleading as to form in that it has been slightly crushed on part of the flank, giving the impression of a more compressed shell than it actually is. In the smallest stage observed, the diameter of the shell is 5 mm. At this stage the cross section of the volution is broadly ovate, with the longest diameter transverse to the dorsoventral diameter. In later stages the cross section quickly becomes, first, subcircular, then broadly subovate in the dorsoventral direction, then subquadrate.

Dimensions of the holotype: Maximum diameter, as preserved, about 95 mm; maximum radius from center to venter 60 mm; maximum dorsoventral diameter of the volution about 40 mm; corresponding transverse diameter 40 mm (estimated). The largest of the paratypes measures: Greatest diameter 140 mm; greatest radius from center to venter about 90 mm; greatest dorsoventral diameter of the body whorl about 55 mm; corresponding transverse diameter 60 mm (estimated).

The large paratype just mentioned is not complete, but it includes most of the living chamber. It is of interest because it shows that the costae continue well developed nearly to the aperture.

Types.—Holotype, U.S.N.M. 105983; 1 figured paratype, U.S.N.M. 105984; 1 figured paratype, U.S.N.M. 105985; 1 unfigured paratype, U.S.N.M. 105986; all from a branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County.

Occurrence.—Grayson County: Locs. 164 (types), ?167.

Range.—Templeton member.

Family PLACENTICERATIDAE

Genus FORBESICERAS Kossmat, 1898

Type species: *Ammonites largilliertianus* D'Orbigny (1841, tome 1, p. 320, pl. 95), (Kossmat, 1898, pt. 3, p. 125 (190)). Designated by Roman (1938, p. 418).

James P. Conlin of Fort Worth, Tex., wrote me in June 1947, of finding three examples of an undescribed species of *Forbesiceras* Kossmat, a genus recorded from the Cenomanian of France and England, but heretofore unreported from America. Subsequently he sent these specimens to me with permission to describe the species, at the same time donating one of them (holotype) to the U. S. National Museum. It was specified that the other two specimens (paratypes) were to be retained by him in his private collection. I have taken pleasure in naming the species *Forbesiceras conlini* in recognition of his generous cooperation.

Forbesiceras conlini Stephenson, n. sp.

Plate 56, figure 1; plate 57, figures 2-6

Shell of medium size, compressed, lenticular in cross section, involute, the volution completely embracing. Umbilicus small, shallow, with gently sloping sides. Venter narrow, truncated. At the earliest stage observed, radial dimension from center to venter 18 mm, the ventral truncation is 3 mm wide, and is broadly excavated, with a weak, narrow, longitudinal ridge in

the center. As growth proceeds the ventral excavation becomes gradually filled, and the central ridge becomes gradually a little stronger, until at a radial dimension of 38 mm a cross section of the venter presents an obtuse angle of about 120°. At still later stages in the available material the venter is badly worn, but it appears to become rounded. At an early stage the ventral ridge is finely and weakly serrate; at later stages the serrations become a little coarser, each individual serration becoming elongated. A row of small, closely spaced, slightly elongated nodes, is present on each ventral angle. The flanks of the volution are very broadly convex. In the early stages the outer two-fifths of each flank is ornamented with numerous small ribs that trend obliquely forward to the ventral angle; the ribs tend to alternate in length, every other one being short and weak. The ribs are well developed on the smallest paratype and are recognizable on the holotype to a radius of 45 mm; they are not recognizable on the largest paratype. Midway of each flank on the earlier stages is a row of small, weak nodes; these are fewer than the ribs and appear to be developed independently of them. These nodes are analogous to the nodes on the flanks of *Forbesiceras obtectum* (Sharpe) from the Cenomanian of England, which is obviously closely related to the Texas species. (Sharpe, 1853, p. 20, pl. 7, fig. 4.) The nodes are distinct on the smaller paratype but are not recognizable on the holotype nor on the larger paratype, having faded out on the later stages. The inner half of each flank, inside the row of nodes, appears to be smooth at all stages.

The pattern of the sutures is best seen in the illustration of the larger of the paratypes. The lobes exhibit numerous denticulations, and the saddles are deeply divided by sublobes and lobules. Assuming that the largest lobe is the first lateral lobe, and the small lobe on the venter is the ventral lobe, then there are two adventitious lobes and two adventitious saddles between the first or superior lateral saddle and the ventral lobe. The second lateral saddle is larger than the first and the third lateral saddle is relatively quite small. Between the third lateral saddle and the line of involution are 5 to 6 small auxiliary saddles and lobes. The holotype and the small paratype are still septate at the largest stages preserved. The larger of the paratypes includes all of the septate part and a part of the living chamber which is poorly preserved.

Dimensions of the holotype: Maximum diameter 155 mm, maximum radius from center to venter 96 mm, maximum dorsoventral diameter 66 mm, corresponding transverse diameter 41 mm. The largest paratype attains a maximum diameter of 180+ mm.

The row of nodes on the flank of this species seems to ally it more closely to *Forbesiceras obtectum* (Sharpe), the English species (Sharpe, 1853, p. 20) from the Lower Chalk (Cenomanian), than to the genotype from

the Cenomanian of France, *F. largilliertianum* (D'Orbigny), which lacks these nodes.

Types.—*Holotype*, U.S.N.M. 105987; 2 paratypes, in the private collection of James P. Conlin, 927 Tierney Road, Fort Worth 3, Tex. The species is named in honor of Mr. Conlin, who donated the holotype to the U. S. National Museum. The types are from the banks and bed of a small tributary to Big Bear Creek, on the estate of Herman A. Dearing (Woodland Hill Farm), 1.5 miles east of Euless, 0.2 mile north of State Highway 183, Tarrant County (Conlin's orig. loc. no. T-10-Kwb). (See plastotypes of 2 paratypes in Conlin's private collection, U.S.N.M. 105988, 105989.)

Occurrence.—Tarrant County: Loc. 55 (holotype, Conlin's coll. 316); 2 paratypes in James P. Conlin's private collection from the same locality (his colls. 4132 and 4133).

Range.—Lewisville member.

Family ENGONOCERATIDAE

Genus METENGNOCERAS Hyatt, 1903

Type species: *Metengonoceras inscriptum* Hyatt, from the Fredericksburg group of the Comanche series (Lower Cretaceous), 12 miles northeast of Decatur, Wise County, Tex. Designated by Reeside and Weymouth, 1931.

1903. *Metengonoceras* Hyatt, U. S. Geol. Survey Mon. 44, p. 179.
 1904. *Engonoceras dumbli* (Cragin). Lasswitz, Geol. und Palaeon. Abh., Band 10 (neue Folge, Band 6), Heft 4, p. 12 (232), pl. 1 (13), fig. 2a, b.
 1924. *Epengonoceras* Spath, Annals and Mag. Nat. History, ser. 9, vol. 14, no. 82, p. 508.
 1923. *Metengonoceras* Hyatt. Adkins, Texas Univ. Bull. 2838, p. 264.
 1928. *Epengonoceras* Spath. Adkins, Texas Univ. Bull. 2838, p. 264.
 1931. *Metengonoceras* Hyatt. Reeside and Weymouth, U. S. Nat. Mus. Proc., vol. 78, art. 17, no. 2860, p. 14.
 1931. *Epengonoceras* Spath. Reeside and Weymouth, U. S. Nat. Mus. Proc., vol. 78, art. 17, no. 2860, p. 14.

A careful reading of the literature and an examination of the available material has led me to conclude that, unless differences other than those now known can be found, *Metengonoceras* Hyatt and *Epengonoceras* Spath are so nearly identical as to render unnecessary their generic separation. The genotype of *Metengonoceras*, *M. inscriptum* Hyatt, is from the Fredericksburg group of the Comanche series; the genotype of *Epengonoceras*, *Metengonoceras dumbli* (Cragin), is from the upper part of the Woodbine formation. The latter possesses a narrow truncated venter that begins in the neanic stage, extends through the ephebic stage into the gerontic stage, and finally, toward the aperture of large shells, broadens out and rounds off to an acutely rounded cross section; this is confirmed by a considerable amount of material available from the Grayson County type locality and other corresponding localities along the strike of the upper Woodbine. In form *M. dumbli* is like *M. inscriptum* except that it is slightly more compressed in cross section. Allowing for certain rather striking differences in pattern, some of which are seen on different individuals and some even on the opposite sides of the same individual, the sutures of *M. dumbli* do not seem sufficiently different from those

of *M. inscriptum* to justify a generic separation. Because one of the important objects of our paleontologic studies is to show the stratigraphic range of genera, the separation of genera on insufficient morphologic grounds is undesirable.

Metengonoceras dumbli (Cragin)

Plate 55, figures 1-4

1893. *Sphenodiscus dumbli* Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 243, pl. 44, fig. 3.
 1903. *Metengonoceras dumbli* (Cragin). Hyatt, U. S. Geol. Survey Mon. 44, p. 185, pl. 27, figs. 3-14.
 1924. *Epengonoceras dumbli* (Cragin). Spath, Annals and Mag. Nat. History, ser. 9, vol. 14, no. 82, p. 508.
 1928. *Epengonoceras dumbli* (Cragin). Adkins, Texas Univ. Bull. 2838, p. 264.
 1931. *Epengonoceras dumbli* (Cragin). Reeside and Weymouth, U. S. Nat. Mus. Proc., vol. 78, art. 17, no. 2860, pp. 14-16.
 1942. *Epengonoceras dumbli* (Cragin). Moreman, Jour. Paleontology, vol. 16, no. 2, p. 217.
 1951. *Metengonoceras dumblei* (Cragin). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, fig. 5 (following p. 163).

Shell of medium size, involute, strongly compressed, narrowly lenticular in complete cross section, the volutions almost completely embracing. Umbilicus narrow and deep, with steep sides. Venter very narrowly truncated and slightly channeled, the truncation not exceeding 2 mm in width except toward the aperture of large adults, where the venter becomes somewhat broadened and passes into an acutely rounded cross section showing no trace of a truncation; the truncation may or may not be reflected on the internal mold. The sides are smooth, presenting neither ribs nor nodes. Growth lines on the living chamber near the aperture are sinuous, exhibiting a broad, shallow sinus on the lower half of the flank, and another on the upper half. The growth lines indicate a slightly projecting ventral crest.

The sutures are notable for their simplicity and their excellent state of preservation in many of the specimens. The saddles are numerous, simple, and entire, unless some of the shallower lobes are interpreted as sublobes dividing broad saddles into two subsaddles. Hyatt, in his detailed description (1903, pp. 185-187) of the type here shown in plate 55, figure 1, interpreted the deeply divided superior lateral saddle as two single saddles and recognized several broad, bipartite saddles in the vicinity of the umbilical shoulder. He thus counted 13 saddles on one side and 14 on the other. He found differences in the details of the suture pattern on the two sides of this individual, and had he had sufficient material before him would have found equally striking differences between the sutures of different individuals. Notable are the individual differences in the degree of constriction of the bases of the saddles, some being wide open and others being nearly closed. Had the smaller lobes in the type specimen referred to been regarded as merely variants in the depth of principal

lobes, the number of saddles on each side would have been 17. Hyatt noted that the small bipartite ventral lobe of the figured type was eccentric to the "right." Among the numerous present available specimens, all that have the sutures sufficiently preserved show eccentricity of this lobe; the deviation from the center is generally even greater than that exhibited by the type specimen; it may be either to one side or the other. The two digitations of the ventral lobe diverge widely rearward. The number of digitations in the lobes ranges from 2 weak ones to 5 well-developed ones; the greater number of digitations are more commonly found in the later stages of growth, but they also reflect in part at least more favorable environmental conditions of growth. Hyatt does not mention having seen the inner sutures of the species. One specimen in the present available material (loc. 154, coll. 17163) shows 6 broad inner saddles separated by narrow, weakly digitate lobes; 2 of the saddles nearest the line of involution are weakly divided by small shallow sublobes, and the other 3 are simple. The dorsal lobe is narrow, coinciding in width with the narrow truncated venter of the enclosed volution and is somewhat shorter than the nearest internal lobe.

The complete living chamber is not represented on any of the available material, but the large topotype shown in plate 55, figure 3, is nearly complete and indicates that this chamber included a little more than half of a volution.

Dimensions of the topotype shown in plate 55, figure 3: Diameter 142 mm; maximum radius from center to venter 81 mm; maximum dorsoventral diameter of volution about 45 mm; corresponding transverse diameter about 27 mm. Dimensions of the type specimen shown in plate 55, figure 1: Diameter 96 mm; maximum radius from center to venter 55 mm; maximum dorsoventral diameter of volution 28 mm; corresponding transverse diameter 19 mm. Maximum measured diameter of a shell of this species about 185 mm.

A specimen from Lampasos County, Tex., in the Roemer collection at the University of Bonn, Germany, figured by Lasswitz (1904, p. 12 (232), pl. 1 (13)) under the name *Engonoceras dumbli* (Cragin), probably belongs to one of the earlier species of *Metengonoceras*, since its geographic location indicates that it came from the Fredericksburg group of the Comanche series.

Types.—Cragin did not designate a holotype, and his only illustration is that of a suture. He mentions "twenty examples which exhibit the suture lines." The present whereabouts of only one of his type specimens is known; it is in the U. S. National Museum and bears the catalog number 29403 (loc. 150). The dimensions of this specimen agree with that of one of Cragin's measured examples. It bears a label which indicates that it was collected by J. A. Taff, and that it is "part of types." Taff collected part of the type material from "four miles east of Whitesboro." The rest of the type material was collected by W. F. Cummins "on Hackberry Creek, and at Keenan's crossing of the Trinity River in Dallas County."

Keenan's crossing of Elm Fork of Trinity River is reported to be near a modern bridge 2.5 miles west by south of Farmers Branch, and Hackberry Creek joins Elm Fork from the north-west about 4 miles southwest of Farmers Branch. The beds that crop out in the vicinity of Keenan's crossing and along Hackberry Creek belong to the lower part of the Eagle Ford shale, including the *Metioceras whitei* zone. Collections recently made by H. R. Bergquist from the *M. whitei* zone in Lamar County, include specimens referable to the genus *Metengonoceras*. The type specimen cited was described and figured by Hyatt (1903, pp. 185-187, pl. 27, figs. 3-14). One plesiotype, U.S.N.M. 105990.

The large figured plesiotype came from a locality 2.8 miles east of Whitesboro (see below) in the near vicinity of Taff's locality, doubtless from the same zone, and may be considered a topotype. No specimens of this genus are available from the two localities in Dallas County from which the Cummins material is reported to have come.

Occurrence.—Tarrant County: Locs. 36, 41, 44, 52, 53, 215a. Denton County: loc. ?83; Grayson County: locs. 152, 154 (includes 1 plesiotype), ?160, 164, 165, 167, 168, 172; 4 miles [sic] east of Whitesboro (loc. 150, a type); Fannin County: loc. 192; Lamar County: locs. 203, 205.

Range.—Lewisville member to Templeton member.

Family METOICOCERATIDAE

Genus METOICOCERAS Hyatt, 1903

Type species: *Ammonites swallowii* Shumard. Implied by Adkins (1928, p. 248) and by Reeside and Weymouth (1931, p. 19). Designated by Shimer and Shrock, 1944.

1903. *Metiococeras* Hyatt, U. S. Geol. Survey Mon. 44, p. 116.

1920. *Metiococeras* Hyatt. Böse, Texas Univ. Bull. 1856, p. 200. 1918 (issued 1920).

1928. *Metiococeras* Hyatt. Adkins, Texas Univ. Bull. 2838, p. 248.

1931. *Metiococeras* Hyatt. Reeside and Weymouth, U. S. Nat. Mus. Proc., vol. 78, art. 17, no. 2860, p. 19.

1942. *Metiococeras* Hyatt. Moreman, Jour. Paleontology, vol. 16, no. 2, p. 210.

1944. *Metiococeras* Hyatt. Shimer and Shrock, Index fossils of North America, p. 591.

Metiococeras swallowii (Shumard)

Plate 51, figures 1-3; plate 52, figures 1-5

1860. *Ammonites swallowii* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 591.

1883. *Ammonites swallowii* Shumard. White, U. S. Geol. and Geog. Survey Terr., 12th Ann. Rept. for 1878, pt. 1, App., p. 39, pl. 18, fig. 1a.

1893. *Buchiceras swallowii* (Shumard). Cragin, Texas Geol. Survey 4th Ann. Rept. for 1892, p. 234 (in part).

1903. *Metiococeras swallowii* (Shumard). Hyatt, U. S. Geol. Survey Mon. 44, p. 118, pl. 11, figs. 7-24; pl. 13, figs. 1, 2; ?pl. 15, figs. 1-4.

1928. *Metiococeras swallowii* (Shumard). Adkins, Texas Univ. Bull. 2838, p. 248.

1931. *Metiococeras swallowii* (Shumard). Reeside and Weymouth, U. S. Nat. Mus. Proc., vol. 78, art. 17, no. 2860, p. 20.

1942. *Metiococeras swallowii* (Shumard). Moreman, Jour. Paleontology, vol. 16, no. 2, p. 210.

1951. *Metiococeras swallowii* (Shumard). Adkins and Lozo, Fondren Science Series 4 (Dallas), pl. 2, fig. 4 (following p. 163).

The failure of Shumard to illustrate this species and the loss of his type material have resulted in some un-

certainty as to the identity of the species among the ammonites later collected from the approximate horizon and area of its recorded occurrence. White (1883, p. 39, pl. 18, fig. 1) reproduced a photograph of a drawing of *Ammonites swallowii*; this drawing was made by A. R. Roessler under Shumard's direction, and may be accepted as an illustration of one of the original types. White's figure is reproduced on plate 52, figure 1, of the present paper. Hyatt, the first reviewer of the species (1903, pp. 118-121, pl. 13, fig. 2), made no reference to White's illustration and apparently had not seen it. Hyatt figured a specimen from Grayson County, Tex. (collection of D. S. Martin), which he considered to be Shumard's species *Metoicoceras swallowii*; his opinion was based mainly on the correspondence of the sutures on the Martin specimen to those on the type of *swallowii*, as described by Shumard. The whereabouts of the Grayson County specimen is unknown, but Hyatt's figure of it agrees well with the one published by White. Other features described by Shumard indicate, in Hyatt's opinion, that two species were confused in the original description, the second one of which Hyatt described under the name *Metoicoceras whitei* (1903, p. 122, pl. 13, figs. 3-5; pl. 14, figs. 1-10, 15); this is the index species of the zone of *Metoicoceras whitei* in the Eagle Ford shale some 50 or 60 feet above the top of the Woodbine formation. The whereabouts of the holotype of *M. whitei* is unknown; a paratype from Utah is shown in Hyatt's plate 13, figures 3-5. In the absence of both Shumard's type material and the Martin specimen from Grayson County, the fine specimen from Red River near old Slate Shoals, Lamar County (pl. 52, figs. 2-5), which appears to be specifically identical with the Grayson County specimen, is considered to be as nearly a typical example of the species as is now available. The description that follows is based on the Lamar County specimen, which includes all of the septate portion and most of the living chamber.

Shell of medium size, laterally compressed, moderately involute, each volution enclosing more than half of the preceding volution in the early stages and progressively less of the preceding volution in the later stages. Umbilicus deep. Venter narrowly truncate. The cross sections of the volution in the young stages are greater in the transverse diameter than in the radial diameter, but the latter becomes progressively longer with advancing age, until in the adult, it is considerably longer than the transverse diameter. At a diameter of 25 mm the ribs number 20 to 22, but they increase in number to about 28 in adults. There is considerable irregularity in the strength of the ribs on the sides, with, however, a tendency to alternation; at the border of the venter they are approximately uniform in size; an occasional weaker rib fuses with a strong one nearby in dichotomous form. The ribs are slightly sinuous in

trend and are inclined forward somewhat from the direct radial direction; on the living chamber they curve noticeably backward as they approach the venter; they cross the venter as very gentle swells. Each rib that reaches the umbilical shoulder in strength bears a prominent node; on the early and medial stages of the shell these nodes are conical, but on the first half of the largest volution of an adult, they are elongated in the radial direction; on the living chamber of the adult stage the nodes become weaker and fade out completely toward the aperture, indicating senility. In the early and medial stages of the shell, each rib bears four ventral nodes, a pair on each side; the node nearest the medial line is prominent and transversely elongated; the lateral nodes of the pairs are less prominent, more nearly conical, and become progressively weaker anteriorly, until on the living chamber they are wanting.

The sutures are comparatively simple and are essentially alike in pattern from the smallest stage observed (diameter about 10 mm) to the largest stage. On the figured example from Lamar County the ventral lobe of the suture nearest the living chamber is 5 or 6 mm wide and 9 or 10 mm long; on each side are 2 or 3 small digitations and posteriorly 2 strong prongs pointing directly backward; the two prongs are separated by a short, squarish ventral saddle that is rendered weakly tripartite by two shallow notches. The superior lateral saddle is broad and bipartite, the outer subsaddle being weakly tripartite and the inner one simple or very weakly bipartite. The first lateral lobe is much smaller than the superior lateral saddle, is about as broad as deep, and ends in 5 or 6 short, fan-shaped digitations. The second lateral saddle is simple, is not quite so broad as the first lateral lobe, and is a little broader than high. The three succeeding lateral lobes are comparatively small and become progressively simpler inward, and the three corresponding saddles are simple. Evidently there is minor individual variation in the suture pattern, for the sutures on some other specimens from localities near old Slate Shoals, referred to this species, are not quite as simple as those on the figured shell, the saddles being rendered very weakly bipartite or tripartite by shallow notches. The form of the young individual up to 70 mm in diameter is strikingly different from that of an adult, being plumper, less compressed, and strongly nodose on the umbilical shoulder. The stronger nodes of these early stages are well exposed in the umbilicus of the large figured example.

Dimensions of the large plesiotype from Lamar County: Diameter 117 mm; maximum radius from center to venter 68 mm; dorsoventral diameter of volution about 43 mm; corresponding transverse diameter about 33 mm.

Types.—The whereabouts of Shumard's type material is not known; presumably it is lost. Hyatt's plesiotype from "Gray-

son County," Tex. (1903, p. 118, pl. 13, fig. 2), is recorded as being in the private collection of D. S. Martin, the present whereabouts of which is unknown to me. The plesiotypes figured on Hyatt's plate 11, figures 7-24, and plate 13, figure 1, are stated to be in his own collection but no locality is given; his collection presumably is in storage in the Museum of Comparative Zoology, Cambridge, Mass., but has not been seen in recent years. The plesiotype shown on Hyatt's plate 15, figures 1-4, are recorded as in the American Museum of Natural History, New York; no locality is given. One plesiotype, U.S.N.M. 105991; 2 plesiotypes U.S.N.M. 105992a-b.

Occurrence.—Grayson, Fannin, and Lamar Counties: Shumard's type material is recorded as having come from "four and a half miles north of Sherman, and bluffs of Red River in Fannin and Lamar Counties." Lamar County: Locs. 201 (2 plesiotypes), 202, 203, 207.

Range.—Templeton member.

Metoicoceras swallowii macrum Stephenson, n. var.

Plate 51, figures 4-7

The holotype of this variety is a young stage, septate throughout. In form, in ornamentation, and in suture pattern it is similar to *Metoicoceras swallowii* but is more compressed, the ribs and nodes are less strongly developed, and the ribs are a little more closely spaced. The suture pattern appears to be a little less simple than in the typical *M. swallowii*, but this is a somewhat variable feature within the species. The nodes on the umbilical shoulder are all radially elongated instead of conical as they are in the typical species.

Dimensions of the holotype: Diameter 45 mm; maximum radius from center to venter 25 mm; dorsoventral diameter about 20 mm (estimated); corresponding transverse diameter 18 mm.

Type.—Holotype, U.S.N.M. 105993; from near old Slate Shoals on Red River, 8 miles east of Arthur City, Lamar County. One figured paratype, U.S.N.M. 105994.

Occurrence.—Lamar County: Locs. 201 (holotype), 207, (paratype, figured).

Range.—Templeton member.

Metoicoceras latoventer Stephenson, n. sp.

Plate 53, figures 1-9; plate 54, figures 9-11

Shell of medium size, laterally compressed, each volution enclosing more than half of the preceding one in the early stages and less than half in the medial and later stages. Umbilicus deep. Venter broadly truncate. Up to a shell diameter of about 50 mm the transverse diameter of the volutions, measured between the nodes, is as great or greater than the radial dimension measured from the line of involution to the venter; in later stages the latter dimension becomes proportionately greater, until at a shell diameter of 100 mm it amounts to 43 mm as compared to a corresponding transverse diameter of 36 mm; beyond the latter stage toward the aperture, the dimension from the line of involution to venter again decreases, owing to senility, but at the aperture it is still somewhat greater than the transverse diameter; these measurements are based on the holotype. The cross sections of the volutions are subquad-

rate in all except the very young stages, where they are subcircular. The living chamber as indicated by the internal mold includes about half a volution. The impressions of the growth lines on the mold are broadly sinuous and, in the adult, inclined rather strongly forward; they indicate a broad, gentle crest at the apertural margin of the venter.

The mature shell bears 17 or 18 more or less irregular, gently sinuous ribs, which are slightly inclined forward even in young shells; the ribs tend to alternate in size, but 2 weak ribs may intervene between 2 strong ones, or 2 strong ones may lie together without an intervening weaker one; an occasional weaker rib appears to fuse rather loosely in dichotomous form with a strong one nearby. On the living chamber the ribs become weaker toward the aperture and are wanting on the last 30 mm of the length of the holotype; the absence of the ribs and the irregular accentuation of growth lines and ridges on this part of the shell indicate senility. A further indication of senility is seen in the closer crowding of several of the sutures immediately back of the living chamber on some adult specimens. The ribs that reach inward to the umbilical shoulder bear strong shoulder nodes; on young shells up to about 25 mm in diameter these nodes are conical but on later stages become radially elongated, fading out, however, on the living chamber of adults. Each rib bears a moderately prominent node, more or less elongated transversely, on each ventral angle, but these nodes become weaker and disappear toward the aperture of adults. On the early and medial stages of the shell each rib bears a much weaker, conical lateral node 4 mm or less inward on the flank from the one at the ventral angle; these nodes become progressively weaker anteriorly and are wanting on the living chamber. A row of weak, elongated, medial ventral nodes is present on young shells up to 20 or 25 mm in diameter and is wanting on all later stages observed.

The adult sutures, best seen on the holotype (pl. 54, figs. 9-11), are essentially like those of the genotype, *Metoicoceras swallowii*, except that the pattern of the saddles is not quite so simple. The ventral lobe is a little deeper than broad and occupies a little less than half the total width of the broad ventral truncation; the sides of the lobe are each modified by 2 or 3 small digitations, and the lobe is terminated rearward by 2 rearward extending prongs enclosing a small, squarish ventral saddle, whose blunt forward end is broken only by 2 very weak notches. The superior lateral saddle is bipartite, and each subsaddle is rendered weakly tripartite by shallow digitations. The rest of the lateral saddles are similar to those of *M. swallowii* except that they are a little more broken by a few shallow digitations. The suture, as seen on a young stage 14 mm in shell diameter, presents all the elements seen in the adult stage, though in somewhat smoother pattern, even the

tripartite character of the subsaddles of the superior lateral lobe being easily recognizable. The most distinguishing feature of the species is its broad ventral truncation and the subquadrate cross section of the larger volutions. In this character it is in strong contrast to *M. swallowii*, whose truncated venter at a corresponding stage is only about two-thirds as broad.

Dimensions of the holotype: Maximum diameter about 115 mm; maximum radius from center to venter 71 mm; maximum dorsoventral diameter of volution about 42 mm; corresponding transverse diameter about 37 mm.

Types.—Holotype, Bureau of Economic Geology, Austin, Tex., coll. 2574, from Templeton member, 4 miles [sic] east of Whitesboro, Grayson County; 1 unfigured paratype in the same collection. (See plastotype, U.S.N.M. 105996 and plastotype of paratype, U.S.N.M. 105997.) One paratype, figured, U.S.N.M. 105998; 1 paratype, figured, U.S.N.M. 105999; 1 paratype, unfigured, U.S.N.M. 106001; 1 paratype, figured, U.S.N.M. 106000; 10 unfigured paratypes, U.S.N.M. 106002.

Occurrence.—Grayson County: Locs. 154 (14 paratypes, 3 figured); Texas Bureau of Economic Geology no. 2574 (holotype and 1 unfigured paratype), from "4 miles [sic] east of Whitesboro, 0.25 mile south of the old Whitesboro-Sherman road."

Range.—Templeton member.

Metoicoceras crassicostrae Stephenson, n. sp.

Plate 58, figures 6-8

This species is based on one individual. Shell of medium size, gently convex on the flanks, each volution enclosing about half of the preceding one. Umbilicus deep. Venter broadly subtruncated but not quite flat. At a shell diameter of 93 mm, the lateral dimension from the line of involution to the venter is about 42 mm, and the maximum transverse diameter measured on the nodes is 39 mm. Cross sections of the volutions subquadrate. The living chamber includes a little more than half a volution. The growth lines are broadly convex in trend on the flanks and bend slightly forward on the venter. The primary ribs that reach the umbilical shoulder on the largest volution of the holotype number 9 or 10. About 6 of these ribs farthest from the aperture bear prominent, more or less radially elongated nodes on the umbilical shoulder; on the 3 ribs nearest the aperture, shoulder nodes are present but much reduced. Several short secondary ribs are present in interspaces between the primary ribs. The venter on the holotype is considerably worn but bears indications of the presence of weak nodes on each rib at the ventral angles. There is also evidence of a second weak node on each rib on the flank 3 or 4 mm inward from the ventral node. The sutures are considerably worn, but they appear to be essentially like those of *Metoicoceras latoventer*, though they may be a little smoother and simpler.

Dimensions of the holotype as preserved: Maximum diameter 94 mm; maximum radius from center to venter about 55 mm; maximum dorsoventral diameter of volu-

tion about 35 mm; corresponding transverse diameter 39 mm.

Compared with *Metoicoceras latoventer*, the venter of this species is broader and not quite so flat at a corresponding stage of growth, the ribs are fewer, the nodes on the umbilical shoulder are much stronger, and the nodes on and near the ventral angles are weaker.

Holotype.—U.S.N.M. 106003; from a branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson County.

Occurrence.—Grayson County: Loc. 164.

Range.—Templeton member.

Unidentified specimens of young *Metoicoceras*

A young individual of *Metoicoceras?* (pl. 44, figs. 3-5) from the Templeton member at the edge of the Red River flood plain, 1.5 miles north of Ragtown, Lamar County (loc. 202, 14551), is a nearly complete internal mold, 11 mm in diameter, showing the living chamber to be something more than half a volution long and to have a transverse diameter of about 5.5 mm. A broken section shows a young stage about 5 mm in diameter; at this stage the ventral lobe is broad, shallow, and weakly bifid; on the flank to the line of involution are 4 simple saddles and 3 shallow, simple lobes. The sutures immediately back of the living chamber are less simple; the ventral lobe is deeper and more strongly bifid, the superior lateral saddle is weakly bifid, the first lateral lobe is weakly trifid and the other 3 lateral saddles and separating lobes are simple. The earliest stage of the conch observed is plumply rounded; the sides become gradually compressed in later stages, the flanks of the living chamber being definitely flattened; the venter of the living chamber is broadly rounded, the flanks and umbilical shoulder are smooth, and there are 2 rows of very weak nodes on each of the poorly defined ventral angles. The shell is too smooth for the young of *Metoicoceras latoventer*, and probably also for the young of *M. swallowii*. U.S.N.M. 106004.

A small, smooth internal mold of *Metoicoceras?*, only 3.4 mm in diameter, from the Templeton member 2.2 miles west of Arthur City, Lamar County (loc. 207, 18274), may pertain to the same species as the preceding, as shown by the form and the simple suture pattern. The specimen is entirely septate. U.S.N.M. 106005.

Two smooth specimens, each about 6 mm. in diameter, from the Templeton member 2.8 miles east of Whitesboro, Grayson County (loc. 154, 14560), may also pertain to *Metoicoceras?*. The sutures are only partly observable, but they seem to be of simple pattern. U.S.N.M. 106006.

A fragment of a large, poorly preserved internal mold of *Metoicoceras?* in ferruginous sandstone of the Templeton member, was collected by Roy T. Hazzard, cut 2.2 miles west of Arthur City, Lamar County (loc. 206, coll. 18877). The mold shows lateral ribs of moderate prominence bearing dull nodes at the ventral angle,

separated by interspaces of equal or greater width. Judging from the lithologic character of the matrix, this specimen came from a layer of ferruginous sandstone 3 to 6 feet below the top of the cut. *Metoicoceras swallowii* (Shumard) is recorded from this locality, but it came from calcareous concretions in sandy shale, in a borrow pit, near the road 25 to 35 feet lower in the section. U.S.N.M. 106007.

Phylum **ARTHROPODA**
 Subphylum **BRANCHIATA**
 Class **CRUSTACEA**
 Subclass **EUCRUSTACEA**
 Superorder **BRANCHIOPODA**
 Order **CONCHOSTRACA**
 Family **LIMNADIIDAE**
 Genus **CYZICUS** Audouin, 1837, *sensu lato*

Type species: *Limnadia tetracera* Krynicki, Recent, in the fresh waters of southwestern Russia. In connection with the introduction of the generic name *Cyzicus* Audouin (1837, p. x), two species were mentioned, *Cyzicus bravaisii* and *C. tetracerus*. So far as I can learn, this is the first usage of *bravaisii*, and, because it is not accompanied by a designation, it must be classed as a nude name, and therefore invalid. The other species, originally described under the name *Limnadia tetracera* Krynicki (1830, p. 176, pl. 7, fig. 1), becomes the genotype of *Cyzicus* Audouin by monotypy.

Cyzicus Audouin replaced the name *Estheria* Ruppell (pre-occupied). (See Daday de Deés, 1915, pp. 234, 235, 278.)

Subsequent to the introduction of the name *Cyzicus* Audouin, the Recent organisms grouped under this name have been subdivided into several genera mainly on the basis of soft parts, which are not available to the paleontologist as a basis for the classification of fossil representatives of the group. For this reason the name *Cyzicus* is here used in a broad sense for a fossil species having the general form and outline of the type species of that genus.

Cyzicus? *shupeii* Stephenson, n. sp.

Plate 58, figures 1, 2

This description is based on the enlarged photograph of a rubber cast made from the external mold of a right valve (holotype). Carapace bivalved, small, subovate in outline, depressed convex, inequilateral. Beaks poorly preserved in the holotype, but some of the paratypes show them to be small, nonprominent, and situated about 0.25 the length of the shell from the anterior extremity. The anterior margin, starting immediately in front of the beak, forms an approximate semicircle to the ventral margin, which is relatively long and very broadly rounded; posterior margin evenly, and a little more narrowly, rounded than a semicircle; dorsal margin straight from the beak to the point where it begins to round into the posterior margin. The surface is ornamented with a series of relatively widely spaced, concentric, low ribs, which, in a photograph, give the impression of narrow, flattish bands. The interspaces are crowded with narrow, radial riblets of more or less

irregular trend and spacing, many of which are entire but several of which fork or anastomose in a more or less irregular manner; some are added by intercalation midway of the interspace. Toward the margin the concentric ribs become so closely crowded that only faint traces of the radial riblets can be detected; this crowding is doubtless an indication of senility. The concentric ribs are not preserved in a small area near the beak of the holotype, but away from the beak about 15 of the more widely spaced ribs, and 12 or more of the closely crowded ribs, can be counted.

The approximate dimensions of the holotype are: Length 3.4 mm, height 2.1 mm, convexity 1 mm.

Features other than those described are not preserved in the available material. The species was found by H. R. Bergquist at one locality only, in the Red Branch member underlying the Lewisville member in Cooke County. It was associated with very poor impressions of *Unio* Retzius, indicating a fresh-water environment.

Several species of *Cyzicus* have been described (under the name *Estheria*) from Triassic and Lower Cretaceous rocks of the United States and Canada but, so far as I know, this is the first species to be recorded from the Upper Cretaceous of North America.

Kobayashi and Huzita (1942, pp. 108-120) have described two species from the Cretaceous Sungari series in Manchoukuo, *Estheria mitsuishii* and *E. septentrionalis*, which, judging from the illustrations, are closely related to *Cyzicus shupeii*.

Types.—Holotype, U.S.N.M. 106008; 30 or more unfigured paratypes (including fragments), U.S.N.M. 106009; 9 or more unfigured paratypes, U.S.N.M. 106010; from a road ditch, 1.35 miles west of the Grayson County line, 2.8 miles S. 70° E. of Callisburg, Cooke County. Named in honor of Nelson W. Shupe, efficient photographer of fossil organisms, U. S. Geological Survey, Washington, D. C.

Occurrence.—Cooke County: Loc. 96 (holotype and paratypes).

Range.—Red Branch member.

Suborder **CIRRIPEDIA**
 Order **THORACICA**
 Family **LEPADIDAE**
 Genus **SCALPELLUM** Leach, 1817
Scalpellum? sp.
 Plate 56, figures 2-8

Abundantly fossiliferous impure limestone of the Lewisville member at a locality (35) on Johnson Creek, 1 mile east of Arlington, Tarrant County, contains the scattered parts of the capitulum of a small goose barnacle, which is here referred questionably to *Scalpellum* Leach (1817, p. 68). Several of the parts are illustrated. The unprepared material in the collection from the locality cited contains an abundance of the parts, probably all belonging to the same species; these are available for the use of any qualified specialist who may desire to study this interesting organism. U.S.N.M. 106011a-g.

DECAPOD CRUSTACEANS FROM THE WOODBINE FORMATION OF TEXAS

By H. B. STENZEL⁷

ABSTRACT

This paper describes the entire decapod crustacean fauna known thus far from the Woodbine formation, Cenomanian, of northern Texas. Small as this collection is, it is unlikely that more specimens will be discovered soon. Of importance is the discovery of a new genus of swimming crab, family Portunidae. This is one of the earliest genera of the family.

INTRODUCTION

On recommendation of John B. Reeside, Jr., of the United States Geological Survey, the United States National Museum early in 1947 sent the writer its small but entire collection of decapod crustaceans from the Woodbine formation of Texas. Because the Woodbine sediments are not a promising source of such fossils, this collection, though small, reflects the thoroughness of the searches made. Additional search by the writer in September 1948 did not yield any material. So far as is known, the Museum's collection contains all the available Decapoda from this formation.

The Upper Cretaceous Woodbine formation is meagerly represented by decapod crustacean fossils. Evidently these fossils were either destroyed before they were embedded or they vanished shortly after burial without leaving a trace, for the abundance of crustaceans living today in shallow marine waters probably indicates that they were abundant also during the Mesozoic and Cenozoic eras.

Sedimentary deposits which have abundant and well-preserved decapod crustacean remains usually have them in association with phosphatic or slightly phosphatic calcareous concretions. The presence of phosphatic material in one kind of concretionary form or another seems to be one of the conditions necessary for the preservation of decapod crustaceans in abundance. Crustacean remains themselves are phosphatic and calcareous. F. W. Clarke (1924, p. 530) reported 14.45 to 49.56 percent of $\text{Ca}_3\text{P}_2\text{O}_8$ and 78.14 to 28.56 percent CaCO_3 in the exoskeletons of various living decapod crustaceans. In marine waters undersaturated with these chemical components no phosphatic or calcareous concretionary materials will be deposited; instead, exoskeletons of decapod crustaceans containing these same chemical components will be dissolved or more or less rapidly corroded. Corrosion or dissolution may be so rapid that remains of dead crustaceans will not endure long enough to be buried or, if buried, they may disappear before the sediment has become compact enough to retain an impression of the

remains. Because most of the Woodbine formation is devoid, or nearly so, of calcareous and phosphatic concretionary materials, it cannot be expected to contain many crustacean remains.

ACKNOWLEDGMENTS

The writer thanks the United States Geological Survey and the United States National Museum for making the collection available to him for study. John B. Reeside, Jr., facilitated progress of the work by advice and by handling the loan of the specimens. L. W. Stephenson gave careful information about stratigraphy and occurrence of the material. Photographs were made by N. W. Shupe of the Geological Survey. Thanks for permission to publish this paper are due the Director, Bureau of Economic Geology, The University of Texas.

SYSTEMATIC PALEONTOLOGY

Order DECAPODA Latreille

Suborder REPTANTIA Boas

Tribe PALINURA Borradaile

Superfamily SCYLLARIDEA Stebbing

Family PALINURIDAE Gray

PALINURID genus undet.

Plate 59, figures 3-7

Locality 28⁸ yielded several fragments of legs and other appendages, including definitely the two last peduncular segments of the left antenna articulated with part of the flagellum. This fragment closely resembles the corresponding part of the left antenna of *Panulirus interruptus* (Randall), the common spiny "lobster," or langouste of the California coast. (See Schmitt, 1921, pp. 108-109.) Generic identification based on so small a fragment cannot be made, and the fossil could well be that of another genus related to *Panulirus*. Family identification, however, is certain.

The first of the 9 preserved proximal segments of the flagellum is about 4 mm long (proximal to distal length), 4.2 mm thick, and 6.5 mm high. The 8 other segments average 1.55 mm long and 5.8 mm high. All segments are devoid of spines or tubercles but have small pits for setae along their distal margins.

The over-all length of the two last peduncular segments of the left antenna is 32 mm. The last segment is laterally compressed, being 16 mm long, about 8 mm thick, and 12 mm high. The inner face is well preserved, the outer face only partly preserved. The inner

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⁸ Fossil collecting localities are described on pages 35-44. See footnote 2, page 35.

face carries 4 sharp distally pointing spines, each about 3 mm long, at the distal edge of the segment. One spine, with only the base preserved, is at the upper distal corner; another spine is opposite to that one at the lower distal corner of the segment; another spine is immediately above, or dorsad, and attached to the hinge tubercle; the fourth spine is halfway between the spine at the hinge tubercle and the one at the lower distal corner. There is a very small spine halfway between the spine at the proximal hinge tubercle and the distal spine that joins the distal hinge tubercle. This small spine is on a rounded longitudinal ridge connecting the proximal with the distal hinge tubercle. Above this ridge the inner face is gently convex up to the comparatively narrow upper edge. Below this ridge the inner face is concave at first but rounds out convexly farther down. The concave portion is smooth, but the convex portions are covered with many minute proximally pointing tubercles. About midway on the lower edge of the segment one of these tubercles is a little more prominent than the others. Except for this small tubercle and the distal spine the lower edge is devoid of major prominences; it is also fairly narrowly rounded and straight, except at the proximal end where it curves rapidly into the joint. The upper edge is well rounded and much broader than the lower; it is poorly preserved but appears devoid of tubercles except for the distal one, the base of which is preserved. The preserved part of the outer face is devoid of concave places, is covered with tiny tubercles, and shows only one small spine; this spine is at the distal end, about halfway between the hinge tubercle of the flagellum and the distal spine of the lower edge.

The hinge between the ultimate and penultimate segments of the peduncle is characteristically oblique to the long axis of the antenna, the outer end of the hinge being displaced distad in comparison with the inner one. This feature is characteristic of the family. Both hinge points are sharp conical tubercles on the ultimate segment and are overlapped in a sharp conical fashion by the hinge tubercle of the penultimate segment.

The penultimate segment of the peduncle is 15 mm long, 12 mm wide at the distal hinge, and 11 mm high at the distal end; it narrows a little proximally. The outer face, as far as it is preserved, does not show any spines, but there are small tubercles on the distal half near the distal hinge point. The upper edge is broadly rounded, devoid of spines, but has tubercles. The inner face shows 3 spines, each about 2 mm long and distally pointing; two of these are at the distal end, one near the upper edge and the other near the lower; the third spine is at the distal third of the inner face in an equilateral triangle with the hinge tubercle and the upper distal spine. The inner face is also covered with tubercles.

Found with the remains of this antenna is the dactylus of an ambulatory leg. It is 22 mm long and gently curved. At the proximal joint it is 7.5 mm high and about 7.2 mm wide and tapers gradually to the sharp distal end. The cross section is roughly square, there being 4 flattish longitudinally disposed faces. Two of the opposing lateral faces carry rows of small, shallow, and flat-bottomed pits once occupied by bunches of hair; one of these faces has one row of circular pits, the opposite face has two rows of pits which are irregular in outline and merge partly. The lower face is slightly concave in cross section and in longitudinal direction. The upper face has a longitudinal groove beginning at the joint and extending about halfway the length of the dactylus. There are two single hair pits in this groove near the middle of the dactylus.

Other fragments are the merus, carpus, and propodus of ambulatory legs. The last two have many distally pointing tubercles but seem to be devoid of spines. The carpus is compressed oval, but the propodus seems to be more tumid in cross section. The carpus is 19 mm long, 12 mm high, and 6 mm wide.

In comparison with the Recent *Panulirus* J. E. Gray the ambulatory legs are shorter and stouter and the antennar peduncle less spinous and more compressed laterally. The structural similarity is, however, great, so that the family determination is assured.

The matrix is a dark brick-red, highly ferruginous, fine-grained sandstone. Preservation is partly as exterior imprints and partly as interior casts. There is a considerable amount of small jointing or cracking and some distortion in the matrix and in several of the ambulatory leg impressions. The dactylus and antenna figured have been cast with latex from their exterior imprints.

The Recent *Panulirus interruptus* (Randall) (plate 59, figs. 1, 2) of the west coast inhabits rocky ledges in water as deep as 35 fathoms, but many individuals stray into rocky tide pools. It has never been recorded north of San Luis Obispo, Calif., and is strictly a southern form.

Fossil representatives of this family are widely distributed and are common in Cretaceous strata. (See Stenzel, 1945, pp. 401-476.) They are not restricted to sandy matrix but are also found in calcareous shales.

Type data.—U.S.N.M. 108230.

Occurrence.—Tarrant County: Loc. 28.

Range.—Euless member.

Tribe ANOMURA Milne-Edwards

Superfamily THALASSINIDEA Dana

Family CALLIANASSIDAE Bate

Genus CALLIANASSA Leach, 1814

1814. Leach, W. E., Edinburgh Encyclopaedia, vol. 7, p. 400.

Type: Callianassa subterranea (Montagu), Recent, along the shores of western Europe.

Callianassa? sp.

Plate 59, figure 8

An incomplete manus, preserved as interior cast, with the proximal end broken. It is not clear whether the exposed surface is the outer or inner one. Surface nearly straight longitudinally, but gently convex from upper to lower margin; convexity greater near root of fixed finger, less toward upper margin. Toward articulation of movable finger the surface rises to a swelling alongside the articulation. Between this swelling and the fixed finger is a depression, at the lower inner margin of which is a rather sharply elevated point. Upper distal margin with a narrow crest separated by a groove from swelling below. The manus, as preserved, is 13 mm long and 11.5 mm high.

The specimen is an interior cast preserved in a very dark brick-red, highly ferruginous, fine-grained sandstone. Other fossils visible are small pelecypod imprints.

Species of *Callianassa* are common from the Late Jurassic to the present time. More than 130 fossil species have already been described. This fragment adds nothing of importance to our knowledge of the genus and is too incomplete and questionable for formal description of a species. Its presence in the Woodbine formation is, however, of ecologic interest.

The genus *Callianassa* being old and successfully adapted to special conditions is widely distributed. *Callianassas* generally burrow in sand or mud, chiefly in the littoral zone but live also in deeper waters. They are adapted to burrowing by their cylindrical shape, but they also swim skillfully by using their pleopods and their well-developed tailfan. Concerning the living *Callianassa longimana* Stimpson in San Francisco Bay, Schmitt (1921, pp. 118-119) writes:

Within the bay *Callianassa longimana* runs very true to type, having been dredged only at stations having a sandy or a purely mud bottom; two specimens were captured by means of the tow-net. * * * The ranges of temperature and salinity based on the survey observations which we are able to record for *Callianassa longimana* are, respectively, 8.2° to 18.9° C. and 18.3 to 31.7. [Depth ranges from 2 to 12¾ fathoms.]

Other species of *Callianassa* from California waters are recorded by Schmitt from the following depths: 21, 264-271, 278, and 322 fathoms. The *Callianassa major* Say is numerous on the beaches of South Carolina. Some beaches are honeycombed with its burrows; their openings are found as a rule from low-water mark to half-tide mark. Burrows are up to 5 feet deep. (See Lunz, 1937.)

What appear to be fossil *Callianassa* burrows are found in the silty beds of the Woodbine formation immediately under the *Ostrea soleniscus* Meek reef at the spillway of Lake Dallas, about 12 miles southeast of Denton, Denton County, Tex. This bed is replete with nearly vertical pipes composed of brick-red impure

clay-ironstone about 2 cm in diameter. These pipes end blind at their lower end and merge upward into a tangle of such pipes. Their shape and occurrence suggest that the *Callianassa* burrows were later filled with sideritic material that has changed to clay-ironstone.

Type data.—U.S.N.M. 108227.

Occurrence.—Tarrant County: Loc.11.

Range.—Dexter member, 4 or 5 feet above top of Grayson marl.

Tribe BRACHYURA Latreille

Subtribe OXYSTOMATA DeHaan

Family CALAPPIDAE Alcock

Genus CENOMANOCARCINUS Van Straelen in Stenzel, 1945.

1936. Van Straelen, Victor, Crustacés décapodes nouveaux ou peu connus de l'époque crétacique: Mus. royale histoire nat. Belgique Bull., vol. 12, no. 45, pp. 37-39.

1945. Stenzel, H. B., Decapod crustaceans from the Cretaceous of Texas: Texas Univ. Pub. 4401, pp. 446-450.

Type by original designation in Stenzel, 1945: "*Cenomanocarcinus inflatus* (A. Milne-Edwards MS.)" from the Cenomanian sands of Le Mans, France.

When Van Straelen proposed this genus in 1936, he assigned to it two species: *C. inflatus* (A. Milne-Edwards MS.) Van Straelen, which Van Straelen described for the first time, and *C. oklahomensis* (Rathbun), to which he gave a pertinent literature reference. However, Van Straelen failed to designate one of these two species as the type species. According to Article 25c (3) of the International Rules of Zoological Nomenclature, it is necessary to designate definitely and unambiguously the type species if the new genus is to be valid. This part of the Rules applies to all generic names proposed after Dec. 31, 1930. Hence, *Cenomanocarcinus* Van Straelen, 1936, is not valid. Stenzel designated *C. inflatus* Van Straelen, 1936, as the type species and repropoed the genus as new in order to establish validity of the genus. Hence, the genus dates validly from Stenzel's paper of 1945.

The known range of the genus is upper Albian to Turonian, and the genus contains at present the following species:

C. armatus (Rathbun) (1935, pp. 50-51) from Denton clay, upper Albian, of Texas.

C. inflatus Van Straelen (1936, pp. 37-39) from the Cenomanian sands of France.

C. oklahomensis (Rathbun) (1935, pp. 44-45) from the Weno limestone, upper Albian, of Oklahoma.

C. vanstraeleni Stenzel (1945, pp. 447-450) from Eagle Ford shale, Turonian, of Texas.

The genus is closely related to *Necrocarcinus* Thomas Bell, 1863, and at least three species are regarded as transitional between the two genera. These transitional species of *Necrocarcinus* are upper Albian to Cenomanian in age. The genus is distinguished from *Necrocarcinus* by its three longitudinal tubercle-bearing ridges on the posterior part of the carapace.

Cenomanocarcinus vanstraeleni Stenzel

Plate, 59, figures 9 and 10

1941. *Cenomanocarcinus vanstraeleni* Stenzel, H. B., in Dallas Petroleum Geologists, Geology of Dallas County, Texas, p. 39 (merely listed, hence a *nomen nudum* herein).
1945. *Cenomanocarcinus vanstraeleni* Stenzel, Texas Univ. Pub. 4401, pp. 447-450, pl. 44 and text fig. 15.

Full description of this species was given in 1945. The solitary fragment at hand is the left pterygostomian region of the ventral face of the carapace and once adjoined the buccal cavity, the left rim of which is preserved in the fragment; it is nearly completely decorticated so that merely a thin skin covering the internal cast is preserved. It measures 24 by 36 mm. For comparison with this fragment (pl. 59, fig. 9) see plate 59, figure 10, the syntype 5 of *C. vanstraeleni* Stenzel in the same orientation and illumination. Syntype 5 shows the same pterygostomian region between the left exognath and the left cheliped and is so similar to the fragment from the Woodbine formation, except for the decortication of the latter, that the generic identification is assured; specific identity is slightly doubtful because specific characters may not be distinguishable in so small a fragment. Usually it is impossible to identify a stray fragment even generically, but in this case the excellent comparative material from the Eagle Ford shale available makes identification possible.

This fragment extends the known range of the species from the zone of *Metoicoceras whitei* Hyatt (1903, pp. 122-127) in the Eagle Ford shale, Turonian, down into the Woodbine formation, Cenomanian. *Cenomanocarcinus vanstraeleni* Stenzel is closely related to *C. inflatus* Van Straelen from the type locality of the Cenomanian, more closely than to the other species of the genus. Both *C. vanstraeleni* and *C. inflatus* are evolutionarily advanced forms, and *C. vanstraeleni* is more advanced than *C. inflatus*, possibly indicating a younger stratigraphic age for the Texas species than for the French species, as seems to be borne out by the relative stratigraphic positions of the two species.

Type data.—Specimen illustrated here is U.S.N.M. 108228. Original types of species are in the Bureau of Economic Geology of The University of Texas, Austin, Tex. Their locality is: California Crossing, north-facing bluff on right bank of Elm Fork of the Trinity River, upstream from and at Chicago, Rock Island and Pacific Railroad bridge, in southwest corner of Joshua McCants survey, on O'Connor dairy land, about 10 miles northwest of Dallas, Dallas County, Tex. This is also the type locality of 7 other crustaceans described by Stenzel and probably the type locality of *Metoicoceras whitei* Hyatt. (See Moreman, 1942, p. 197.)

Occurrence.—Grayson County: Loc. 165.

Range.—Templeton member. Type locality of species in the *Metoicoceras whitei* zone of Eagle Ford shale, estimated by L. W. Stephenson to be 50 to 60 feet above its base.

Subtribe BRACHYGNATHA Borradaile

Superfamily BRACHYRHYNCHA Borradaile

Family PORTUNIDAE Miers

Genus WOODBINAX Stenzel, n. gen.

Type species: *Woodbinax texanus* Stenzel, n. sp., herewith designated.

Comparison with known genera is severely limited because of the fragmentary nature of the one specimen. Nevertheless the carapace of *Woodbinax* has several features that assign it securely to the family Portunidae. These are: the flatness of the carapace as a whole, the presence of an epigastric line surmounting the protogastric swellings, and the presence of a crescentlike epibranchial ridge at the anterior margin of each branchial region.

Cretaceous Portunidae are very rare, and only two other genera are known: *Carcineretes* Withers (1922,

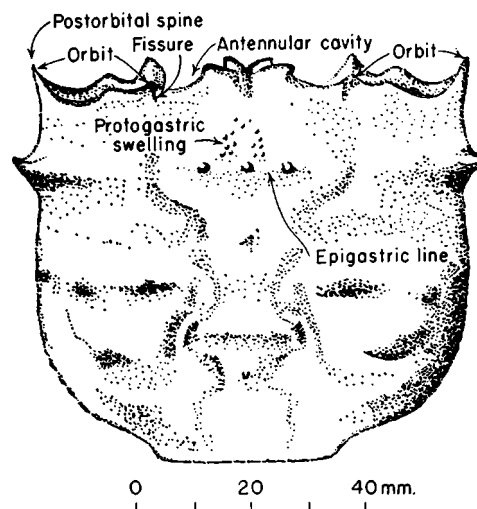


FIGURE 6.—Carapace of the type species of *Ophthalmoplax* Rathbun, 1935; composition from several specimens in collection of the Texas Bureau of Economic Geology.

pp. 534-541, pls. 16, 17) and *Ophthalmoplax* Rathbun (1935, pp. 52-54). The Cretaceous genus *Lithophylax* A. Milne-Edwards & P. Brocchi, 1879, which had been placed by Rathbun in the family Portunidae, has now finally been figured and re-evaluated by Van Straelen (1936, pp. 43-44, pl. 4, fig. 9), who has placed it in a new family, Lithophylacidae. According to Van Straelen this family is related to the Goneplacidae and therefore does not resemble the Portunidae.

Diagrams of the carapace of each of the three Cretaceous genera (figs. 6, 7, 8) facilitate comparison. In two of these diagrams dotting indicates shade, so that the surface sculpture may become apparent. The diagram of *Carcineretes* is copied from Withers, who seems to have indicated shade by short transverse lines. The diagram of *Ophthalmoplax* is a composite of several specimens of the type species in the collections of

the Bureau of Economic Geology of The University of Texas, donated to it by the Rio Bravo Oil Co.

The genera *Ophthalmoplax* and *Carcineretes* are similar in their general subquadrate outline. They also have the postorbital spine at the anterolateral corner of the carapace, and the distance from one postorbital spine to the other is great; it is the maximal width

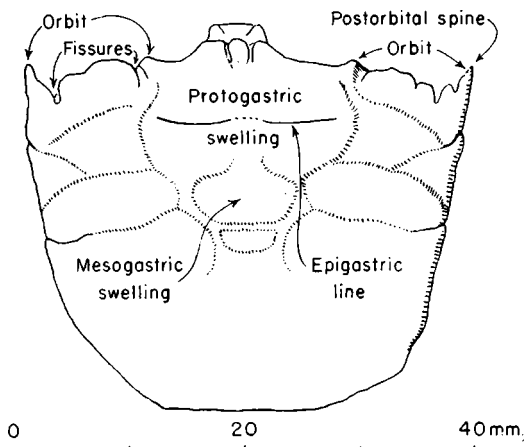


FIGURE 7.—Carapace of the type species of *Carcineretes* Withers, 1922; *Carcineretes woolacotti* T. H. Withers, male, holotype; after Withers.

of the carapace. *Woodbinax* has comparatively small orbits. Beyond the left postorbital spine, there is enough of the specimen preserved to show that the carapace extended laterally beyond the spine. Therefore, the carapace is probably not subquadrate. The *Woodbinax* also has two fissures in each upper orbital margin; *Ophthalmoplax* has one fissure only at the

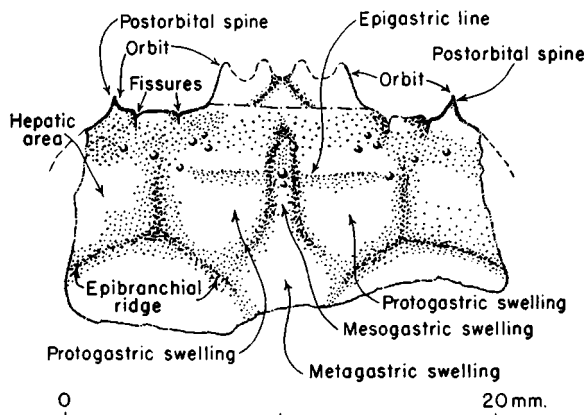


FIGURE 8.—Carapace of the type species of *Woodbinax* Stenzel, n. gen.; *Woodbinax texanus* Stenzel, monotype.

outer end of the upper margin of the antennular cavity; *Carcineretes* has two open fissures in the upper orbital margin, one of these near the base of the postorbital spine. Also it has one or two fissures at the same place as the single fissure in *Ophthalmoplax*. Another feature common to *Ophthalmoplax* and *Carcineretes* is the lack of definition of the median anterior fingerlike extension of the mesogastric swelling. In these two

genera this extension is merged with the two protogastric swellings to make one broad transverse swelling. In *Woodbinax* this fingerlike median extension is well defined by deep subparallel grooves.

The epibranchial swellings are curved convexly forward in *Woodbinax* and are reminiscent of similar outlines in Cenozoic genera of the family. No such curved swellings are present in the two other Cretaceous genera. The legs of *Carcineretes* are flattened into swimming paddles; those of *Ophthalmoplax* and *Woodbinax* are unknown. The *Ophthalmoplax* and *Carcineretes* seem to be closely related genera; but *Woodbinax* seems closer to some of the Cenozoic genera than to them.

Woodbinax texanus Stenzel, n. gen., n. sp.

Plate 59, figure 11; text figure 8.

The single specimen is a fragment of an interior cast showing the dorsal face of the carapace. It lacks the anterolateral parts distad from the postorbital spine and the part behind the epibranchial and metagastric regions. Preserved are small pieces along the orbits and anterolateral margin. Width of the fragment is 19 mm. The interorbital front is broken off, but an impression of its ventral face is retained. Front with four dents; the outer two dents are the inner orbital dents; the two others are median, project slightly more than the outer two. At the base of the ventral surface of the front is a triangular elevation, preserved as a concave imprint, which is apparently the triangular base of the interantennular septum. Orbits with an inner and an outer dent, between which the orbital margin recedes and has two narrow fissures; orbital margin between these two fissures faintly curved forward in two places; width of orbit 6 mm from tip of inner to outer dent. Only 2.5 mm of the anterolateral margin adjoining the outer orbital dent is preserved and has no indication of dents. Mesogastric swelling with a 4-mm long anterior extremity bounded by two parallel, wide, and fairly deep grooves joining near the front; posterior part merging imperceptibly into the metagastric region, both nearly pentagonal in outline and flat and low. Protogastric swelling higher than mesogastric, surrounded on the sides and to the rear by grooves, about 5 mm long and wide; at the anterior it carries a transverse epigastric ridge, the anterior slope of which is steeper than the posterior. Hepatic area has a diagonal low swelling. Epibranchial area has a curved ridge, from which a long gentle slope extends to the posterior. Cervical grooves broad and fairly deep; groove between hepatic and protogastric swellings similar.

There are several small, low tubercles on the carapace: two median on the anterior end of the extension of the mesogastric region at the level of the epigastric ridges; one in each groove outlining this extension near their junction; three forming a triangle in the postorbital groove and inward and back of the inner orbital

margin fissure; two in the postorbital groove near the outer orbital margin fissure; two in line with and at the outer end of the epigastric ridge; one back of the latter two and on the lateral margin of the protogastric swelling. Surface of carapace, where preserved, covered with countless small granules. Slightly coarser granules on top of the epigastric ridges.

The matrix is a dark brick-red, highly ferruginous, fine-grained sandstone, and the specimen is an interior filling of the carapace by that matrix. Small portions of the carapace, replaced by ocher-yellow limonite, adhere to the surface of this filling.

Type data.—Monotype, U.S.N.M. 108226.

Occurrence.—Grayson County: Loc. 115.

Range.—Lewisville member.

POSITION UNCERTAIN

Crustacean fragment

Plate 59, figure 12

A piece 14 mm long and 2 mm in diameter is apparently a leg fragment. It is slightly curved and has spinous tubercles. U.S.N.M. 108229.

Occurrence.—Fannin County: Loc. 192.

Range.—Hard lenses in sandy shale, 3 feet below tuffaceous clay bed, in Lewisville member, roughly 70 feet below top of Woodbine formation.

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PLATES 8–59

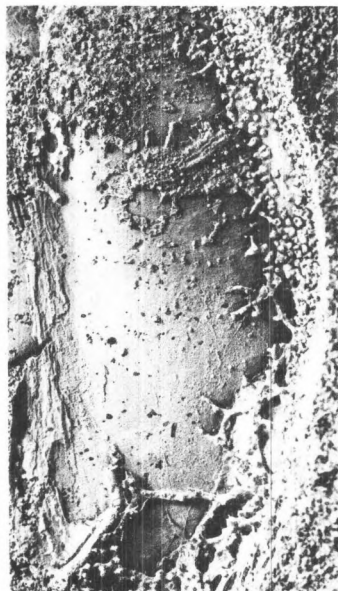
PLATE 8

FIGURES 1-3. *Cliona retiformis*, n. sp. (p. 50).

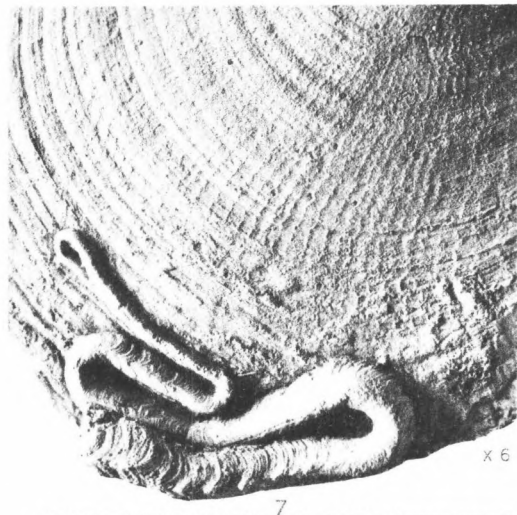
1. Holotype ($\times 2$), ferruginous casts of sponge borings in shell of *Ostrea soleniscus* Meek (shell substance removed in solution), from Eules member on State Highway 183, within 1.2 miles west-southwest of Eules, Tarrant Co. Loc. 29. U.S.G.S. 19041, U.S.N.M. 105068.
2. Paratype ($\times 2$), similar casts of borings in an oyster shell of the same species at the same locality. U.S.N.M. 105069.
3. Paratype ($\times 1$), entrance borings made by young sponges in shell of *Ostrea soleniscus* Meek, from Lewisville member on Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 72. U.S.G.S. 504, U.S.N.M. 105071.
- 4-6. *Specus fimbriatus*, n. sp. (p. 51).
- 4, 5. Two paratypes ($\times 3$), ferruginous casts of sponge borings in shells of bivalve mollusks (shell substance removed in solution), from Eules member on east-west road, 2.6 miles north of Arlington, Tarrant Co. Loc. 19. U.S.G.S. 18980, U.S.N.M. 105074 and 105075.
6. Holotype ($\times 3$), similar ferruginous casts in shell of bivalve mollusk, from marine facies in lower part of Dexter member, field north of east-west road, 3.2 miles east-southeast of Handley, Tarrant Co. Loc. 15. U.S.G.S. 18989, U.S.N.M. 105073.
- 7-9. *Serpula implicata*, n. sp. (p. 52).
7. Holotype ($\times 6$), tube attached to shell of *Anomia ponticulana* Stephenson, from Lewisville member on Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 78. U.S.G.S. 18648, U.S.N.M. 105076.
8. Paratypes ($\times 2$), tubes attached to shell of *Ostrea soleniscus* Meek, from Lewisville member on Timber Creek, southwest of Lewisville (exact locality not stated), Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105077a.
9. Paratypes ($\times 6$), tubes attached to the same shell as the preceding. U.S.N.M. 105077b.



1 x 2



2 x 2



x 6

7



3

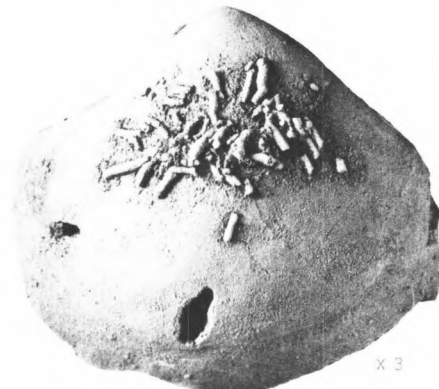


8 x 2



x 6

9



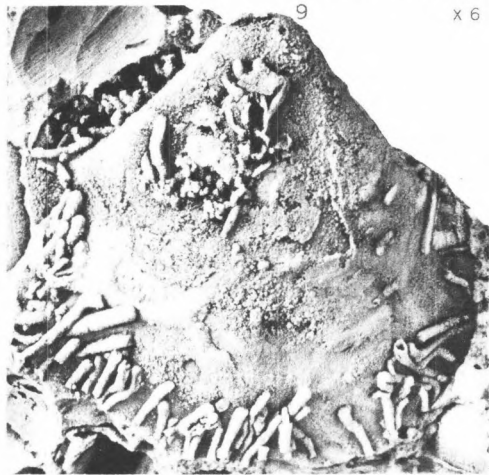
x 3

4



x 3

5



x 3

6

SPONGES AND CHAETOPODS FROM THE WOODBINE FORMATION

PLATE 9

FIGURE 1. *Serpula* sp. (p. 52).

Tubes (× 2) attached to shell of *Aguileria cummingsi* White, from Lewisville member on Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105080.

2-6. *Graysonia bergquisti*, n. sp. (p. 53).

2. Paratype (× 4), ferruginous casts of vesicles (internodes) in shell of bivalve mollusk (shell substance removed in solution), from Lewisville member in gully east of the Whitesboro road, 1.75 miles south of Sandusky, Grayson Co. Loc. 117. U.S.G.S. 18966, U.S.N.M. 105088.

3. Paratype (× 6) casts of stolons and vesicles, some of which appear to be attached to each other, in shell of mollusk, also from loc. 117. U.S.N.M. 105087.

4. Paratype (× 4), ferruginous casts of stolons in shell of *Ostrea soleniscus* Meek (shell substance removed in solution), also from loc. 117. U.S.N.M. 105086.

5. Paratype (× 3), ferruginous casts of nodes and club-shaped vesicles in shell of large gastropod, from Lewisville member in branch east of north-south road, 2.5 miles north of Sadler, Grayson Co. Loc. 132. U.S.G.S. 20271, U.S.N.M. 105083.

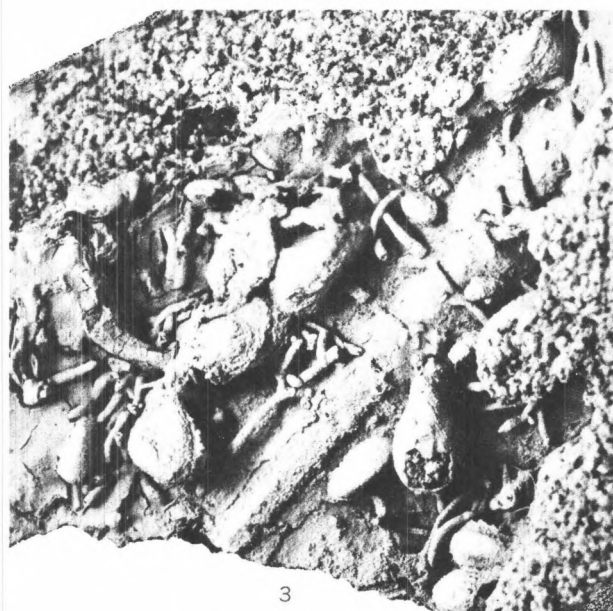
6. Holotype (× 3), ferruginous casts of stolons and nodose and club-shaped vesicles in shell of *Gymnentome valida brevis* Stephenson, also from loc. 132. U.S.N.M. 105082.



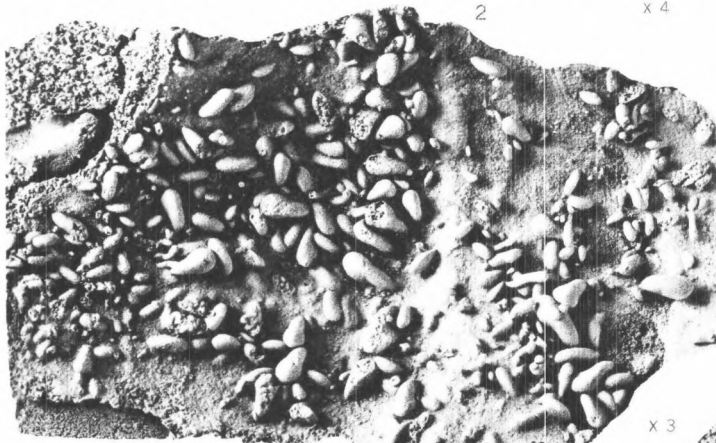
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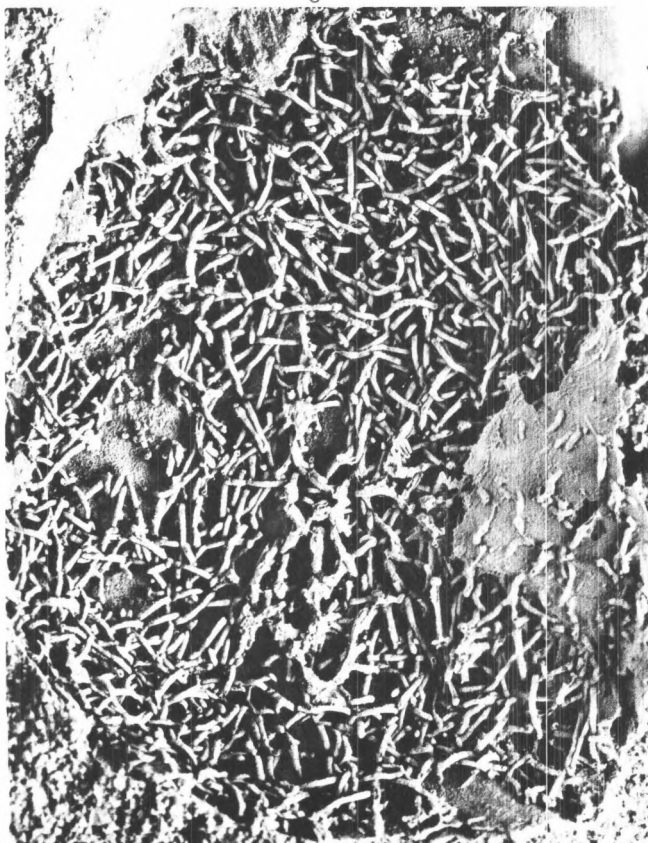
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6 x 3



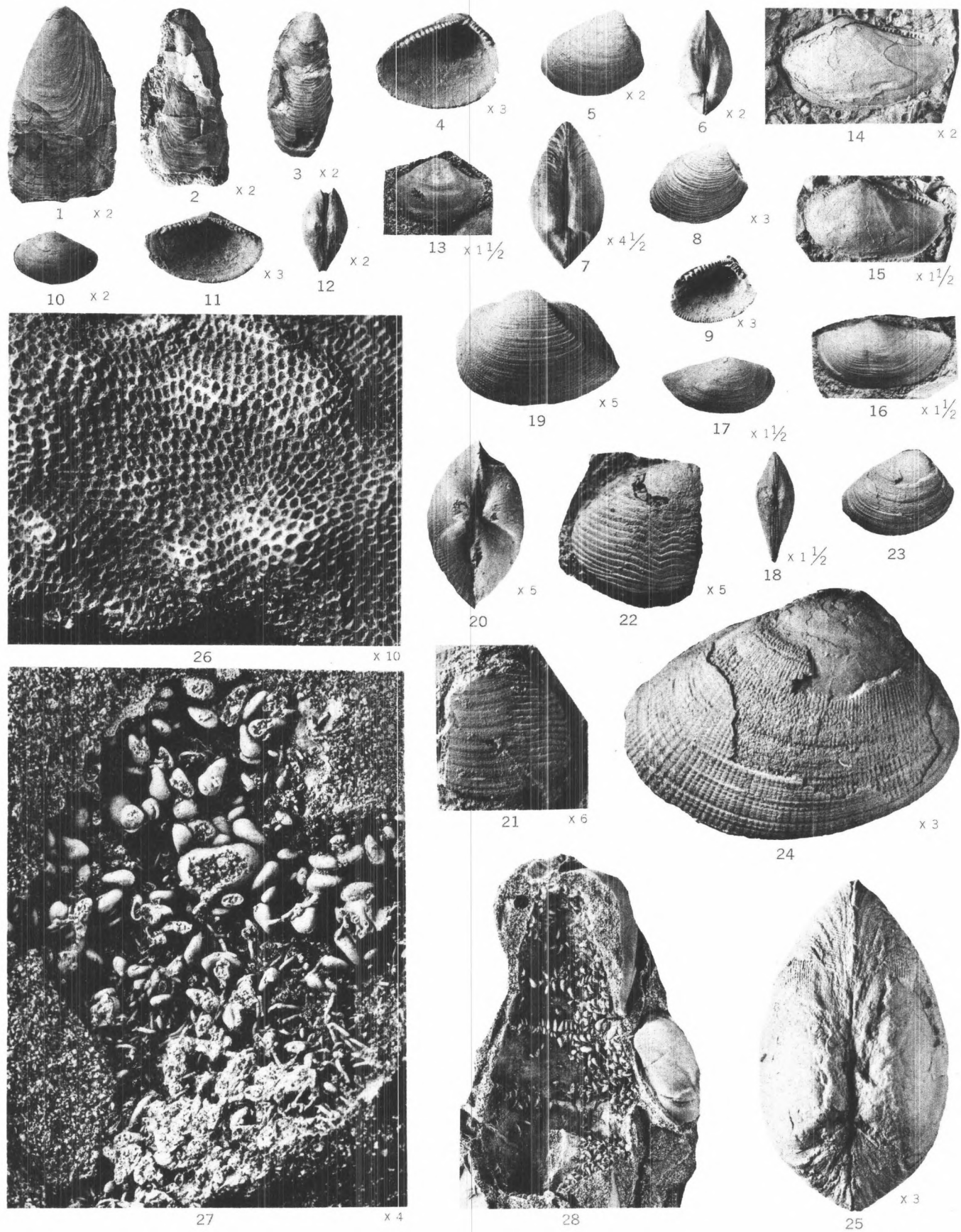
4 x 4

BRYOZOA FROM THE WOODBINE FORMATION

PLATE 10

FIGURES 1-3. *Lingula subspatulata* Hall and Meek? (p. 54).

1. Example ($\times 2$), partly crushed shell from Templeton member, bluff on branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105093.
2. Example ($\times 2$), crushed shell from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105095.
3. Example ($\times 2$), partly crushed shell from Lewisville member, Red River at Hyatts Bluff, 4.5 miles northwest of Ravenna, Fannin Co. Loc. 179. U.S.G.S. 10555, U.S.N.M. 105096.
- 4-6. *Nucula rivulana*, n. sp. (p. 54).
4. Paratype ($\times 3$), interior view of right valve, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105098.
- 5, 6. Holotype ($\times 2$), side and top views, from the same source. U.S.N.M. 105097.
- 7-9. *Nucula sholsa*, n. sp. (p. 55).
- 7, 8. Holotype, top view ($\times 4\frac{1}{2}$) and side view ($\times 3$), from Templeton member, bed of Red River near old Slate shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105100.
9. Paratype ($\times 3$), interior view of right valve, from the same source. U.S.N.M. 105101.
- 10-12. *Nuculana? mutuata*, n. sp. (p. 57).
- 10, 12. Holotype ($\times 2$), side and top views, from Lewisville member (Tarrant unit of Moreman), borrow pit south of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, Tarrant Co. Loc. 50. U.S.G.S. 18992, U.S.N.M. 105115.
11. Paratype ($\times 3$), interior view of left valve from same source. U.S.N.M. 105116.
13. *Nuculana?*, sp. (p. 57).
Internal mold of a left valve ($\times 1\frac{1}{2}$), from the Lewisville member in a branch east of a north-south road, 2.5 miles north of Sadler, Grayson Co. Loc. 132. U.S.G.S. 20271, U.S.N.M. 105118.
- 14-16. *Yoldia? septariana* Cragin (p. 57).
14. Plesiotype ($\times 2$), left valve from Templeton member, gullies south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 14560, U.S.N.M. 105119.
15. Cotype ($\times 1\frac{1}{2}$), left valve from Templeton member, 4 miles [sic] east-southeast of Whitesboro, Grayson Co. Coll. Univ. of Texas, Austin. (See plastotype, U.S.N.M. 105120.)
16. Plesiotype ($\times 1\frac{1}{2}$), left valve from Lewisville member, small branch, north of old road, south of State Highway 114, 1.4 miles west of Grapevine, Tarrant Co. Loc. 49. U.S.G.S. 19512, U.S.N.M. 105121.
- 17, 18. *Yoldia? subacuta*, n. sp. (p. 58).
Holotype ($\times 1\frac{1}{2}$), right side and top views, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105123.
- 19, 20. *Breviarca habita*, n. sp. (p. 60).
Left and top views of holotype ($\times 5$), from Templeton member, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105131.
21. *Acila (Truncacila)? sp. a* (p. 56).
Portion of right valve ($\times 6$), from Lewisville member (Tarrant unit of Moreman), north of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 41. U.S.G.S. 14567, U.S.N.M. 105111.
22. *Acila (Truncacila)? sp. b* (p. 56).
Portion of left valve ($\times 5$), from Templeton member, east-west road, 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105113.
- 23-25. *Acila (Truncacila)? chicotana*, n. sp. (p. 56).
23. Holotype, left side ($\times 1$), from Templeton member, borrow pit north of road 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. 18619, U.S.N.M. 105108.
- 24, 25. Holotype ($\times 3$), left side and top views.
26. *Membranipora* sp. (p. 53).
Part of zoarium ($\times 10$) encrusting a shell of *Ostrea soleniscus* Meek, from Lewisville member, Timber Creek, about 2.25 miles south-southwest of Lewisville, Denton Co. Loc. 82. U.S.G.S. 7559, U.S.N.M. 105092.
- 27, 28. *Graysonia bergquisti*, n. sp. (p. 53).
27. Paratype ($\times 4$), ferruginous casts of stolons and vesicles (some apparently connected with each other) in shell of mollusk (shell substance removed in solution), from Lewisville member, field east of north-south road, 0.5 mile north of U. S. Highway 82, 0.5 west of Grayson County line, in Cooke Co. Loc. 99. U.S.G.S. 20269, U.S.N.M. 105090.
28. Paratype ($\times 1$), similar ferruginous casts of vesicles (internodes) in shell of *Gymnentome valida* Stephenson, from Lewisville member, branch east of north-south road, 2.5 miles north of Sadler, Grayson Co. Loc. 132. U.S.G.S. 20271, U.S.N.M. 105084.



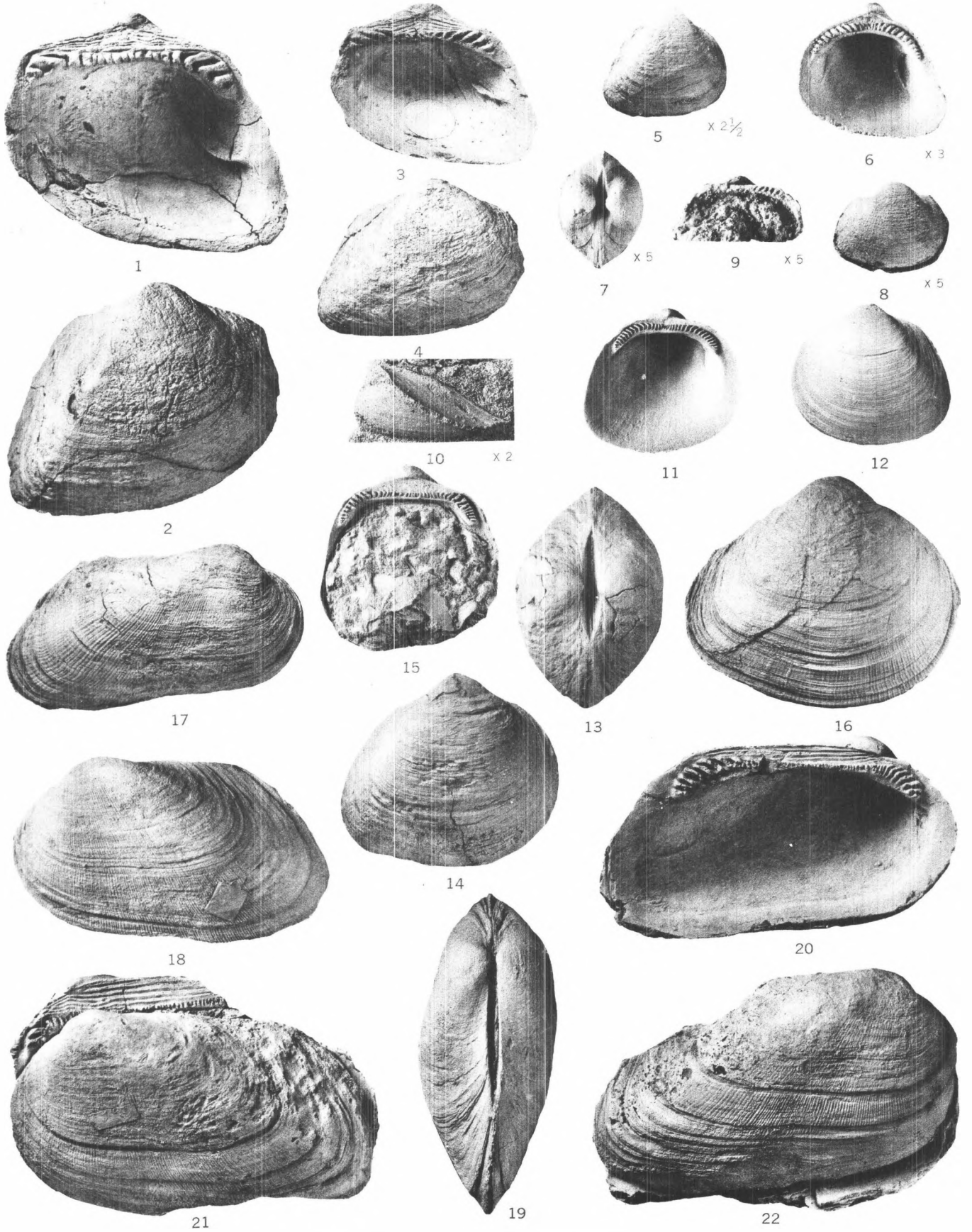
BRYOZOA, BRACHIOPODS, AND PELECYPODS FROM THE WOODBINE FORMATION

PLATE 11

[Figures natural size except as indicated]

FIGURES 1-4. *Idonearca blanpiedi*, n. sp. (p. 63).

- 1, 2. Views of the holotype, a right valve, from Templeton member, 4 miles southwest of Denison (probably near Ellsworth School), Grayson Co. U.S.G.S. 439a, U.S.N.M. 105146.
- 3, 4. Views of a paratype, a right valve, from Templeton member, old Sherman road, 3.25 miles [sic] southwest of Denison [probably near Ellsworth, 4 miles], Grayson Co. U.S.G.S. 16436, U.S.N.M. 105148.
- 5, 6. *Breviarca (Sanoarca) fauwana*, n. sp. (p. 62).
 5. Exterior of holotype, a right valve ($\times 2\frac{1}{2}$), from Lewisville, member, from a small stream gorge, 0.35 mile west of road, 1.9 miles S. 54° W. of center of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105143.
 6. Interior view of the holotype ($\times 3$).
- 7-9. *Breviarca minor*, n. sp. (p. 60).
 - 7, 8. Holotype ($\times 5$), top and right side views, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105127.
 9. Paratype ($\times 5$), hinge of left valve, from Templeton member, borrow pit 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. 18274, U.S.N.M. 105129.
10. *Linter?* sp. (p. 62).
 - Internal mold of left valve ($\times 2$), from Lewisville member, Hillsboro road, 2 miles east of Whitney, Hill Co. Loc. 3. U.S.G.S. 11836, U.S.N.M. 105145.
- 11-16. *Breviarca (Sanoarca) grandis*, n. sp. (p. 61).
 - 11, 12. Views of a medium-sized paratype, from the Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105138.
 - 13, 14. Views of the holotype, from the same source. U.S.N.M. 105137.
 15. Hinge of the left valve of a paratype from the same source. U.S.N.M. 105139.
 16. Right valve of a large paratype, from the Lewisville member, on a branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105141.
- 17-22. *Protarca? tramitensis* (Cragin). (p. 59).
 17. Right side of an example from Lewisville member, "4 miles south [sic] of Lewisville," Denton Co. Loc. 69. U.S.N.M. 21842; essentially a topotype.
 - 18, 19. Views of another example in the same collection. U.S.N.M. 21842b; essentially a topotype.
 20. Hinge and interior of a left valve in the same collection. U.S.N.M. 21842c; essentially a topotype.
 - 21, 22. Views of a specimen believed to be a cotype. Univ. of Texas Collection. (See plastotype, U.S.N.M. 105125.)

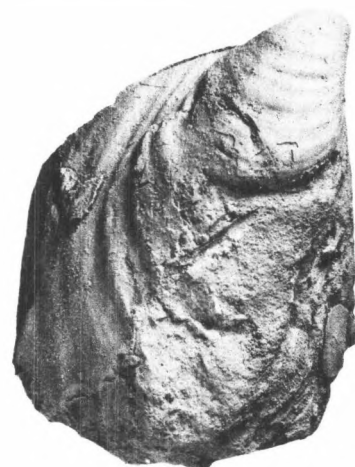


PELECYPODS FROM THE WOODBINE FORMATION

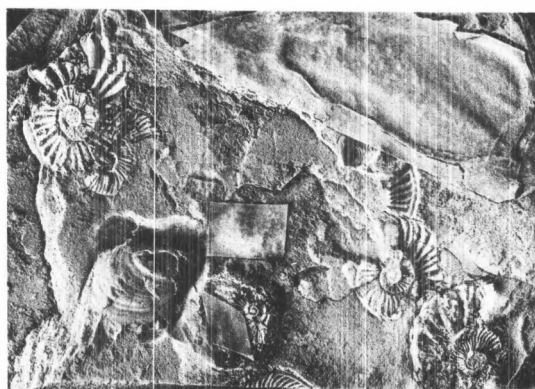
PLATE 12

[Figures natural size except as indicated]

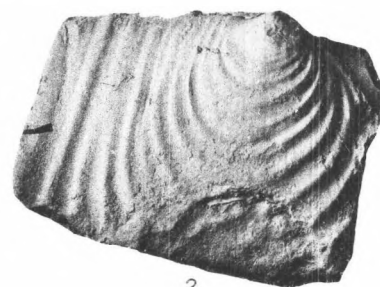
- FIGURE 1. *Inoceramus* sp. a (p. 66).
Right valve from Templeton member, right bank of Red River, 1.5 miles north of Ragtown, Lamar Co. Loc. 202.
U.S.G.S. 14551, U.S.N.M. 105161.
2. *Inoceramus* sp. b (p. 66).
Right valve from Templeton member, gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson Co.
Loc. 154. U.S.G.S. 17163, U.S.N.M. 105162.
- 3, 4. *Inoceramus fragilis* Hall and Meek (p. 64).
Inserted for comparison with *I. prefragilis* Stephenson.
3. Holotype at left of diamond on piece of gray shale, showing association with prints of young shells of *Collignoniceras woolgari* (Mantell), from the Carlile shale (Colorado group), Missouri River, 5 miles below the mouth of Vermillion River. Am. Mus. Nat. History 9358/1. (See plastotype, U.S.N.M. 105163.)
4. Holotype ($\times 2$).
5. *Lima* sp. (p. 81).
A left valve ($\times 2$) from Templeton member, bed of Red River near old Slate shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105250.
- 6-9. *Inoceramus arvanus*, n. sp. (p. 65).
6. Internal mold of a paratype, from Lewisville member, field east of road, 0.5 mile north of U. S. Highway 82, 0.5 mile west of Grayson County line, in Cooke Co. Loc. 99. U.S.G.S. 20269, U.S.N.M. 105158a.
7. Rubber cast of external mold of the holotype from the same source. U.S.N.M. 105157.
8. Internal mold of left valve of a paratype from the same source. U.S.N.M. 105158b.
9. Internal mold of right valve of a paratype from the same source. U.S.N.M. 105158c.
- 10-12. *Inoceramus prefragilis*, n. sp. (p. 64).
10. Holotype, Lewisville member, near small branch 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19015, U.S.N.M. 105151.
- 11, 12. Paratypes, a young left and a young right valve from the same source. U.S.N.M. 105152a-b.



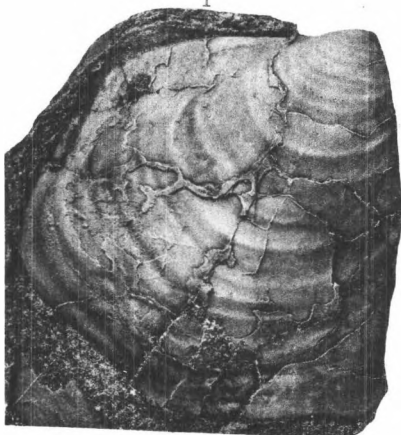
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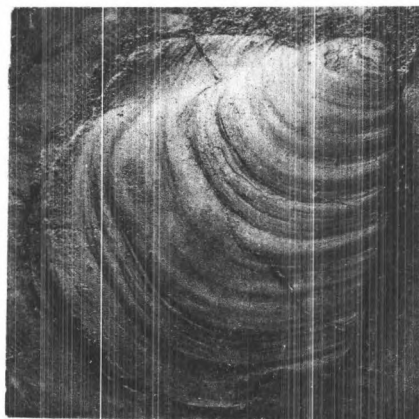
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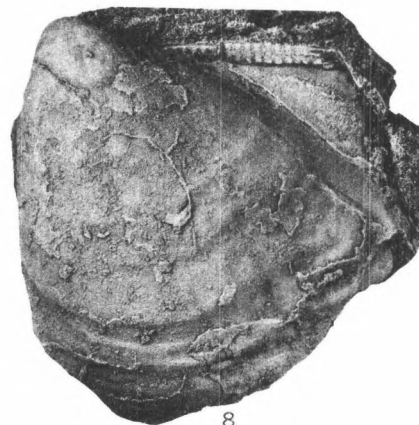
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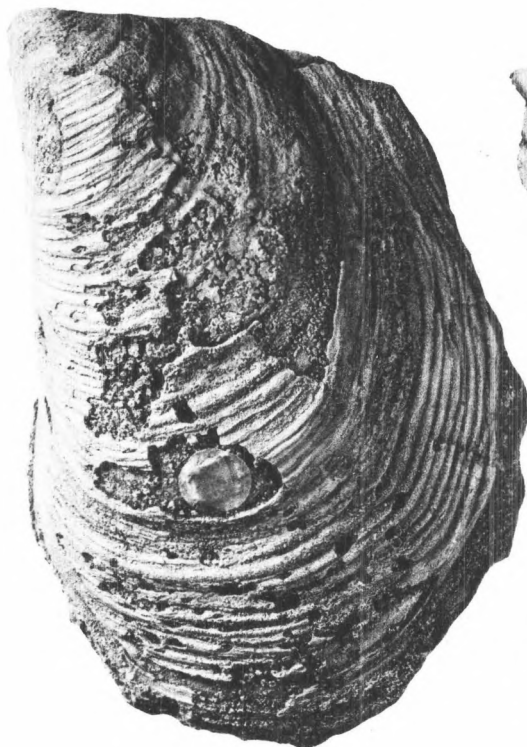


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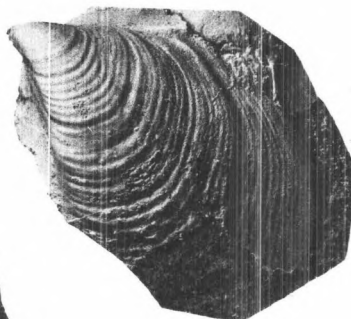
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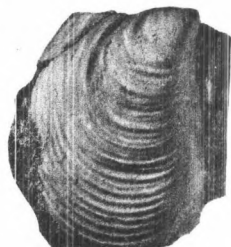
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9

PELECYPODS FROM THE WOODBINE FORMATION

PLATE 13

[Figures natural size except as indicated]

FIGURES 1, 2. *Inoceramus prefragilis*, n. sp. (p. 64).

1. Paratype, an unusually large right valve showing senile characters over all but the umbonal region, from the Lewisville member near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19500, U.S.N.M. 105154.

2. Hinge of the preceding specimen.

3-5. *Plicatula goldenana*, n. sp. (p. 81).

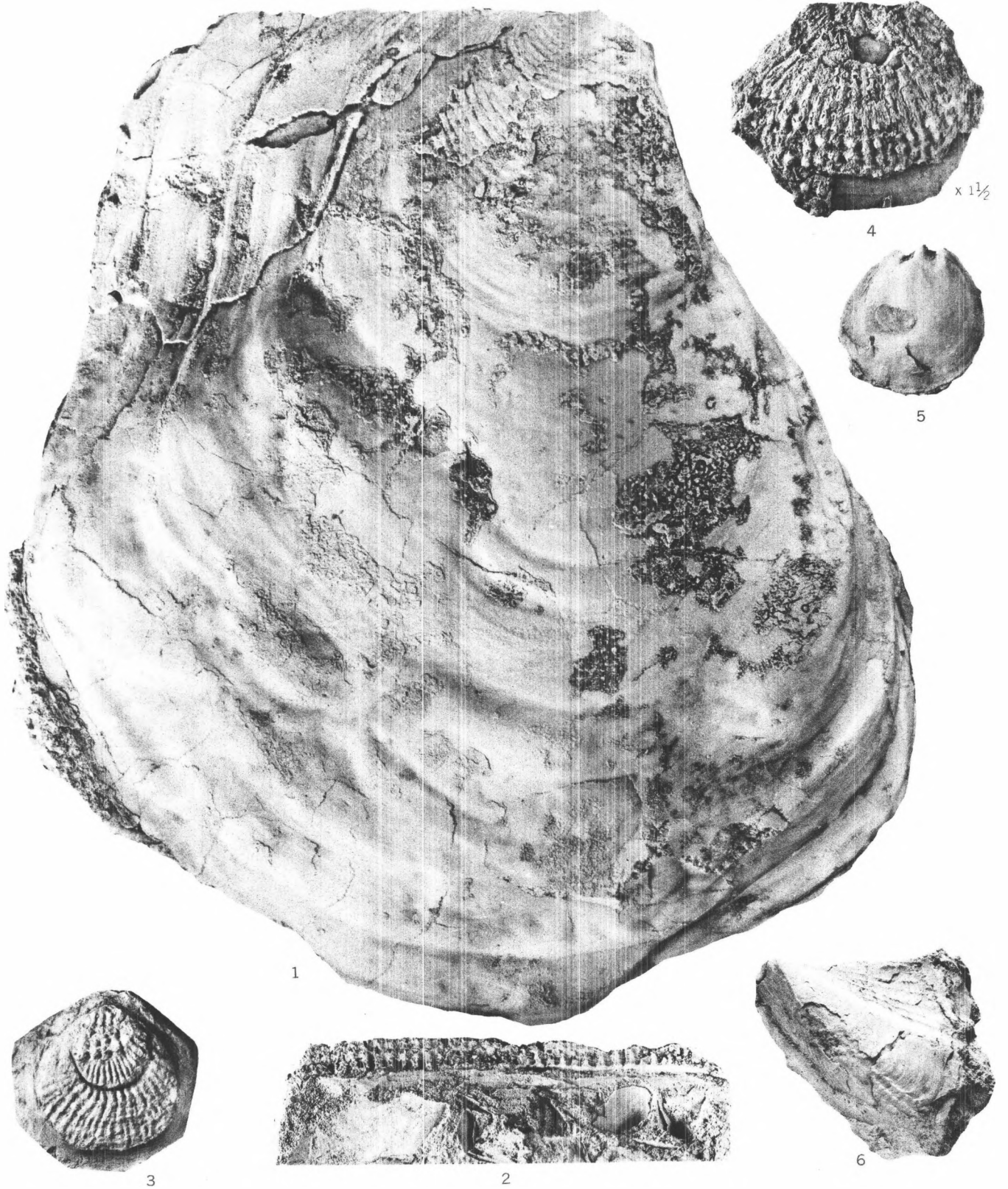
3. Holotype, a left valve, from Templeton member, Golden Bluff, Red River, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 13570, U.S.N.M. 105246.

4. Paratype ($\times 1\frac{1}{2}$), incomplete right valve from the same source. U.S.N.M. 105247a.

5. Paratype, right side of internal mold from the same source. U.S.N.M. 105247b.

6. *Pseudoptera serrata*, n. sp. (p. 71).

Holotype, a left valve, from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19015, U.S.N.M. 105181.

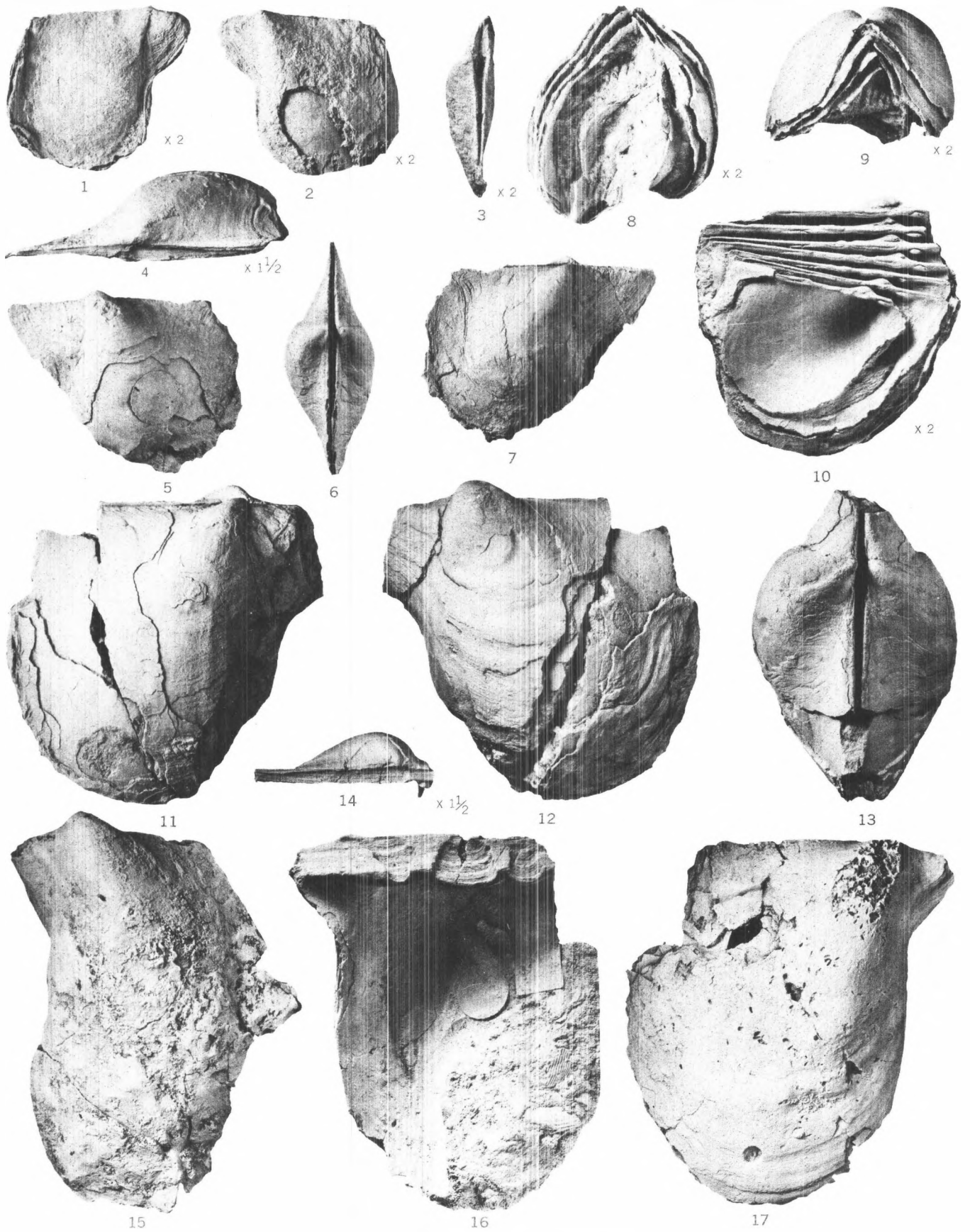


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 14

[Figures natural size except as indicated]

- FIGURES 1-3. *Phelopteria timberensis*, n. sp. (p. 70).
Views of the holotype ($\times 2$), from Lewisville member, near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 14565, U.S.N.M. 105177.
- 4-14. *Phelopteria dalli* (Stephenson) (p. 68).
4. Hinge of a right valve, plesiotype ($\times 1\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105168.
5-7. Views of a plesiotype, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105170.
8, 9. Front and ventral views of a multiple-shelled plesiotype ($\times 2$), from Lewisville member, 2 miles [sic] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105172.
10. Interior view of a multiple-shelled plesiotype ($\times 2$), from the same source. U.S.N.M. 105173.
11-13. Views of a plesiotype from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105171.
14. Incomplete hinge of a left valve, plesiotype ($\times 1\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105169.
- 15-17. *Panis cuneiformis*, n. sp. (p. 67).
15. Paratype, a left valve, from Lewisville member, cut along spur to gravel pit, Chicago, Rock Island and Pacific Railroad at Dorothy Siding, 1.2 miles west of Dallas County line, in Tarrant Co. Loc. 45. U.S.G.S. 18219, U.S.N.M. 105166.
16, 17. Views of the holotype, a right valve, from the same source. U.S.N.M. 105164.

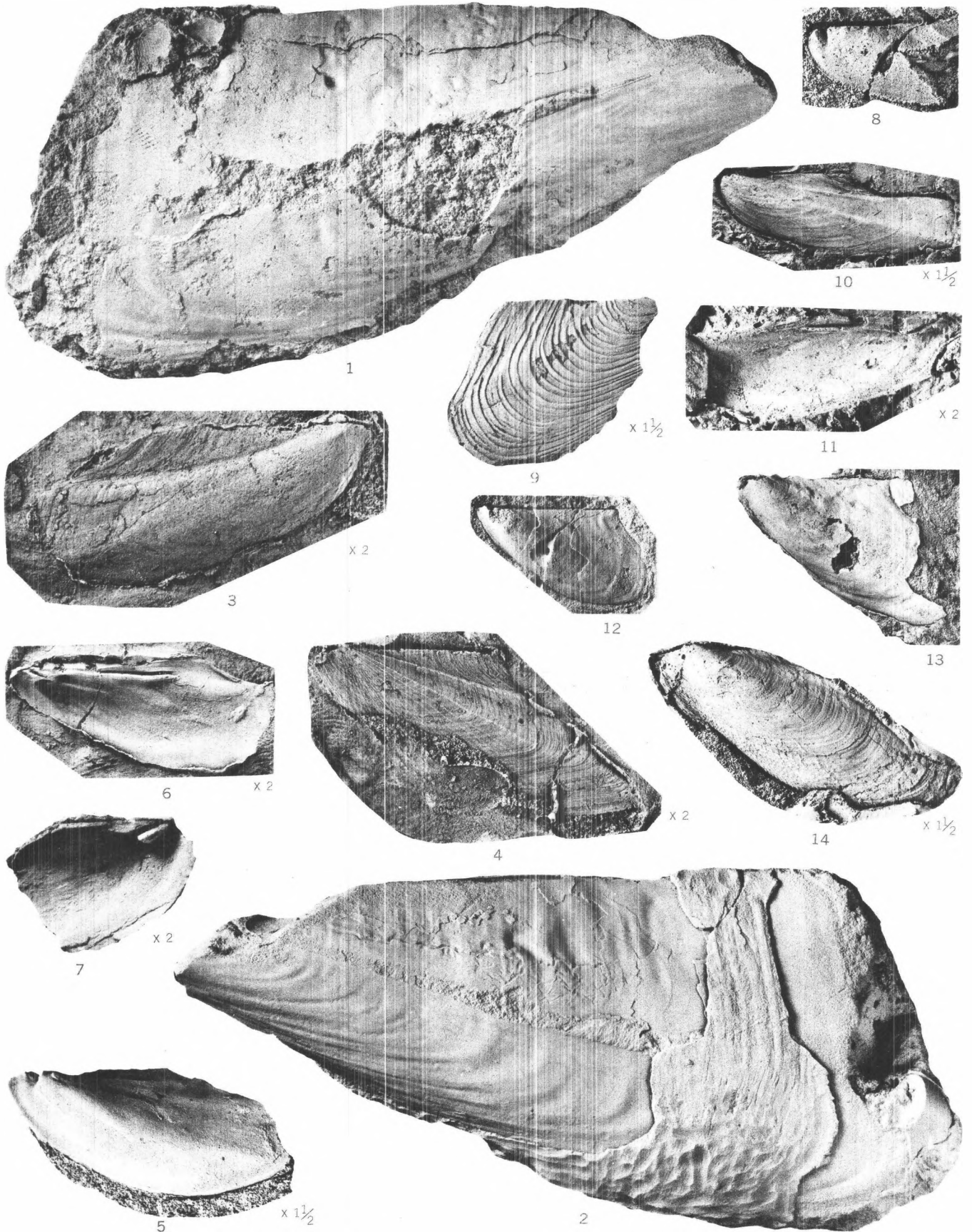


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 15

[Figures natural size except as indicated]

- FIGURES 1, 2. *Pinna* sp. (p. 63).
Side views of the only available specimen, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105150.
- 3-7. *Pseudoptera viana*, n. sp. (p. 72).
3. Rubber cast of right valve of holotype ($\times 2$), from Lewisville member, U. S. Highway 82, 0.35 mile west of Grayson County line, in Cooke Co. Loc. 98. U.S.G.S. 20259, U.S.N.M. 105190.
4. Rubber cast of left valve of a paratype ($\times 2$) from the same source. U.S.N.M. 105191.
5. Left side of internal mold of holotype ($\times 1\frac{1}{2}$).
6. Rubber cast showing hinge of right valve of a paratype ($\times 2$) from Lewisville member, Johnson Creek, 1.5 miles northeast of Methodist Church at Arlington, Tarrant Co. Loc. 47. U.S.G.S. 18639, U.S.N.M. 105193.
7. Hinge of left valve of a paratype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105195.
8. *Pseudoptera?* sp. (p. 73).
Internal mold of a left valve, from Lewisville member, gully east of the Whitesboro road, 1.75 miles south of Sandusky, Grayson Co. Loc. 117. U.S.G.S. 18966, U.S.N.M. 105201.
9. *Pseudoptera* sp. (p. 73).
Fragment of right valve ($\times 1\frac{1}{2}$), from Lewisville member, gully 1,250 feet north of east-west road, 3.5 miles N. 28° E. of Savoy, Fannin Co. Loc. 191. U.S.G.S. 19714, U.S.N.M. 105202.
- 10, 11. *Pseudoptera rushana*, n. sp. (p. 72).
10. Rubber cast of interior of left valve of holotype ($\times 1\frac{1}{2}$), from Dexter member (marine facies), field north of east-west road, 3.2 miles east-southeast of Handley, Tarrant Co. Loc. 15. U.S.G.S. 18989, U.S.N.M. 105197.
11. Rubber cast of internal mold of left valve, a paratype ($\times 2$), showing hinge features, from the same source. U.S.N.M. 105198.
- 12-14. *Pseudoptera hornensis*, n. sp. (p. 71).
12. Paratype, internal mold of left valve, from Lewisville member, ravine east of Waco road, 2.8 miles east of Gholson, McLennan Co. Loc. 2. U.S.G.S. 14587, U.S.N.M. 105188.
13. Holotype, view of left side, from Lewisville member, Horne Branch, 0.2 mile east of Woodbury, Hill Co. Loc. 5. U.S.G.S. 13575, U.S.N.M. 105185.
14. Rubber cast of external mold of left valve of a paratype ($\times 1\frac{1}{2}$), from the same source as the holotype. U.S.N.M. 105186.



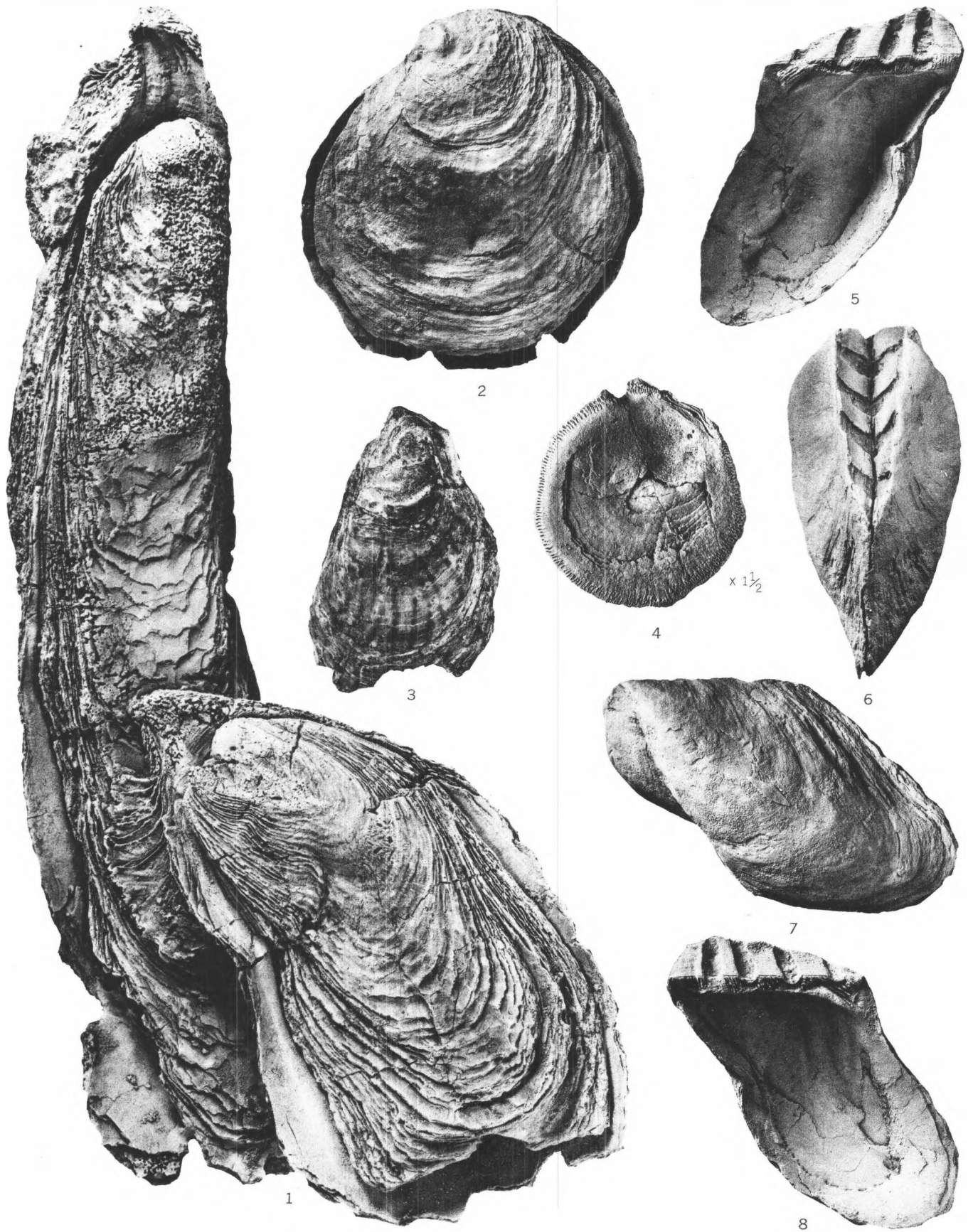
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 16

[Figures natural size except as indicated]

FIGURES 1-4. *Ostrea soleniscus* Meek (p. 74).

1. Plesiotypes, typical elongated example, to which is attached a less elongated example, from Lewisville member, 4 miles [probably less than 3 miles] west or southwest of Lewisville, Denton Co. Loc. 68. U.S.N.M. 21840.
 2. Plesiotype, a subcircular variant, from Lewisville member, crest of north-facing slope of Brushy Creek Valley, 3.4 miles N. 15° E. of Savoy, Fannin Co. Loc. 186. U.S.G.S. 18617, U.S.N.M. 105203.
 3. Plesiotype, a small example showing original color markings, from Lewisville member, below spillway at Lake Dallas dam (Garza Dam), Denton Co. Loc. 85. U.S.G.S. 18233, U.S.N.M. 105204.
 4. Plesiotype ($\times 1\frac{1}{2}$), a small subcircular variant showing crenulations on inner margin, also from loc. 85. U.S.G.S. 19003, U.S.N.M. 105205.
- 5-8. *Aguileria cumminsi* White (p. 66).
5. Interior of left valve, a cotype, from Lewisville member, Timber Creek, "4 miles south [probably about 2.5 miles southwest] of Lewisville, Denton Co." Loc. 67. U.S.N.M. 20134a.
 - 6, 7. Views of a cotype from the same source. U.S.N.M. 20134b.
 8. Interior of a right valve, a cotype, from the same source. U.S.N.M. 20134c.



PELECYPODS FROM THE WOODBINE FORMATION

PLATE 17

[All figures natural size]

FIGURES 1-3. *Ostrea carica* Cragin (p. 75).

1, 2. Two clusters of shells in the Collection of the Bureau of Economic Geology, Austin, Tex., bearing the Bureau number R17395, believed to be cotypes (probably from Timber Creek, Denton Co. Loc. 65).

3. A shell in the same collection, bearing a red ticket no. 48, also believed to be a cotype. The red ticket indicates Lewisville member, on Timber Creek southwest of Lewisville, Denton Co. (See plastotypes, U.S.N.M. 106012a-c.)

4-6. *Exogyra columbella* Meek (p. 77).

4. Rubber cast of one of the cotypes, from sandstone of early Colorado age, at Covero, N. Mex., U.S.N.M. 20254.

5, 6. Plesiotypes, from Lewisville member, Walnut Creek, 5.5 miles northeast of Mansfield, Tarrant Co. Loc. 48. U.S.G.S. 18640, U.S.N.M. 105220a-b.

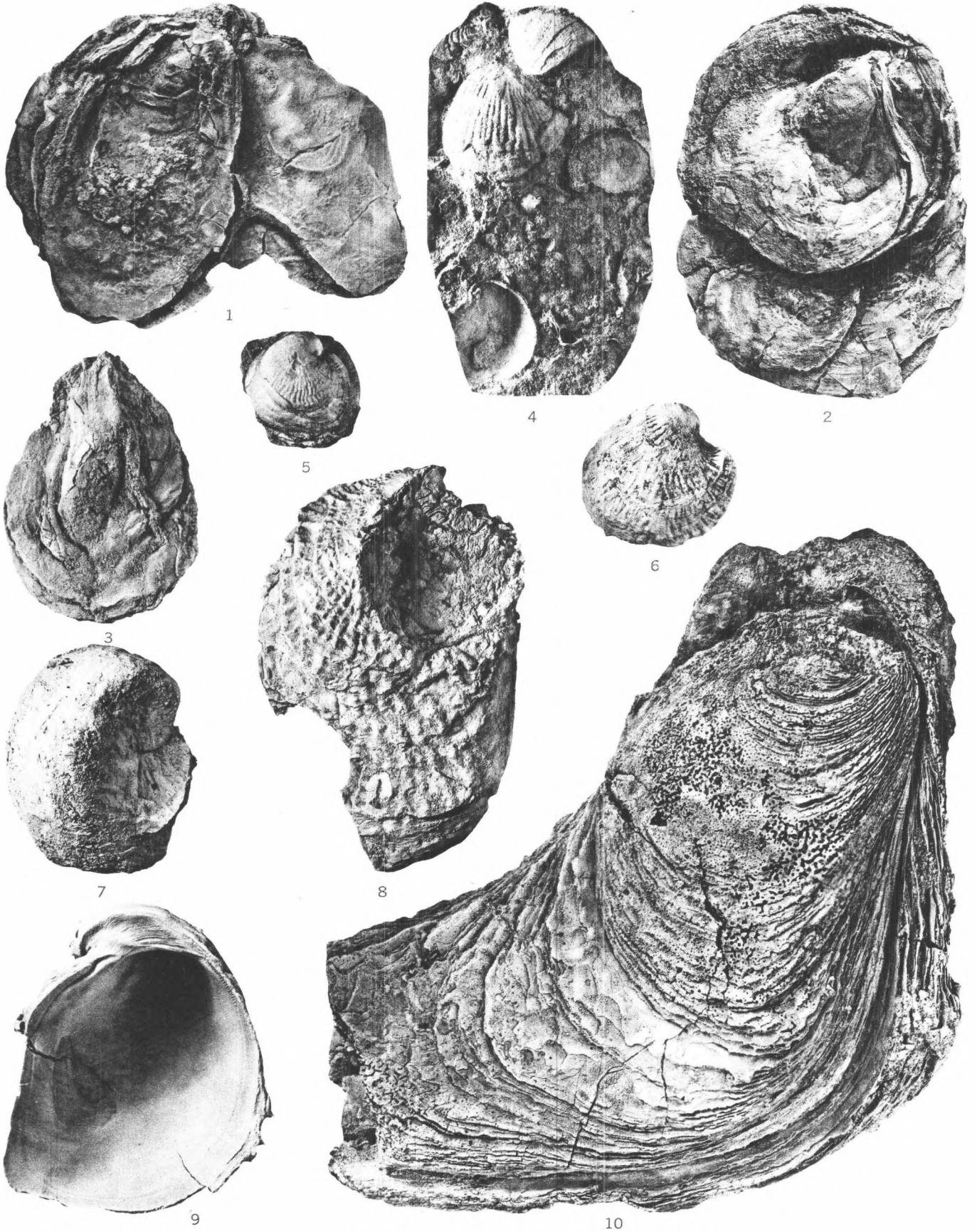
7-10. *Ostrea soleniscus* Meek (p. 74).

7. Plesiotype, a small exogyroid variant, from Lewisville member, road to Anthony, 3 miles N. 12° E. of Savoy, Fannin Co. Loc. 187. U.S.G.S. 18624, U.S.N.M. 105206.

8. Plesiotype, a small costate variant, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105207.

9. Plesiotype, interior of a small exogyroid variant, from the Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105207.

10. Plesiotype, right side of large, broad, irregular variant with exogyroid beak, from Lewisville member, near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 7556, U.S.N.M. 105209.

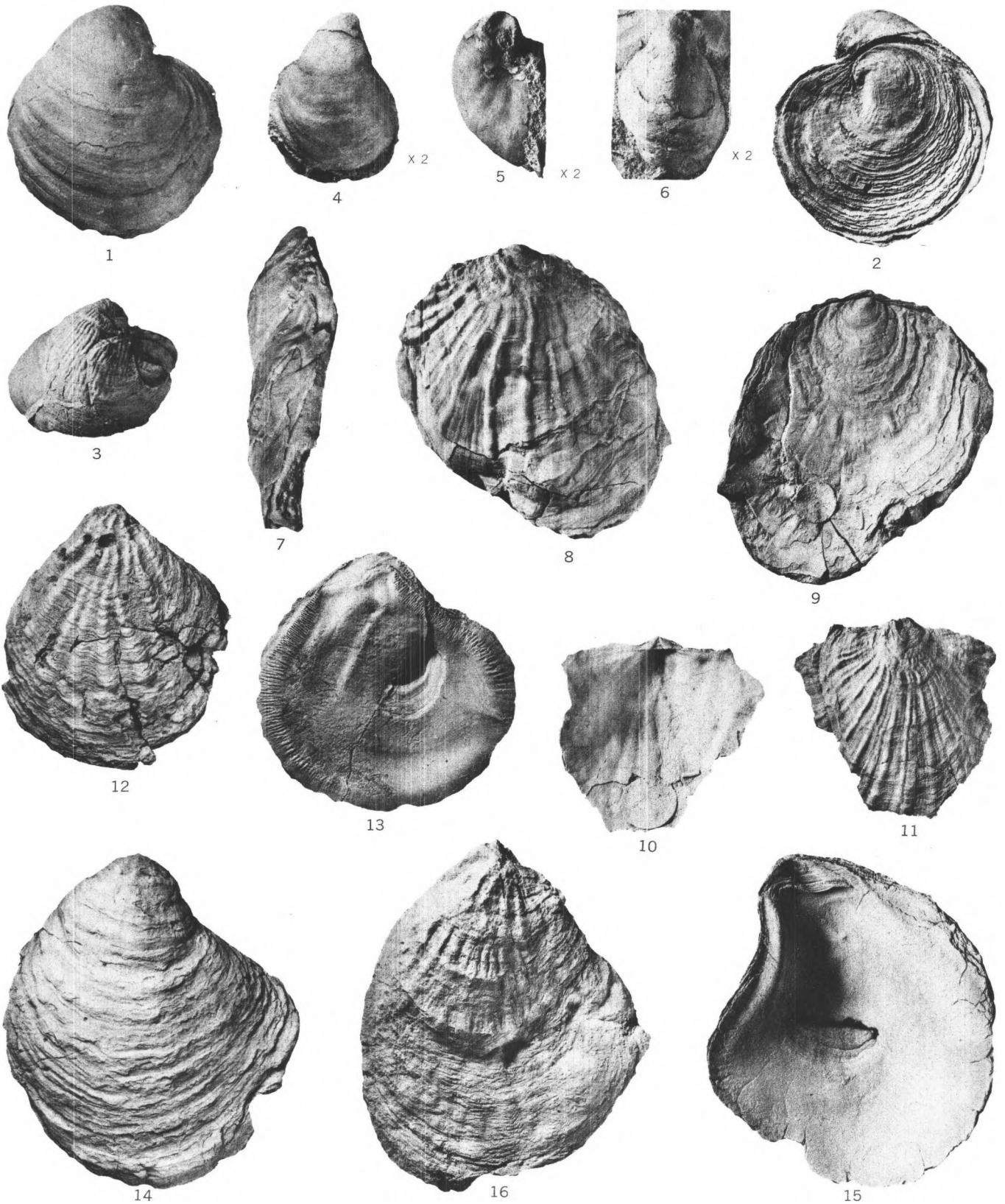


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 18

{Figures natural size except as indicated}

- FIGURES 1-3. *Exogyra columbella levis*, n. var. (p. 77).
1, 2. Views of the holotype from Templeton member, Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson Co. Loc. 152. U.S.G.S. 14557, U.S.N.M. 105222.
3. Paratype, a partly costate variant, from the same source. U.S.N.M. 105223.
- 4-6. *Exogyra* sp. (p. 78).
4, 5. Side and front views ($\times 2$) of a left valve, from Lewisville member, Aquilla Creek 1.2 miles east of Aquilla, Hill Co. Loc. 6. U.S.G.S. 19018, U.S.N.M. 105225a.
6. Side view ($\times 2$) of a left valve, from the same source. U.S.N.M. 105225b.
- 7-11. *Ostrea subradiata* Cragin (p. 75).
7-9. Views of a plesiotype, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105210.
10, 11. Views of a plesiotype, from Lewisville member (Tarrant unit of Moreman), ditch north of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 46. U.S.G.S. 18221, U.S.N.M. 105211.
- 12-16. *Ostrea leveretti*, n. sp. (p. 76).
12. Paratype, a left valve, from Lewisville member, Johnson Creek, 2 miles [probably 1.5 miles] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105219.
13. Paratype, interior of a right valve showing crenulations, from Lewisville member, 1.5 miles northeast of Methodist Church at Arlington, Tarrant Co. Loc. 47. U.S.G.S. 18639, U.S.N.M. 105215.
14, 15. View of the holotype, a left valve, from the same source: U.S.N.M. 105214.
16. Paratype, a left valve, from Lewisville member, on a small branch 2.25 miles west of Grandview, Johnson Co. Loc. 10. U.S.G.S. 14141, U.S.N.M. 105217.



PELECYPODS FROM THE WOODBINE FORMATION

PLATE 19

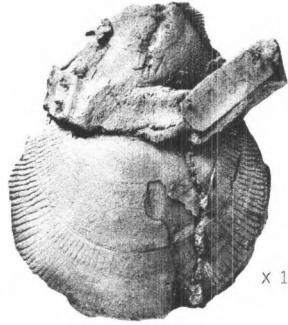
[Figures natural size except as indicated]

- FIGURES 1-4. *Pecten (Camptonectes) martinsensis*, n. sp. (p. 80).
1, 2. Views of a cotype ($\times 1\frac{1}{2}$), from Templeton member, Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson Co. Loc. 152. U.S.G.S. 14557, U.S.N.M. 105241a.
3, 4. Views of a cotype ($\times 2\frac{1}{2}$) from the same source. U.S.N.M. 105241b.
- 5, 6. *Pecten (Camptonectes) ellsworthensis*, n. sp. (p. 80).
Views of left and right sides of the holotype ($\times 1\frac{1}{2}$), from Templeton member, old Sherman Highway at Ellsworth School, 4 miles southwest of Denison, Grayson Co. Loc. 155. U.S.G.S. 14556, U.S.N.M. 105239.
7. *Pecten (Camptonectes) cavanus*, n. sp. (p. 80).
Right valve of holotype ($\times 3$), from Templeton member, upper part of road cut, 2.2 miles west of Arthur City, Lamar Co. Loc. 206. U.S.G.S. 18877, U.S.N.M. 105243.
- 8, 9. *Pecten (Camptonectes) moodyi*, n. sp. (p. 79).
8. Paratype ($\times 1\frac{1}{2}$), a left valve, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13569, U.S.N.M. 105237.
9. Holotype ($\times 1\frac{1}{2}$), a right valve, from the same source. U.S.G.S. 14546, U.S.N.M. 105235.
- 10-12. *Unio* sp. a (p. 78).
10. Internal mold of a small example, from Eules member, on a slope near right angle turn of country road. 3.5 miles northwest of Grapevine, Tarrant Co. Loc. 31. U.S.G.S. 20276, U.S.N.M. 105228.
11. Right side of a larger internal mold, from Red Branch member, on an east-west road 2.8 miles S. 70° E. of Callisburg, 1.35 miles west of Grayson County line, in Cooke Co. Loc. 96. U.S.G.S. 20262, U.S.N.M. 105230.
12. Left side of an elongated example, from Red Branch member, on hillside 0.85 mile N. 44° W. of Star School, in north-eastern Grayson Co. Loc. 102. U.S.G.S. 20316, U.S.N.M. 105229.
13. *Unio* sp. b (p. 79).
Right side of incomplete internal mold, from the same source. U.S.N.M. 105231a.
14. *Unio* sp. c (p. 79).
Right side of a large incomplete internal mold from the same source. U.S.N.M. 105234.
- 15, 16. *Crenella subcircularis*, n. sp. (p. 86).
Views of the holotype ($\times 4$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105286.



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1



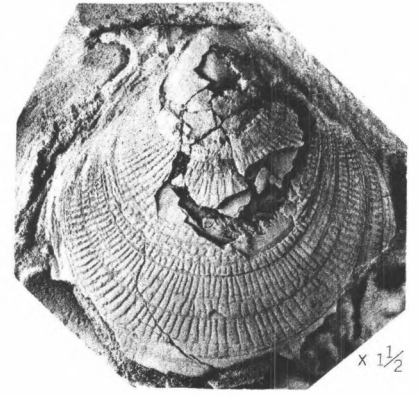
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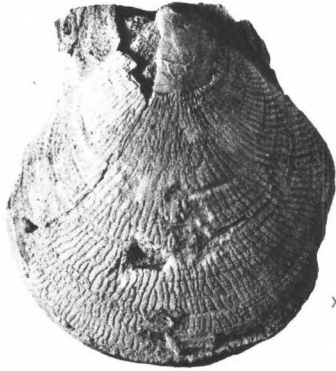
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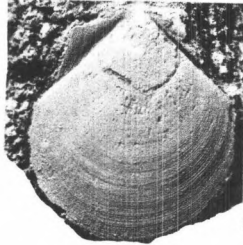
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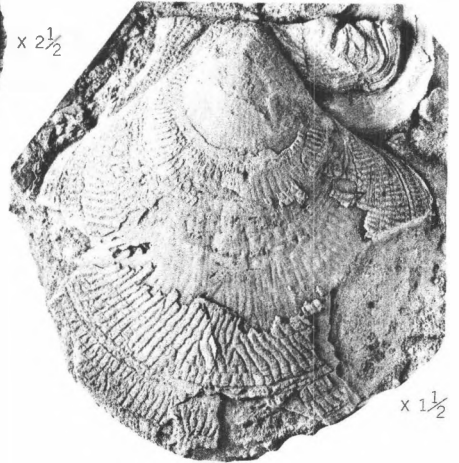
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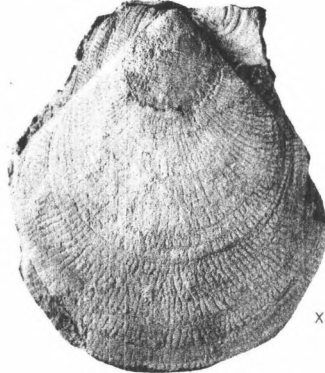


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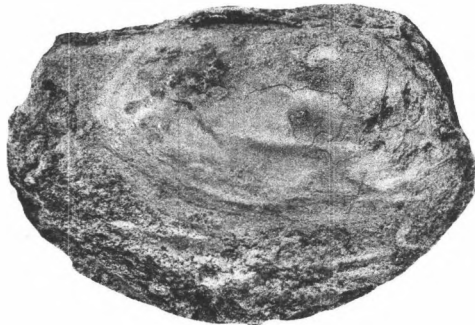


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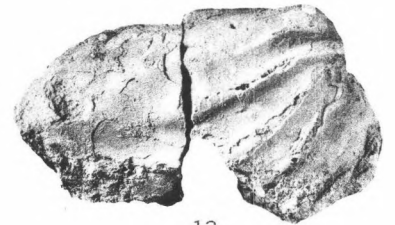


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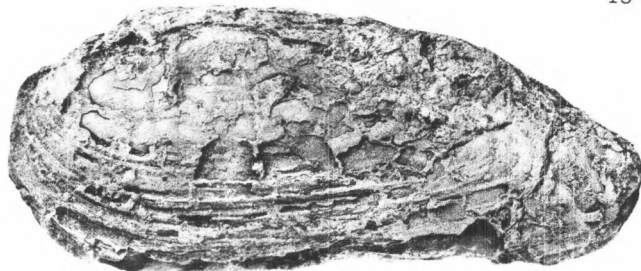


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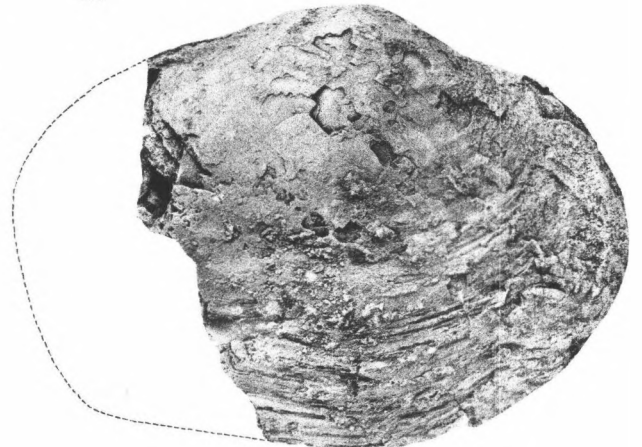


x 4

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12



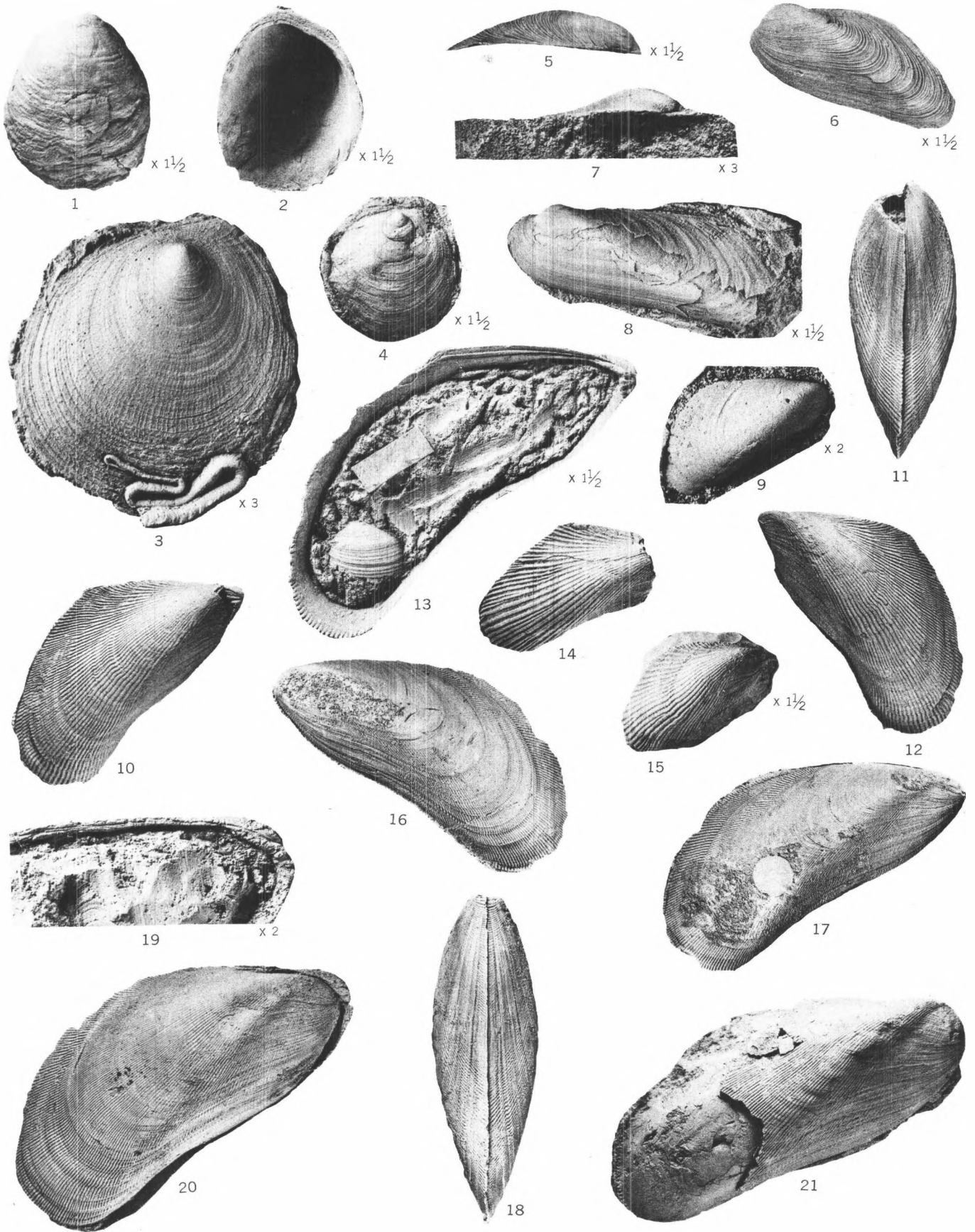
14

PLATE 20

[Figures natural size except as indicated]

FIGURES 1-4. *Anomia ponticulana*, n. sp. (p. 81).

- 1, 2. Paratype ($\times 1\frac{1}{2}$), views of exterior and interior, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18627, U.S.N.M. 105257.
3. Holotype ($\times 3$), a left valve from Lewisville member, Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 78. U.S.G.S. 18648, U.S.N.M. 105252.
4. Paratype ($\times 1\frac{1}{2}$), a left valve also from loc. 184. U.S.G.S. 18256, U.S.N.M. 105255.
- 5, 6. *Volsella alveolana*, n. sp. (p. 82).
Views of the holotype ($\times 1\frac{1}{2}$), a left valve, from Templeton member in gully near barn, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson Co. Loc. 171. U.S.G.S. 20592, U.S.N.M. 105262.
- 7, 8. *Volsella tarrantana*, n. sp. (p. 82).
7. Left hinge of a paratype ($\times 3$), from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105260.
8. Holotype ($\times 1\frac{1}{2}$), a left valve from the same source. U.S.N.M. 105259.
9. *Volsella modesta*, n. sp. (p. 83).
Rubber cast from external mold of holotype ($\times 2$), from Eules member, cut on Arlington-Grapevine road, 1 mile west by south of Eules, Tarrant Co. Loc. 25. U.S.G.S. 18995. U.S.N.M. 105265.
- 10-13. *Brachidontes fulpensis*, n. sp. (p. 84).
10-12. Views of the holotype, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105271.
13. Interior view of a paratype ($\times 1\frac{1}{2}$), a left valve from Lewisville member, from the same source. U.S.G.S. 18627, U.S.N.M. 105272.
- 14, 15. *Brachidontes arlingtonanus*, n. sp. (p. 85).
14. Holotype, a right valve, from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105275.
15. Paratype ($\times 1\frac{1}{2}$), a right valve from the same source. U.S.N.M. 105276.
- 16-18. *Brachidontes filisculptus microcostae*, n. var. (p. 84).
Views of the holotype, from Lewisville member, Timber Creek, 4 miles [3 miles] west by south of Lewisville, Denton Co. Loc. 72. U.S.G.S. 504, U.S.N.M. 105269.
- 19-21. *Brachidontes filisculptus* (Cragin), (p. 83).
19. Hinge of left valve of a plesiotype ($\times 2$), from Lewisville member near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 14565, U.S.N.M. 105268.
20. Right side of a specimen, probably a cotype, from Lewisville member, Timber Creek southwest of Lewisville, Denton Co. Loc. 70. U.S.N.M. 32694.
21. Right side of a cotype, also from Lewisville member, Timber Creek. Loc. 63. (Coll. of Bur. Econ. Geol. Austin, 707; see plastotype, U.S.N.M. 105266.)

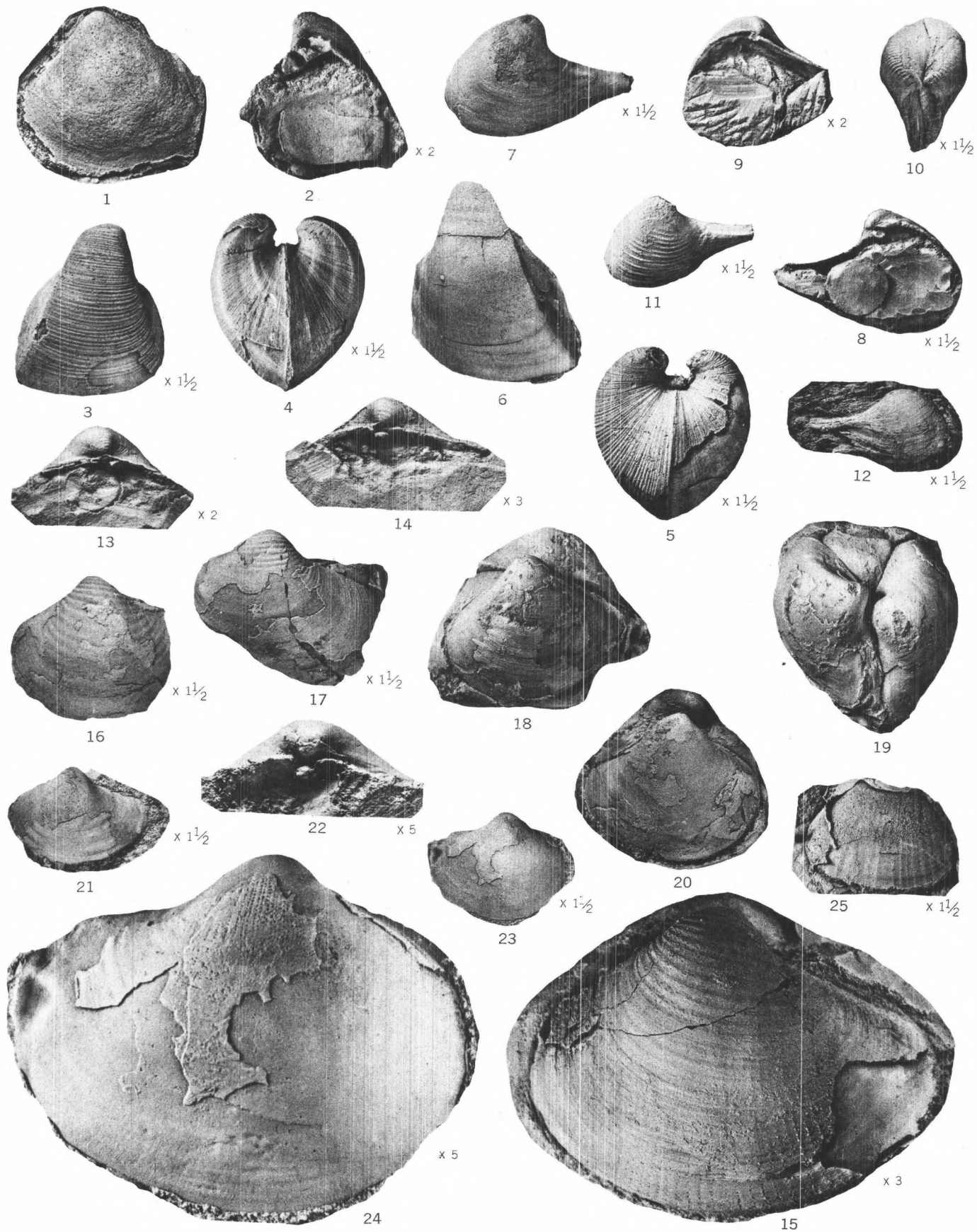


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 21

[Figures natural size except as indicated]

- FIGURES 1-3. *Anatimya longula*, n. sp. (p. 90).
1. Left side of a paratype, from Lewisville member, Johnson Creek, 1.5 miles northeast of Methodist Church, Arlington, Tarrant Co. Loc. 47. U.S.G.S. 18639, U.S.N.M. 105308.
 - 2, 3. Right side and top views of holotype, from the same source. U.S.N.M. 105307.
- 4-6. *Anatimya eulessana*, n. sp. (p. 91).
4. Rubber cast of external mold of holotype, from Euless member, State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant Co. Loc. 27. U.S.G.S. 19039, U.S.N.M. 105310.
 5. Internal mold of the holotype.
 6. Rubber cast of external mold of a paratype, from Euless member, east-west road 2.6 miles north of Arlington, Tarrant Co. Loc. 19. U.S.G.S. 18980, U.S.N.M. 105311.
7. *Laternula?* sp. (p. 90).
From Templeton member, bluff 1 mile north, 1.85 miles east of Sadler, Grayson Co. Loc. 167. U.S.G.S. 20542, U.S.N.M. 105306.
8. *Laternula gemmea*, n. sp. (p. 90).
Holotype ($\times 2$), a right valve, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105304.
9. *Laternula tofana*, n. sp. (p. 89).
Holotype, an incomplete right valve, from Lewisville member, near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105300.
- 10-12. *Laternula virgata*, n. sp. (p. 88).
- 10, 11. Views of the holotype, from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105295.
 12. Paratype, from Lewisville member (Tarrant unit of Moreman), branch of Big Bear Creek, 1.2 miles northeast of Euless, Tarrant Co. Loc. 53. U.S.G.S. 18997, U.S.N.M. 105297.
13. *Laternula scutulum*, n. sp. (p. 89).
Holotype, a left valve, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105298.
14. *Laternula johnsonana*, n. sp. (p. 90).
Holotype ($\times 2$), a left valve, from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 477, U.S.N.M. 105302.
- 15-17. *Botula plumosa*, n. sp. (p. 87).
15. Right side of holotype ($\times 3$), from Lewisville member, small stream cut, 0.2 mile south, 0.5 mile west of Star School, in northeastern Grayson Co. Loc. 137. U.S.G.S. 20538, U.S.N.M. 105288.
- 16, 17. Views of the paratype ($\times 4$), from the same source. U.S.N.M. 105289.
18. *Botula carolinensis* (Conrad)? (p. 87).
Figured example ($\times 3$), a left valve, from Lewisville member, Aquilla Creek, 1.6 miles west of Peoria, Hill Co. Loc. 4. U.S.G.S. 13572, U.S.N.M. 105287a.
- 19-22. *Pholadomya goldenensis*, n. sp. (p. 87).
19. Right side of a questionable example, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. ?12872, U.S.N.M. 105293.
 20. Left side of incomplete paratype, from Templeton member, Golden Bluff, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 13799, U.S.N.M. 105292.
 21. Holotype, from the same source. U.S.G.S. 13570, U.S.N.M. 105291.
 22. Top side of holotype ($\times 2$), to show details.

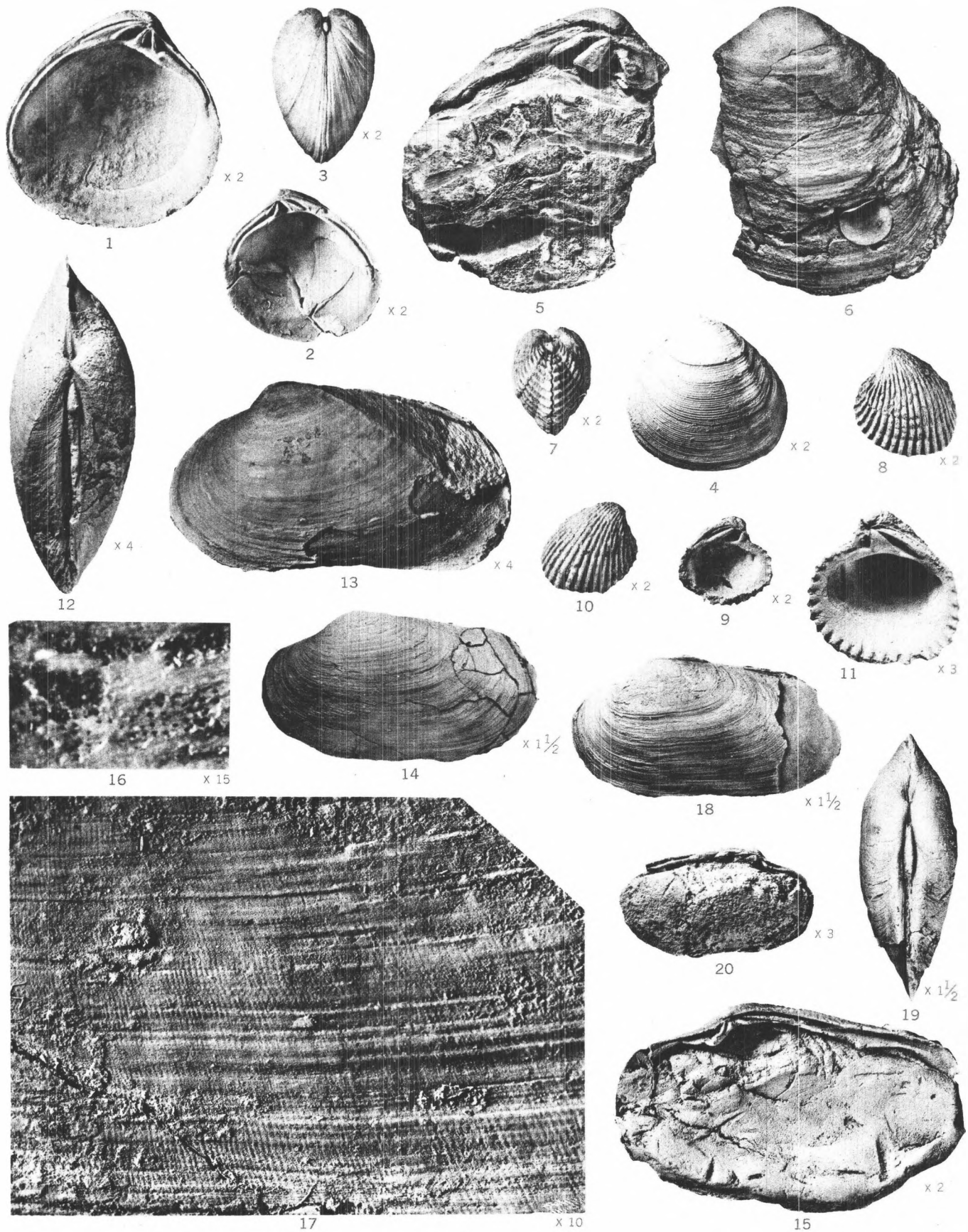


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 23

FIGURES 1-4. *Fulpia pinguis* Stephenson (p. 97).

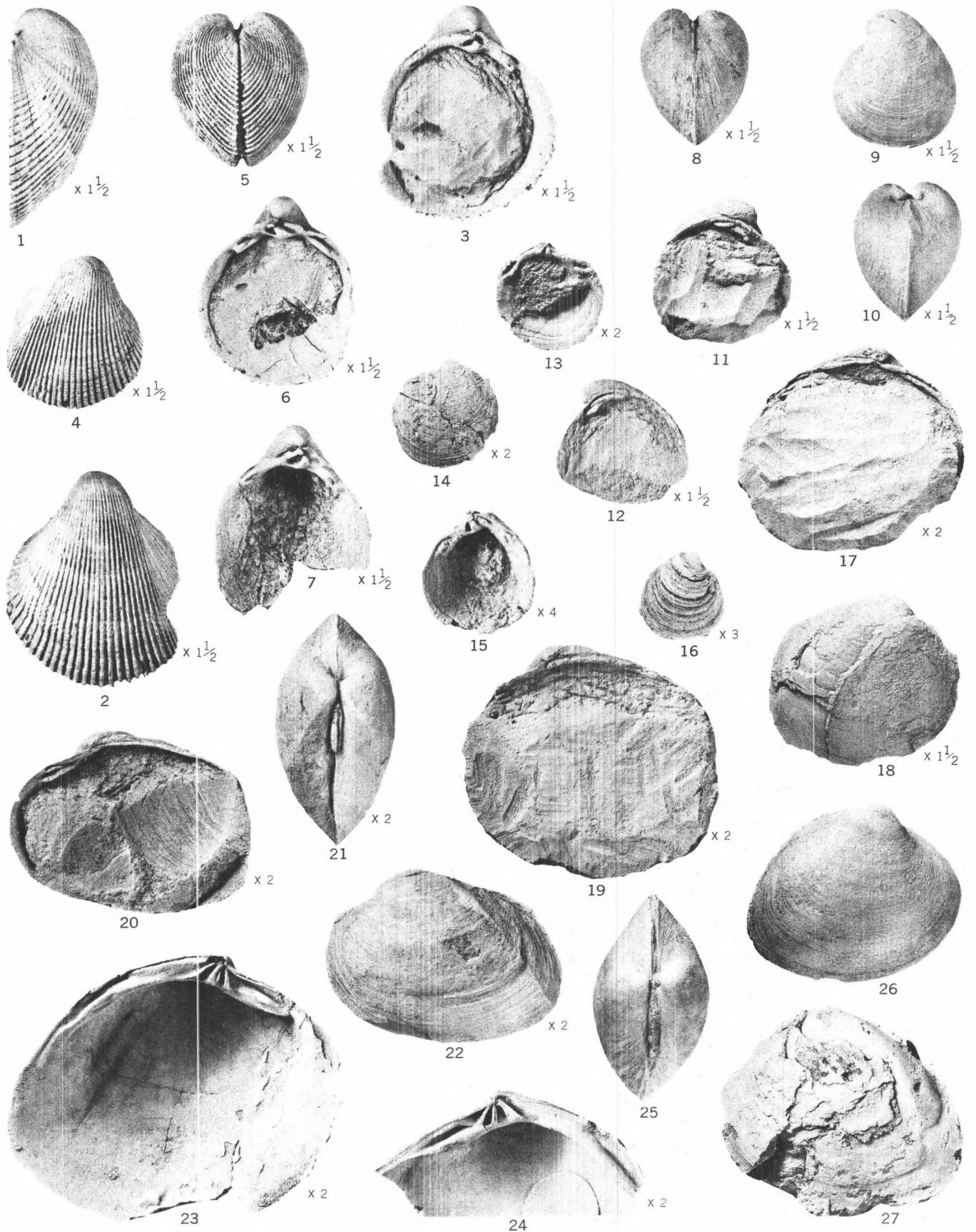
- 1, 2. Left and right hinges of paratypes ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 103863.
- 3, 4. Views of the holotype ($\times 2$), from the same source. U.S.N.M. 103862.
- 5, 6. *Veniella?* sp. (p. 95).
Views of an incomplete left valve ($\times 1$), Lewisville member, Walnut Creek, 4.5 miles, east-northeast of Mansfield, Tarrant Co. Loc. 43. U.S.G.S. 14579, U.S.N.M. 105335.
- 7-11. *Venericardia alveana*, n. sp. (p. 99).
- 7, 8. Views of the holotype ($\times 2$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105349.
9. Hinge of left valve of a paratype ($\times 2$), from the same source. U.S.N.M. 105350.
10. A paratype ($\times 2$), exterior of a right valve, from the same locality. U.S.G.S. 13797, U.S.N.M. 105353.
11. Hinge and interior of a right valve of a paratype ($\times 3$), from the same locality. U.S.G.S. 14546, U.S.N.M. 105352.
- 12, 13. *Pollex? angulatus*, n. sp. (p. 95).
- 12, 13. Views of the holotype ($\times 4$), a nearly complete shell, from Lewisville member, in a small stream cut, 0.2 mile south, 0.5 mile west of Star School, in northeastern Grayson Co. Loc. 137. U.S.G.S. 20538, U.S.N.M. 105332.
- 14-19. *Pollex obesus*, n. sp. (p. 94).
- 14, 15. Exterior of left valve ($\times 1\frac{1}{2}$) and hinge of right valve ($\times 2$), of a paratype, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 19715, U.S.N.M. 105330.
16. Selected portion of the surface of the preceding left valve ($\times 15$), to show tiny spine scars.
17. Selected portion of the same shell ($\times 10$) to show radial lining.
- 18, 19. Views of the holotype ($\times 1\frac{1}{2}$), from Lewisville member, gully near fence 1,250 feet north of east-west road, 3.5 miles N. 28° E. of Savoy, Fannin Co. Loc. 191. U.S.G.S. 19714, U.S.N.M. 105329.
20. Hinge of small paratype ($\times 3$), from the same source. U.S.N.M. 105333.



PELECYPODS FROM THE WOODBINE FORMATION

PLATE 24

- FIGURES 1-7. *Cardium (Trachycardium) tinninense*, n. sp. (p. 102).
- 1-3. Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105366.
- 4, 5. Right side and rear views of a paratype ($\times 1\frac{1}{2}$), from Templeton member, Martins Spring Branch, $2\frac{1}{8}$ miles west of Pottsboro, Grayson Co. Loc. 153. U.S.G.S. 18250, U.S.N.M. 105371.
- 6, 7. Hinges of right and left valves of paratypes ($\times 1\frac{1}{2}$), also from loc. 201. U.S.G.S. 12873, U.S.N.M. 105368a-b.
- 8-12. *Isocardia slatana parva*, n. var. (p. 105).
- 8-10. Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105383.
- 11, 12. Hinges of left and right valves of paratypes ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105384.
- 13, 14. *Lucina dentonana*, n. sp. (p. 100).
Interior and exterior views of holotype ($\times 2$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105360.
- 15, 16. *Lucina aspera*, n. sp. (p. 101).
Interior view ($\times 4$), and exterior view ($\times 3$), of holotype, from Templeton member, borrow pit north of road, 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. 18274, U.S.N.M. 105362.
- 17-19. *Sexta ethelana*, n. sp. (p. 102).
17. Hinge of paratype ($\times 2$), a left valve, from Templeton member, north-south road, 0.5 mile northwest of Ethel, Grayson Co. Loc. 156. U.S.G.S. 14563, U.S.N.M. 105359.
- 18, 19. Exterior ($\times 1\frac{1}{2}$) and hinge ($\times 2$) of holotype, a right valve from the same source. U.S.N.M. 105358.
- 20-22. *Sexta naricula*, n. sp. (p. 101).
20. Hinge of a paratype ($\times 2$), a right valve, from Templeton member, bluff on tributary of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105356.
- 21, 22. Top and side views of holotype ($\times 2$) from the same source. U.S.N.M. 105355.
- 23-27. *Dentonia leveretti* (Cragin) (p. 98).
- 23, 24. Hinges of left and right valves ($\times 2$) of plesiotypes, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105344a-b.
- 25, 26. Views of a cotype ($\times 1$), Cragin's measured specimen, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. (Univ. of Texas Collection. See plastotype, U.S.N.M. 105347.)
27. Exterior of an incomplete plesiotype ($\times 1$), a left valve, to show pallial sinus, from Lewisville member, Timber Creek, about 3 miles west by south of Lewisville, Denton Co. Loc. 76. U.S.G.S. 7553, U.S.N.M. 105343.



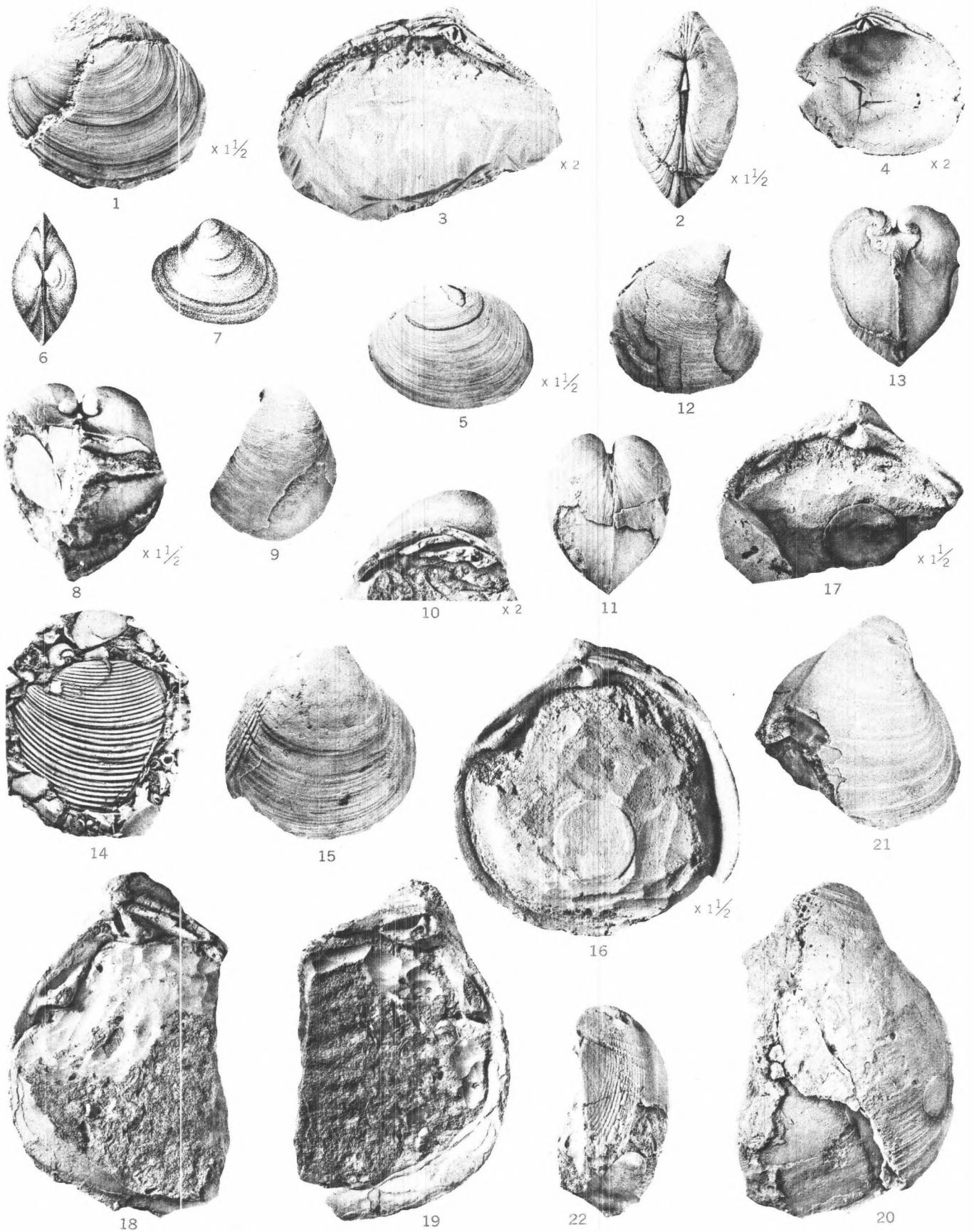
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 25

[Figures natural size except as indicated]

FIGURES 1-7. *Callistina lamarensis* (Shumard) (p. 105).

- 1, 2. Side and top views ($\times 1\frac{1}{2}$) of an example from Templeton member, borrow pit north of road, 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. 18619, U.S.N.M. 105387.
- 3, 4. Left and right hinges ($\times 2$) of examples from the same locality. U.S.G.S. 18274, U.S.N.M. 105388a-b.
5. Left side of selected neotype ($\times 1\frac{1}{2}$) from the same locality. U.S.G.S. 18619, U.S.N.M. 105386.
- 6, 7. Reproduction of drawings made by A. R. Roessler under Shumard's direction but not published by Shumard; reproduced by White (see synonymy), and here reproduced from White's plate.
- 8-13. *Isocardia slutana*, n. sp. (p. 105).
 8. Front view of incomplete paratype ($\times 1\frac{1}{2}$), from Templeton member, Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson Co. Loc. 152. U.S.G.S. 14557, U.S.N.M. 105381a.
 9. Left side of a paratype from the same source. U.S.N.M. 105381b.
 10. Left hinge of a paratype ($\times 2$) from the same source. U.S.N.M. 105381c.
- 11-13. Rear, right side, and front views of holotype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105379.
14. *Protocardia* sp. (p. 104).
Rubber cast of an external mold of a left valve, from Lewisville member, Hillsboro road, 2 miles east of Whitney, Hill Co. Loc. 3. U.S.G.S. 11836, U.S.N.M. 105377.
- 15-17. *Protocardia torta*, n. sp. (p. 103).
 15. Holotype, a right valve, from Lewisville member, Timber Creek, about 2.25 miles south-southwest of Lewisville, Denton Co. Loc. 81. U.S.G.S. 7558, U.S.N.M. 105372.
 16. Hinge of holotype ($\times 1\frac{1}{2}$).
 17. Hinge of paratype ($\times 1\frac{1}{2}$), a left valve from Lewisville member, Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 84. U.S.G.S. 11731, U.S.N.M. 105373.
- 18-22. *Protocardia timberensis*, n. sp. (p. 103).
 - 18-20. Hinges of right and left valves, and exterior of right valve, of an incomplete paratype, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 74. U.S.G.S. 1567, U.S.N.M. 105375.
 - 21, 22. Side and rear views of holotype, a right valve, from Lewisville member near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 14565, U.S.N.M. 105374.

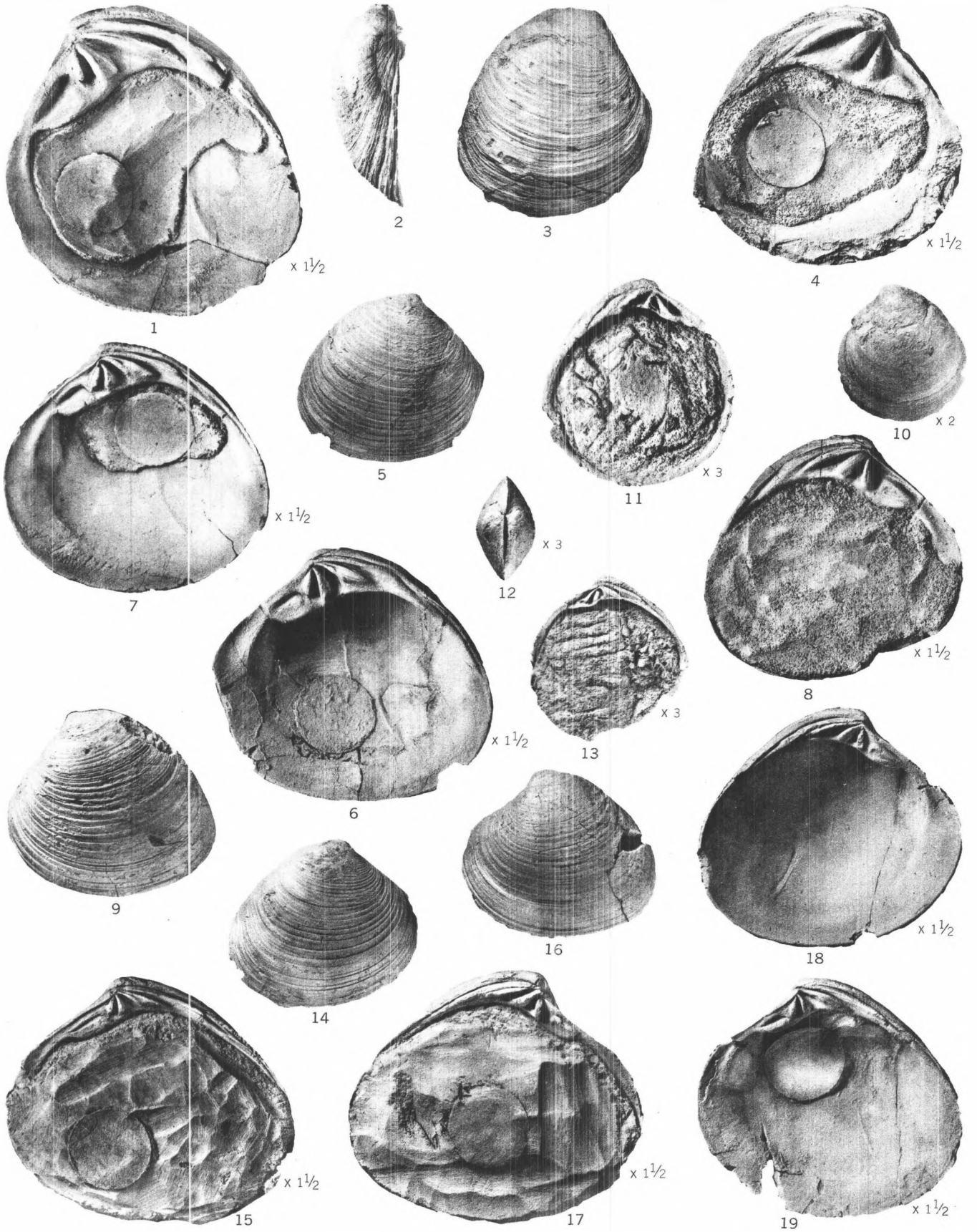


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 26

[Figures natural size except as indicated]

- FIGURES 1-4. *Callistina (Larma) alta*, n. sp. (p. 108).
1. Hinge of holotype ($\times 1\frac{1}{2}$), a right valve, from Lewisville member, 2.4 miles east by south of Whitesboro, Grayson Co. Loc. 112. U.S.G.S. 18243, U.S.N.M. 105397.
 - 2, 3. Front and side views of holotype.
 4. Hinge of left valve of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105398.
- 5-9. *Callistina (Larma) taffi* (Cragin) (p. 107).
5. Exterior of a right valve, from Lewisville member, Sheep Creek, 1,600 feet north of an east-west road, 4 miles N. 37° E. of Savoy, Fannin Co. Loc. 182. U.S.G.S. 18248, U.S.N.M. 105395a.
 6. Interior of same shell ($\times 1\frac{1}{2}$).
 7. Interior of a right valve ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105395b.
 8. Hinge of a left valve ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105395c.
 9. Neotype, a left valve from the same source. U.S.N.M. 105394.
- 10-13. *Cyclorisma orbiculata*, n. sp. (p. 110).
10. Holotype ($\times 2$), a left valve, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105412.
 11. Hinge of holotype ($\times 3$).
 - 12, 13. Top view of a small paratype ($\times 3$), and hinge of a right valve of a paratype ($\times 3$) from the same source. U.S.N.M. 105413a-b.
- 14-19. *Callistina (Larma) munda*, n. sp. (p. 106).
14. Holotype, a right valve, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105390.
 15. Hinge of holotype ($\times 1\frac{1}{2}$).
 16. A paratype, a left valve from the same locality. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105392a.
 17. Hinge of the same paratype ($\times 1\frac{1}{2}$).
 18. Interior of a paratype ($\times 1\frac{1}{2}$), a left valve, from the same source. U.S.N.M. 105392b.
 19. Interior of a paratype ($\times 1\frac{1}{2}$), a right valve, from the same source. U.S.N.M. 105392c.



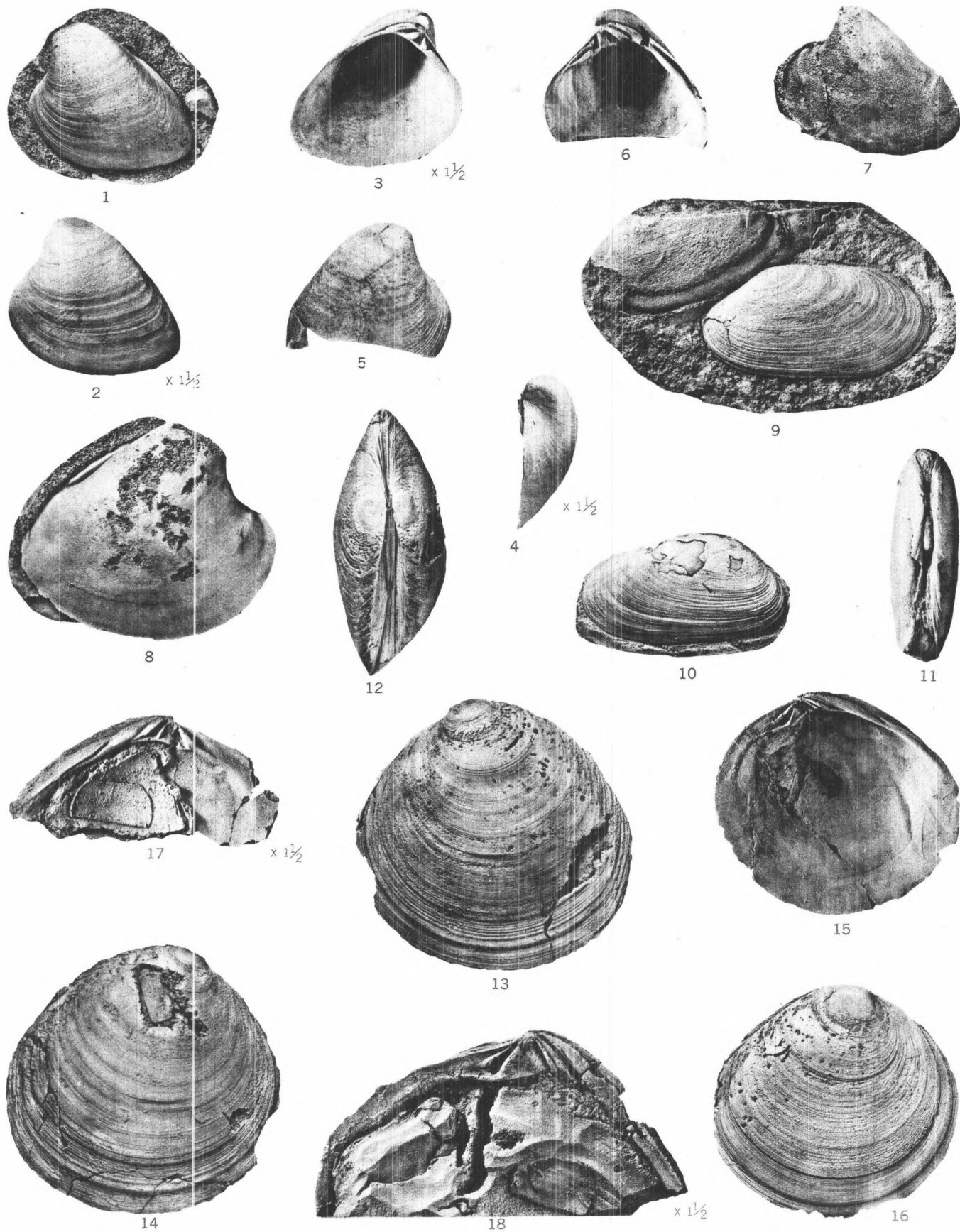
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 27

[Figures natural size except as indicated]

FIGURES 1-7. *Pharodina ferrana*, n. sp. (p. 109).

1. Rubber cast of external mold of a paratype, an adult individual, from Lewisville member, branch east of north-south road, 2.5 miles north of Sadler, Grayson Co. Loc. 132. U.S.G.S. 20271, U.S.N.M. 105409.
- 2-4. Views of the holotype ($\times 1\frac{1}{2}$), a medium-sized left valve, from Lewisville member, in a small stream gorge, 1.9 miles S. 54° W. of the center of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105406.
- 5, 6. Views of a paratype, an incomplete adult right valve, from the same source. U.S.N.M. 105407.
7. Internal mold of a paratype, a left valve, from Lewisville member, north-south road, 0.8 mile southwest of Gordonville, Grayson Co. Loc. 116. U.S.G.S. 18965, U.S.N.M. 105404.
8. *Pharodina?* sp. (p. 109).
Internal mold of right valve, from Lewisville member, branch east of north-south road 2.5 miles north of Sadler, Grayson Co. Loc. 132. U.S.G.S. 20271, U.S.N.M. 105411.
- 9-11. *Legumen ligula*, n. sp. (p. 110).
9. Holotype, a left valve (and part of internal mold of another specimen), from Templeton member, gully north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 170. U.S.G.S. 20550, U.S.N.M. 105417.
- 10, 11. Views of a paratype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105415.
- 12-18. *Cyprimeria patella*, n. sp. (p. 108).
12-14. Views of the holotype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105400.
- 15, 16. Interior and exterior views of a paratype, a right valve, from the same locality. U.S.G.S. 14546, U.S.N.M. 105401a.
17. Hinge of a paratype ($\times 1\frac{1}{2}$), a left valve, from the same locality. U.S.N.M. 105401b.
18. Hinge of a paratype ($\times 1\frac{1}{2}$), a right valve from the same locality. U.S.G.S. 12873, U.S.N.M. 105403.

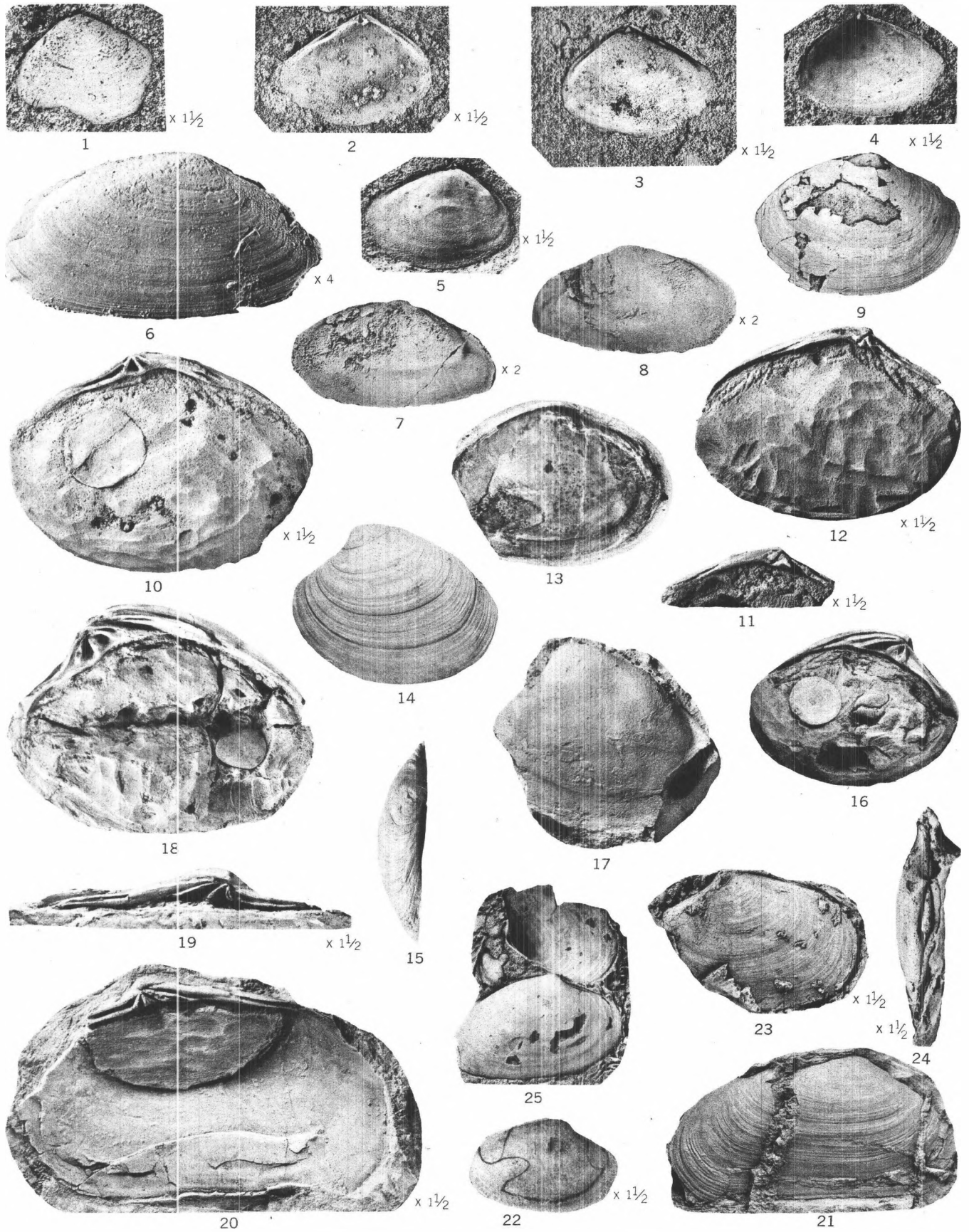


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 28

[Figures natural size except as indicated]

- FIGURES 1-5. "*Tellina*" *parkerana*, n. sp. (p. 114).
1-3. Holotype ($\times 1\frac{1}{2}$), a right valve, rubber cast from external mold, rubber cast from internal mold, and internal mold, from Lewisville member, Hillsboro road, 2.5 miles northwest of Parker, Johnson Co. Loc. 9. U.S.G.S. 13571, U.S.N.M. 105444.
4, 5. Paratype ($\times 1\frac{1}{2}$), rubber cast made from internal mold, and internal mold, from the same source. U.S.N.M. 105445.
6-8. "*Tellina*" *stabulana*, n. sp. (p. 114).
6. Left side of holotype ($\times 4$), from Templeton member, gully south of a barn, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105439.
7, 8. Views of a paratype ($\times 2$), an internal mold, from Lewisville member (Tarrant unit of Moreman), branch north of Chicago, Rock Island and Pacific Railroad near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18998, U.S.N.M. 105440.
9-13. *Nelltia stenzeli*, n. sp. (p. 113).
9, 10. Exterior ($\times 1$) and interior ($\times 1\frac{1}{2}$) of the holotype, a right valve, from Lewisville member (Tarrant unit of Moreman), Chicago, Rock Island and Pacific Railroad, 0.9 mile west of the Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105431.
11. Hinge of left valve of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105435a.
12. Hinge of left valve of a paratype ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18998, U.S.N.M. 105433.
13. Incomplete right valve of a paratype, showing pallial sinus, from the same locality, U.S.G.S. 18218, U.S.N.M. 105435b.
14-18. *Flaventia ludana*, n. sp. (p. 112).
14-16. Views of the holotype, a left valve, from Templeton member, gully, south of a barn, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105426.
17. Internal mold of a paratype, a left valve, from the same source. U.S.N.M. 105427.
18. Hinge of a paratype, a right valve, from Templeton member, gully north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 173. U.S.G.S. 20594, U.S.N.M. 105429.
19-25. *Sinonia levis*, n. sp. (p. 111).
19. Hinge of left valve of a paratype ($\times 1\frac{1}{2}$), from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105421.
20, 21. Right hinge ($\times 1\frac{1}{2}$) and exterior of right valve of a paratype ($\times 1$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105423a.
22. Right side of a paratype ($\times 1\frac{1}{2}$), a small internal mold from the same source. U.S.N.M. 105423b.
23-25. Rubber casts of right valve and top ($\times 1\frac{1}{2}$) of external mold of a paratype, and an associated internal mold of a right valve ($\times 1$), from Lewisville member, Horne Branch, 0.2 mile east of Woodbury, Hill Co. Loc. 5. U.S.G.S. 13575, U.S.N.M. 105425a-b.

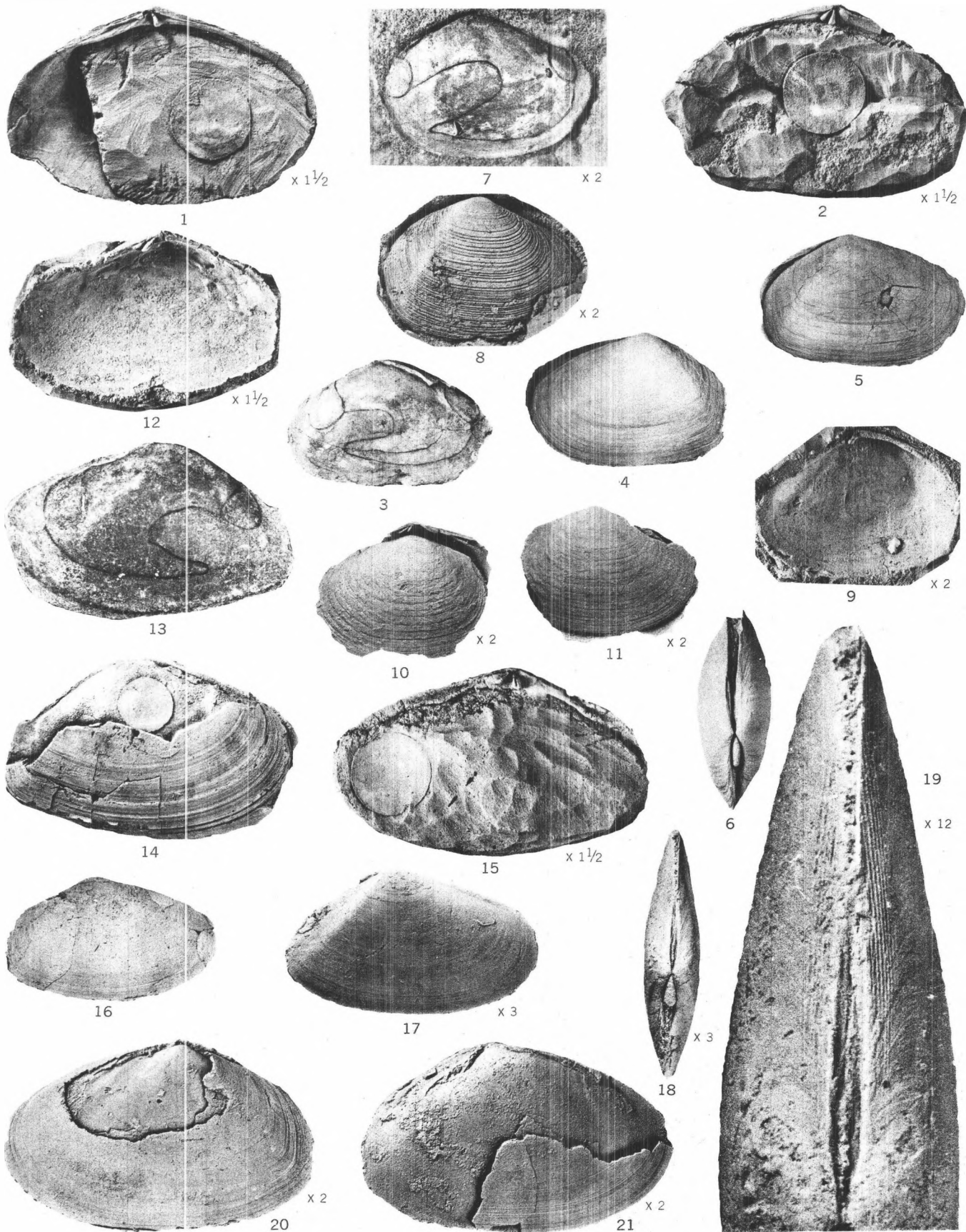


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 29

[Figures natural size except as indicated]

- FIGURES 1-6. *Solyma stewarti*, n. sp. (p. 117).
1-3. Hinges of left and right valves of 2 paratypes ($\times 1\frac{1}{2}$) and internal mold of right valve of 1 of them ($\times 1$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105463a-b.
4-6. Views of the holotype, from the same source. U.S.N.M. 105462.
7-11. *Linearia (Liothyris) concentrica*, n. sp. (p. 116).
7-9. Internal mold, rubber cast of external mold, and rubber cast of internal mold, of paratypes ($\times 2$), from Lewisville member, Hillsboro road, 2 miles east of Whitney, Hill Co. Loc. 3. U.S.G.S. 11836, U.S.N.M. 105458.
10, 11. Views of the holotype ($\times 2$), from Templeton member, branch of Iron Ore Creek, 0.4 mile south, 0.8 mile west of Star School, in northeastern Grayson Co. Loc. 172. U.S.G.S. 20593, U.S.N.M. 105456.
12. *Linearia* sp. (p. 116).
Interior of a right valve ($\times 1\frac{1}{2}$), from Lewisville member (Tarrant unit of Moreman), branch north of Chicago, Rock Island and Pacific Railroad near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18986, U.S.N.M. 105460.
13-16. "*Tellina*" *dugansensis*, n. sp. (p. 115).
13-14. Views of an incomplete paratype, from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105448.
15, 16. Hinge ($\times 1\frac{1}{2}$) and exterior of holotype ($\times 1$), a right valve, from the same locality. U.S.G.S. 19500, U.S.N.M. 105447.
17-21. "*Tellina*" *virana*, n. sp. (p. 114).
17, 18. Right side and top views of a paratype ($\times 3$), from Lewisville member, small branch north of Chicago, Rock Island and Pacific Railroad near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18998, U.S.N.M. 105443.
19. Anterodorsal portion of same enlarged ($\times 12$) to show radial lining near margin.
20, 21. Views of the holotype ($\times 2$), from Lewisville member branch of Big Bear Creek at road crossing, 1.2 miles northeast of Euless, Tarrant Co. Loc. 53. U.S.G.S. 18997, U.S.N.M. 105442.



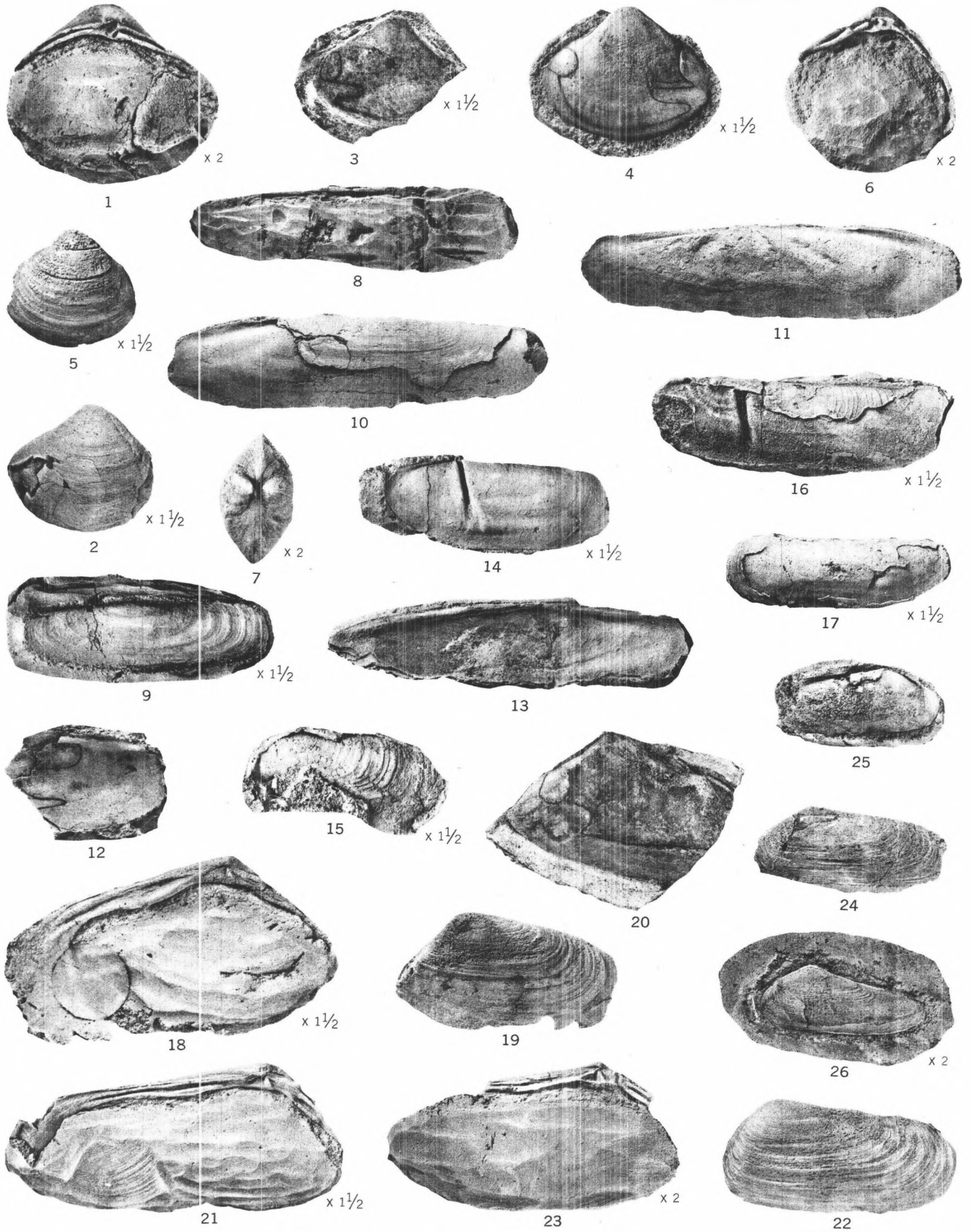
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 30

[Figures natural size except as indicated]

FIGURES 1-7. *Cymbophora spooneri*, n. sp. (p. 121).

- 1, 2. Hinge ($\times 2$) and exterior ($\times 1\frac{1}{2}$) of holotype, a left valve, from Lewisville member, near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19015, U.S.N.M. 105492.
- 3, 4. Internal molds of 2 paratypes, right and left valves ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105493a-b.
5. A paratype ($\times 1\frac{1}{2}$), a left valve, from Lewisville member, cut of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 39. U.S.G.S. 13583, U.S.N.M. 105495.
6. Hinge of right valve of a paratype ($\times 2$), from Templeton member, road 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105497.
7. Top view of a paratype ($\times 2$), from Templeton member, small branch 2.2 miles north of Sherman Junction, Grayson Co. Loc. 158. U.S.G.S. 18220, U.S.N.M. 105496.
- 8-13. *Senis elongatus*, n. sp. (p. 120).
8. Hinge of right valve of a paratype, from Lewisville member, branch north of old Keller road, 1.4 miles west of Grapevine, Tarrant Co. Loc. 49. U.S.G.S. 18987, U.S.N.M. 105484.
9. Small left valve of a paratype ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, about 1 mile west of the Dallas County line, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105482.
- 10-13. Right exterior, left side of internal mold, fragment of interior of right valve, and interior of left valve, of holotype, from the same source. U.S.N.M. 105481.
- 14-17. *Leptosolen angustus*, n. sp. (p. 119).
- 14, 15. Internal mold, and rubber cast of part of external mold, of left valve of a paratype ($\times 1\frac{1}{2}$), from marine facies at base of Dexter member, crossroads 1.4 miles northeast of Handley, Tarrant Co. Loc. 11. U.S.G.S. 18979, U.S.N.M. 105480.
16. Holotype ($\times 1\frac{1}{2}$), an incomplete left valve, from Lewisville member, small branch, north of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 41. U.S.G.S. 14567, U.S.N.M. 105478.
17. A paratype ($\times 1\frac{1}{2}$), an incomplete right valve from the same source. U.S.N.M. 105479.
- 18-20. *Protodonax robustus*, n. sp. (p. 118).
- 18, 19. Hinge ($\times 1\frac{1}{2}$), and exterior of holotype ($\times 1$), a right valve from Lewisville member, near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105474.
20. Part of internal mold of a paratype, a right valve, from the same source. U.S.N.M. 105475.
- 21-23. *Protodonax lingulatus*, n. sp. (p. 117).
21. Hinge of right valve of a paratype ($\times 1\frac{1}{2}$), from the Lewisville member, from the same source as the preceding one. U.S.G.S. 18972, U.S.N.M. 105466.
22. Holotype, a right valve from the same source. U.S.N.M. 105465.
23. Hinge of a paratype ($\times 2$), a small right valve, from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 76. U.S.G.S. 7553, U.S.N.M. 105469.
- 24-26. *Protodonax lingulatus tensus*, n. var. (p. 118).
24. Holotype, a right valve from Lewisville member, near a branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105470.
- 25, 26. Internal mold of left valve ($\times 1$), and exterior of right valve ($\times 2$), of paratypes from the same source. U.S.N.M. 105471a-b.



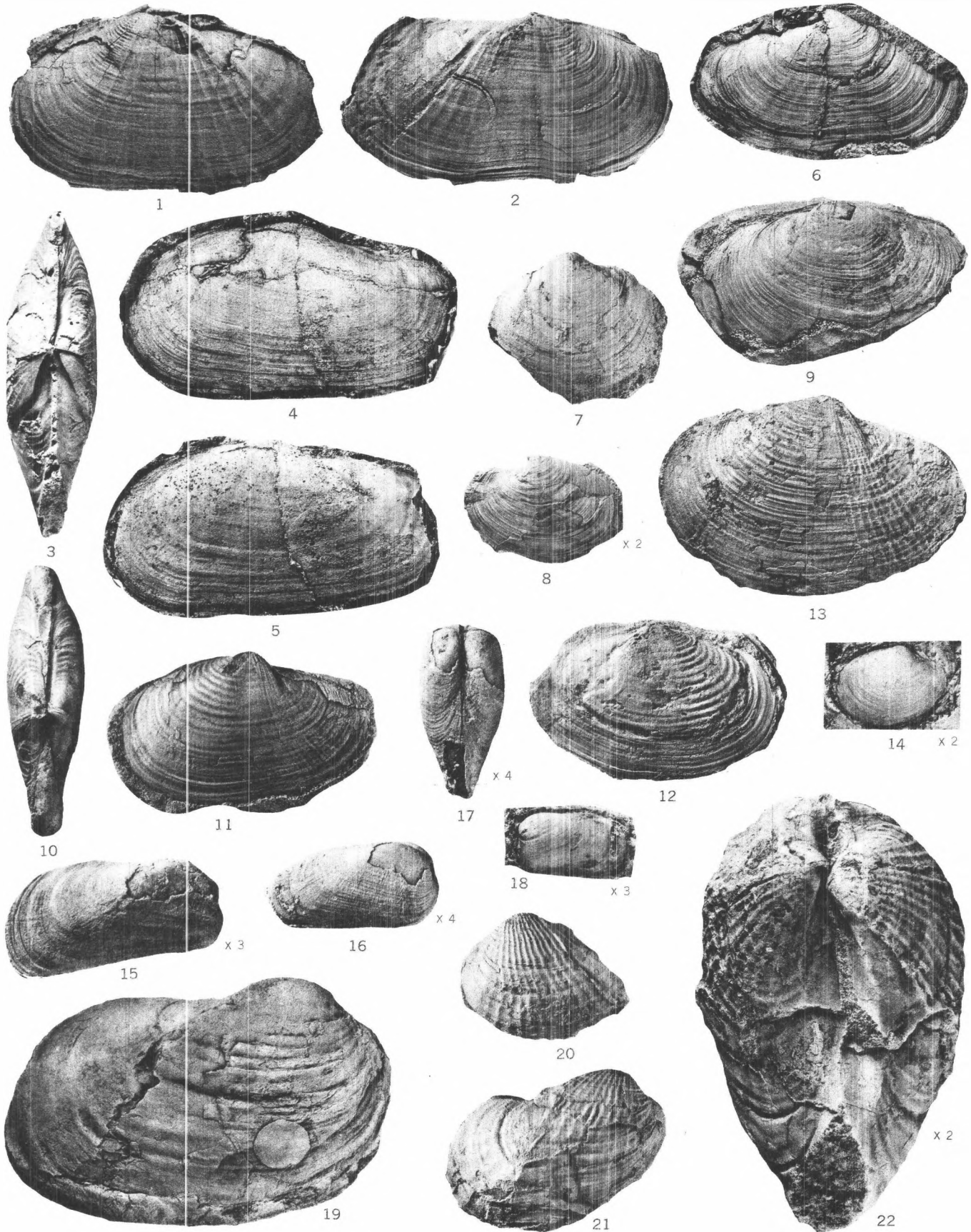
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 31

[Figures natural size except as indicated]

FIGURES 1-5. *Aliopecten compressa*, n. sp. (p. 125).

1. Left side of internal mold of a paratype, from Lewisville member, Johnson Creek, "2 miles [probably about 1.5 miles] northeast of Arlington, Tarrant Co." Loc. 34. U.S.G.S. 476, U.S.N.M. 105520.
- 2, 3. Hinge ($\times 1\frac{1}{2}$) and exterior of holotype ($\times 1$), a right valve, from Templeton member, road 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105517.
- 4, 5. Right and left hinges of paratypes ($\times 1\frac{1}{2}$) from the same source. U.S.N.M. 105518a-b.
- 6-10. *Priscopecten cymba*, n. sp. (p. 124).
- 6-8. Internal mold ($\times 1\frac{1}{2}$), and left and right hinges ($\times 2$), of paratypes, from Lewisville member (Tarrant unit of Moreman), Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105510a-c.
- 9, 10. Right side and top side of holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105509.
- 11, 12. *Cymbophora saccellana*, n. sp. (p. 123).
Views of the holotype, a left valve, from Lewisville member, near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Peuland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19500, U.S.N.M. 105506.
13. *Priscopecten munda*, n. sp. (p. 125).
Holotype ($\times 2$), a right valve, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas Co. line, in Tarrant Co. Loc. 41. U.S.G.S. 14567, U.S.N.M. 105514.
- 14-17. *Cymbophora puteana*, n. sp. (p. 122).
- 14, 15. Right side and top views of holotype ($\times 1\frac{1}{2}$), from Lewisville member (Tarrant unit of Moreman), borrow pit south of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 50. U.S.G.S. 18992, U.S.N.M. 105503.
- 16, 17. Left and right hinges of paratypes ($\times 2$), from the same source. U.S.N.M. 105504a-b.
- 18-21. *Cymbophora securis*, n. sp. (p. 122).
- 18, 19. Left side and top views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105499.
20. Right side of internal mold of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105500.
21. Hinge of a paratype ($\times 1\frac{1}{2}$), a right valve, from Templeton member, bluff 1 mile north, 1.85 miles east of Sadler, Grayson Co. Loc. 167. U.S.G.S. 20542, U.S.N.M. 105502.
- 22-28. *Cymbophora schucherti*, n. sp. (p. 121).
- 22-25. Views of the holotype, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, 1 mile west of the Dallas County line, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105485.
26. Hinge of right valve of a paratype from the same source, U.S.N.M. 105486.
27. Hinge of left valve of a paratype, from Lewisville member, Timber Creek, about 3 miles west by south of Lewisville, Denton Co. Loc. 76. U.S.G.S. 7553, U.S.N.M. 105490.
28. Internal mold of a paratype, a right valve, from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105489.



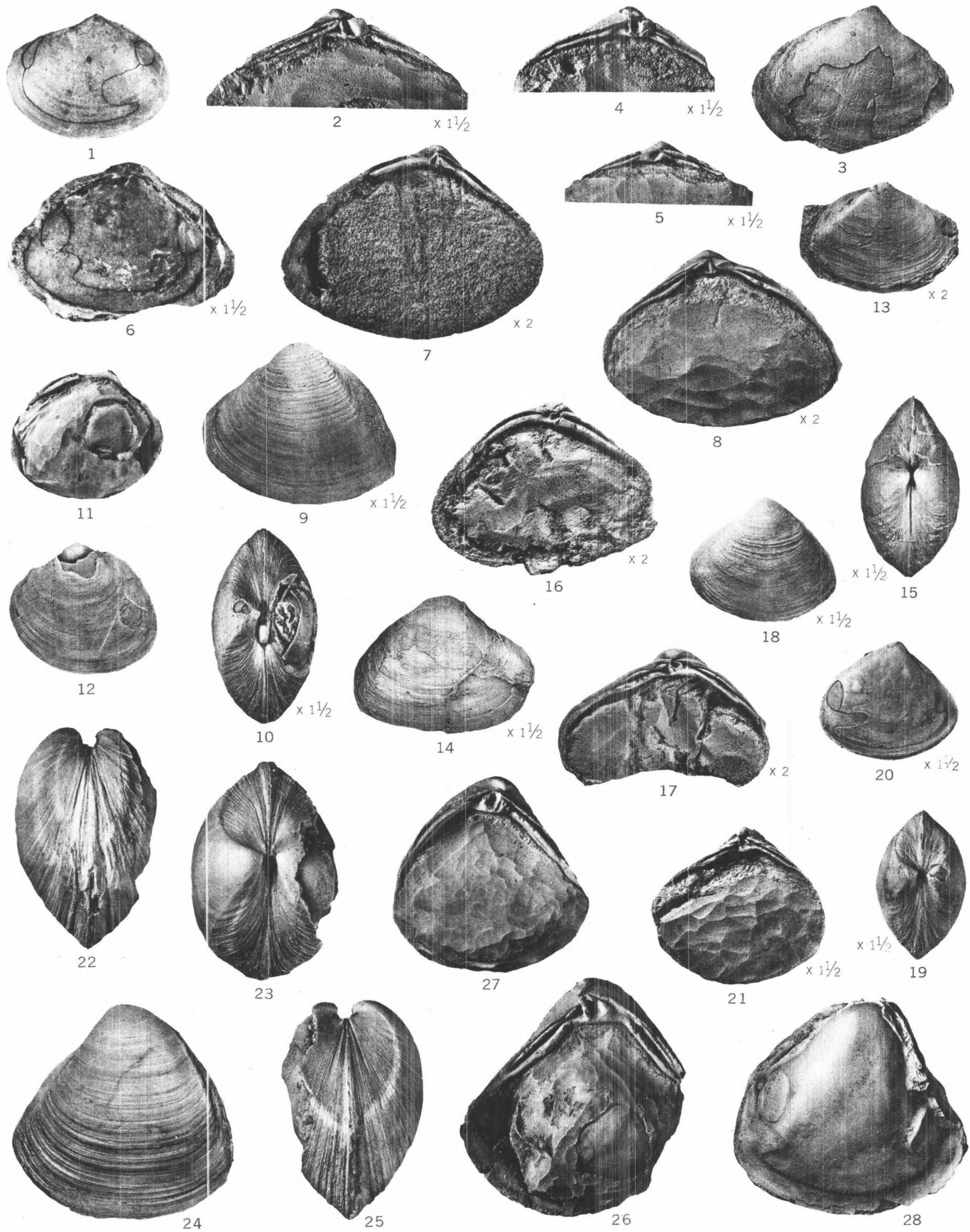
PELECYPODS FROM THE WOODBINE FORMATION

PLATE 22

[Figures natural size except as indicated]

FIGURE 1. *Crassatella* sp. (p. 96).

- Internal mold of left valve, from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 22. U.S.G.S. 19015, U.S.N.M. 105341.
- 2-6. *Opis? elevata*, n. sp. (p. 96).
2. Hinge of right valve of a paratype ($\times 2$), from Templeton member, road 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105339.
- 3-5. Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105336.
6. Left side of large paratype, an internal mold, from the same source. U.S.N.M. 105337.
- 7-12. *Cuspidaria alaeformis* (Shumard) (p. 93).
- 7, 8. Views of a plesiotype ($\times 1\frac{1}{2}$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105327.
9. Hinge of a plesiotype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105325a.
10. Top view of a plesiotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105325b.
11. Side view of a plesiotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105325c.
12. Neotype ($\times 1\frac{1}{2}$), from Lewisville member, Hyatts Bluff, Red River, 4.5 miles N. 62° W. of Ravenna, Fannin Co. Loc. 179. U.S.G.S. 18618, U.S.N.M. 105323.
- 13-20. *Psilomya concentrica* (Stanton) (p. 92).
- 13, 14. Left ($\times 2$) and right ($\times 3$) hinges of plesiotypes, from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105315a, b.
15. Plesiotype ($\times 3$), a left valve showing radiating rows of spines and spine scars, from the same source. U.S.N.M. 105315c.
- 16, 17. Two plesiotypes ($\times 1\frac{1}{2}$), right and left valves, from Templeton member, Golden Bluff, Red River, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 13799, U.S.N.M. 105316a, b.
- 18-20. Views of a plesiotype showing both valves partly separated, from the same source. U.S.N.M. 105316c.
- 21-24. *Psilomya levis*, n. sp. (p. 92).
21. Holotype ($\times 1\frac{1}{2}$), a left valve, from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105318.
22. Hinge of a paratype ($\times 5$), a right valve from the same source. U.S.N.M. 105319.
23. Side view of the same paratype ($\times 1\frac{1}{2}$).
24. The same ($\times 5$) to show tiny spine scars.
25. *Liopistha* sp. (p. 93).
- Rubber cast of incomplete external mold ($\times 1\frac{1}{2}$), from Lewisville member, 2 miles [probably 1.5 miles] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105322.

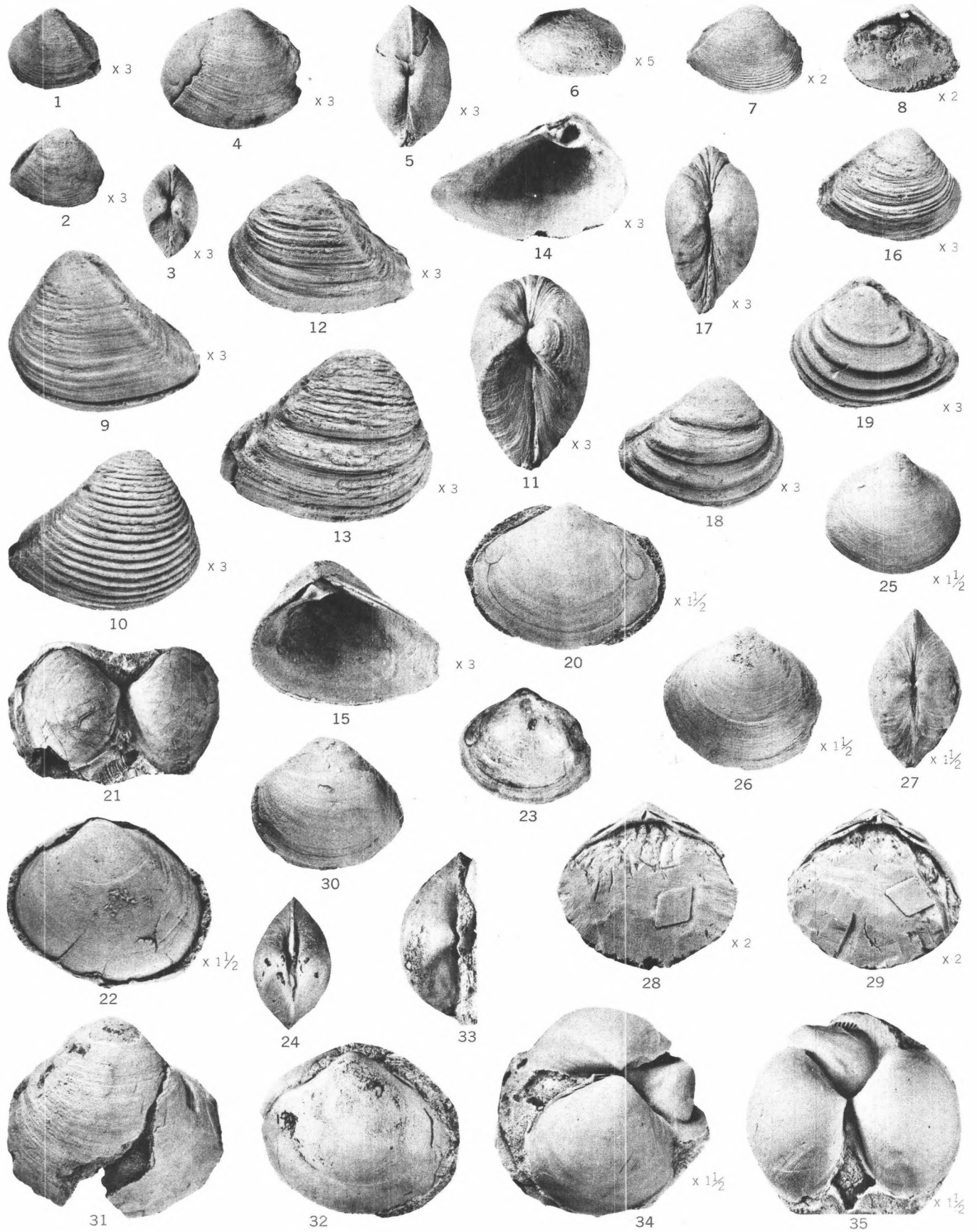


PELECYPODS FROM THE WOODBINE FORMATION

PLATE 32

[Figures natural size except as indicated]

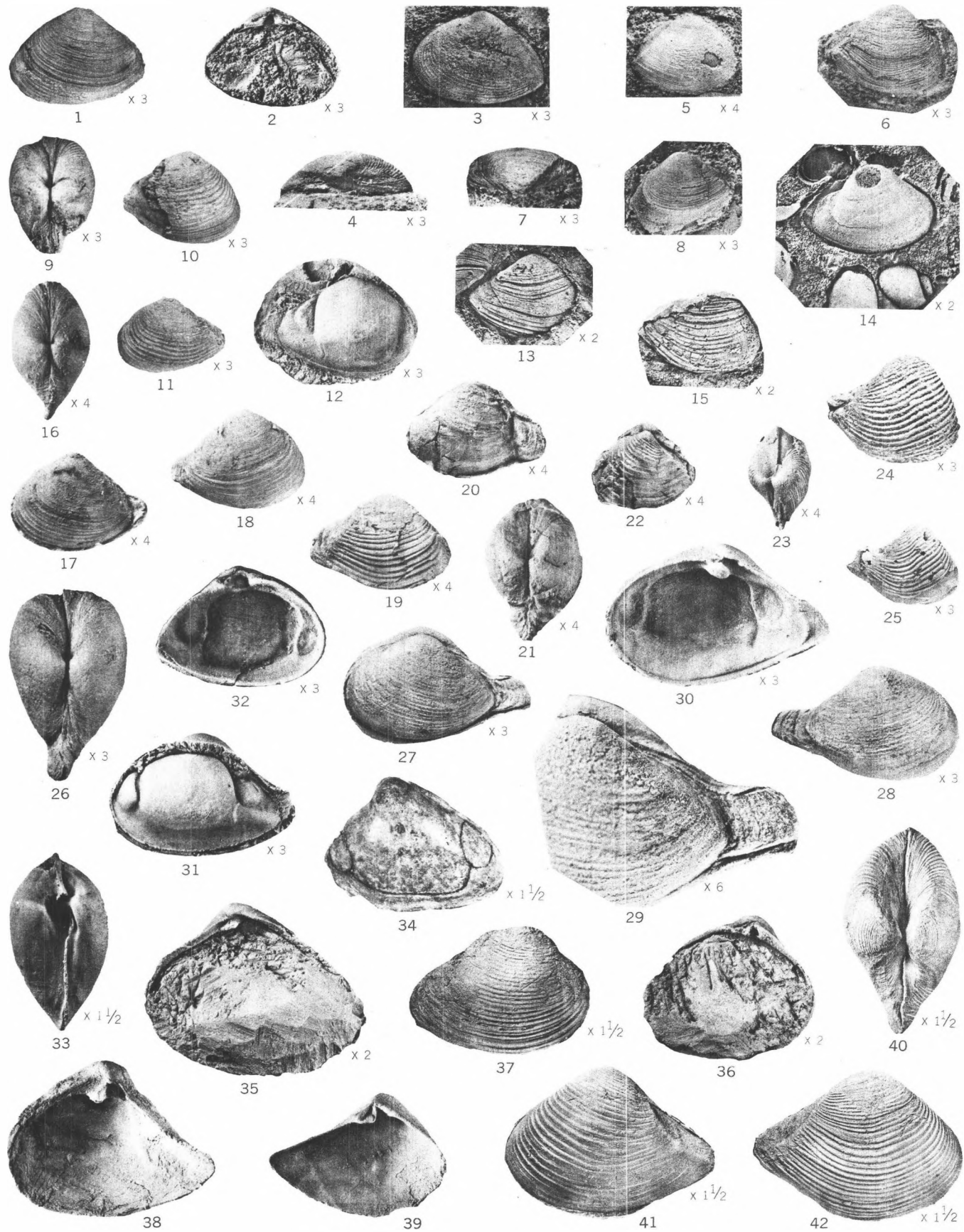
- FIGURES 1-3. *Caryocorbula? tradingensis*, n. sp. (p. 130).
Views of the holotype ($\times 3$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105541.
- 4, 5. "*Corbula? pulvinata*", n. sp. (p. 137).
Views of the holotype ($\times 3$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105585.
6. "*Corbula? starana*", n. sp. (p. 137).
Holotype ($\times 5$), a right valve, from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 477, U.S.N.M. 105583.
- 7, 8. "*Corbula? dentonensis*", n. sp. (p. 136).
Views of the holotype ($\times 2$), a right valve, from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 76. U.S.G.S. 7553, U.S.N.M. 105581.
- 9-15. *Caryocorbula? orisana*, n. sp. (p. 129).
9-11. Views of the holotype ($\times 3$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105535.
12. Left side of a paratype ($\times 3$), from the same source. U.S.N.M. 105536a.
13. Right side of a paratype ($\times 3$), from the same source. U.S.N.M. 105536b.
14. Left hinge of a paratype ($\times 3$), from the same source. U.S.N.M. 105536c.
15. Right hinge of a paratype ($\times 3$), from the same source. U.S.N.M. 105536d.
- 16-19. *Caryocorbula? varia*, n. sp. (p. 129).
16. Right side of a paratype ($\times 3$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105539.
- 17-19. Views of the holotype ($\times 3$), from the same source. U.S.N.M. 105538.
20. *Geltena subcompressa*, n. sp. (p. 128).
Holotype ($\times 1\frac{1}{2}$), an internal mold of a left valve, from Lewisville member, Hillsboro road, 2.5 miles northwest of Parker, Johnson Co. Loc. 9. U.S.G.S. 13571, U.S.N.M. 105533.
- 21-24. *Geltena nitida*, n. sp. (p. 127).
21. Internal molds of right and left valves of a paratype, from Lewisville member, Johnson Creek, 1.5 miles northeast of Methodist Church at Arlington, Tarrant Co. Loc. 47. U.S.G.S. 18639, U.S.N.M. 105529a.
22. Rubber cast of external mold of a paratype ($\times 1\frac{1}{2}$) from the same source. U.S.N.M. 105529b.
- 23, 24. Views of the holotype, an internal mold from the same source. U.S.N.M. 105528.
- 25-29. *Geltena subequilatera* Stephenson (p. 126).
25. Right side of a paratype ($\times 1\frac{1}{2}$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 103762.
- 26, 27. Left side and top views of holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 103761.
28, 29. Left and right hinges of paratypes ($\times 2$) from the same source. U.S.N.M. 103762.
- 30-33. *Geltena obesa*, n. sp. (p. 127).
30. Left side of a paratype, from Lewisville member, headwater branch of Walnut Creek, east of road, 0.7 mile north of Gordonville, Grayson Co. Loc. 114. U.S.G.S. 18963, U.S.N.M. 105524.
31. Holotype, an incomplete right valve, from the same source. U.S.N.M. 105523.
- 32, 33. Views of a paratype, an internal mold of a left valve, from Lewisville member on the same branch, 0.5 mile north of Gordonville. Loc. 126. U.S.G.S. 18976, U.S.N.M. 105526.
- 34, 35. *Geltena prunoides*, n. sp. (p. 128).
Views of the holotype ($\times 1\frac{1}{2}$), internal molds of both valves, from Lewisville member, Johnson Creek, 2 miles [probably 1.5 miles] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105531.



PELECYPODS FROM THE WOODBINE FORMATION

PLATE 33

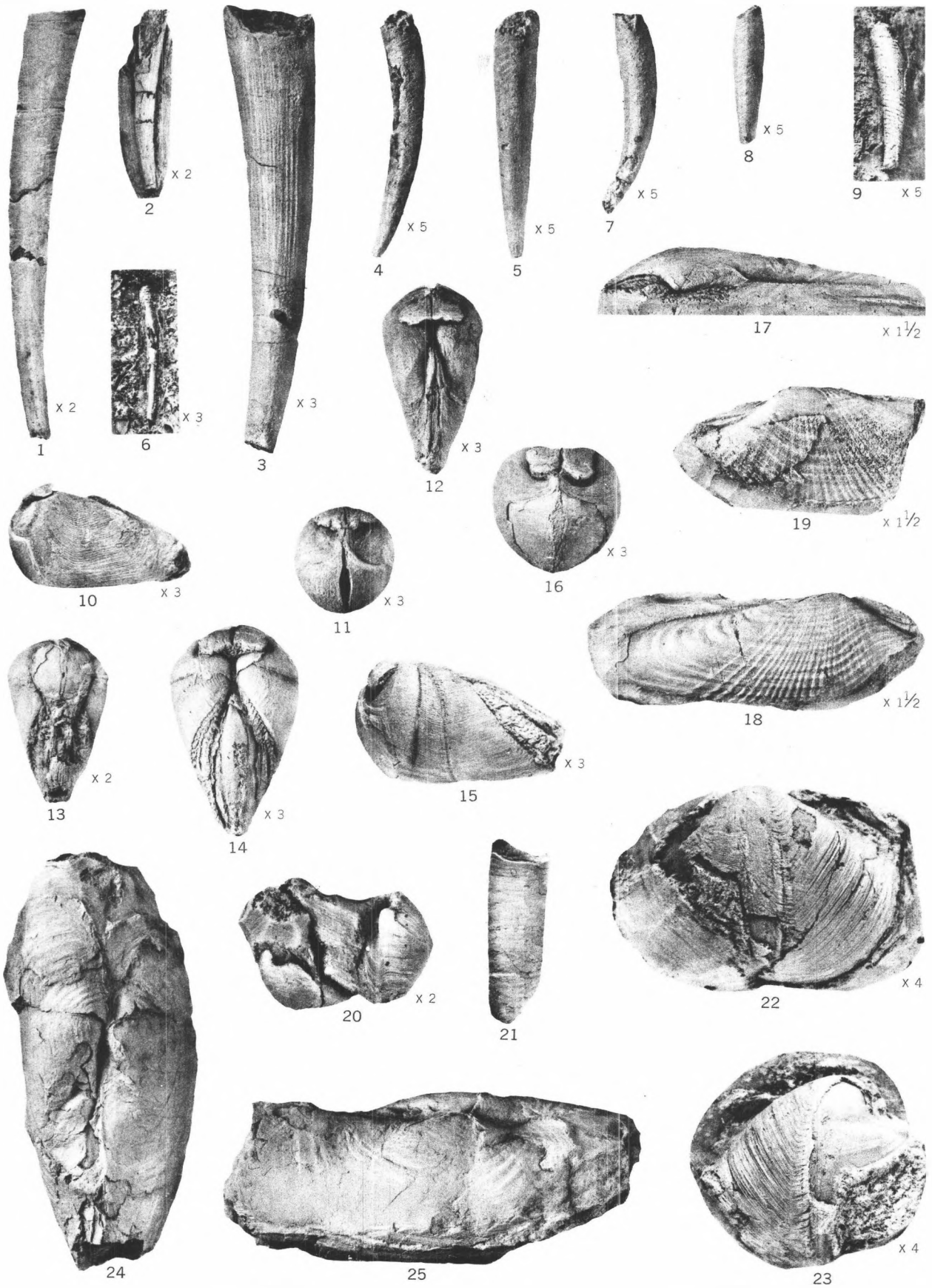
- FIGURES 1, 2. "*Corbula*" *anniculana*, n. sp. (p. 136).
Views of the holotype ($\times 3$), a left valve, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, 1 mile west of the Dallas County line, Tarrant Co. Loc. 44. U.S.G.S. 18986, U.S.N.M. 105579.
- 3, 4. "*Corbula*" *ponsana*, n. sp. (p. 136).
Views of the holotype ($\times 3$), a left valve, from Lewisville member, near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 14565, U.S.N.M. 105577.
- 5-8. "*Corbula*" *senecta*, n. sp. (p. 135).
5. A paratype ($\times 4$), a right valve, from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105573.
6, 7. Views of the holotype ($\times 3$), a right valve, from the same source. U.S.N.M. 105572.
8. A paratype ($\times 3$), a left valve, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105575.
- 9-12. *Parmicorbula* *rupana*, n. sp. (p. 133).
9, 10. Views of the holotype ($\times 3$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105620.
11, 12. Left valve, and internal mold right valve, of paratype ($\times 3$), from the same source. U.S.N.M. 105621a-b.
- 13-15. *Parmicorbula?* *hillensis*, n. sp. (p. 133).
13, 14. Rubber cast of part of external mold ($\times 2$), and internal mold ($\times 2$), of holotype, a right valve, from Lewisville member, northeast-southwest road, 3 miles northeast of Whitney, Hill Co. Loc. 7. U.S.G.S. 19020, U.S.N.M. 105555.
15. Rubber cast of part of external mold of a paratype ($\times 2$), a right valve, from the same source. U.S.N.M. 105556.
- 16-18. *Parmicorbula* *numerosa*, n. sp. (p. 132).
Views of the holotype ($\times 4$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105551.
- 19-21. *Parmicorbula* *corneliana*, n. sp. (p. 132).
Views of the holotype ($\times 4$), from the Templeton member, also from loc. 165. U.S.G.S. 20315; U.S.N.M. 105553.
- 22-25. *Parmicorbula* *sinuosa*, n. sp. (p. 131).
22, 23. Views of a paratype ($\times 4$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105549a.
24. Holotype ($\times 3$), a right valve, from the same source. U.S.N.M. 105548.
25. A paratype ($\times 3$), a right valve, from the same source. U.S.N.M. 105549b.
- 26-32. *Parmicorbula* *rokesi*, n. sp. (p. 131).
26-28. Views of the holotype ($\times 3$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 103713.
29. Part of left side of holotype ($\times 6$), to show accessory plate.
- 30, 31. Interior of a right valve, and internal mold of a left valve, of paratypes ($\times 3$), from the same source. U.S.N.M. 105544a-b.
32. Interior of left valve of a paratype ($\times 3$), from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105546.
- 33-37. *Ursirivus?* *arlingtonanus*, n. sp. (p. 135).
33, 34. Views of a paratype ($\times 1\frac{1}{2}$), an internal mold, from Lewisville member, Johnson Creek, 2 miles [probably 1.5 miles] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105571.
- 35, 36. Right and left hinges of paratype ($\times 2$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105569a-b.
37. Holotype ($\times 1\frac{1}{2}$), a right valve from the same source. U.S.N.M. 105568.
- 38-42. *Ursirivus* *fannincensis*, n. sp. (p. 134).
38, 39. Interior views of paratypes ($\times 4$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105565a-b.
40-42. Views of the holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105564.



PELECYPODS FROM THE WOODBINE FORMATION

PLATE 34

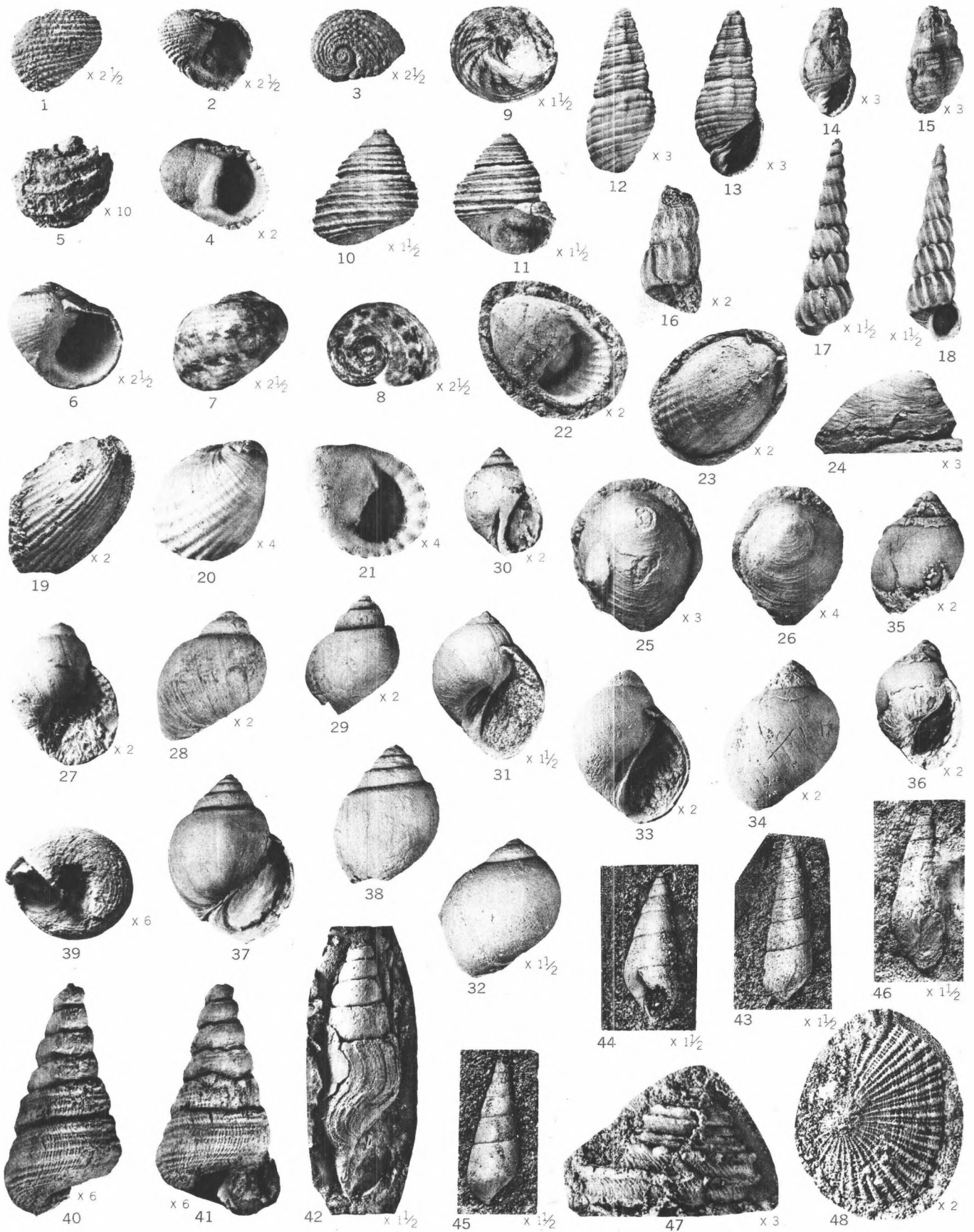
- FIGURES 1, 2. *Dentalium alineatum*, n. sp. (p. 142).
1. Holotype ($\times 2$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Loc. 201. U.S.G.S. 14546, U.S.N.M. 105603.
 2. A paratype ($\times 2$) from the same source. U.S.N.M. 105604.
 3. *Dentalium sublineatum*, n. sp. (p. 142).
Holotype ($\times 3$), from the same member and locality as the preceding. U.S.G.S. 14546, U.S.N.M. 105607.
 - 4, 5. *Dentalium minor*, n. sp. (p. 143).
Views of the holotype ($\times 5$), from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105610.
 6. *Dentalium* sp. (p. 143).
Incomplete tube ($\times 3$), from Templeton member, gullies south of the old Sherman road, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 14092, U.S.N.M. 105613a.
 - 7-9. *Cadulus praetenuis*, n. sp. (p. 143).
7. Holotype ($\times 5$), from the same member and locality as the preceding. U.S.G.S. 14560, U.S.N.M. 105615.
8, 9. Paratypes ($\times 5$), from the same source. U.S.N.M. 105616a and b.
 - 10-12. *Opertochasma subconicum*, n. sp. (p. 140).
Views of the holotype ($\times 3$), from Lewisville member, small stream cut, 0.2 mile south, 0.5 mile west of Star School, in northeastern Grayson Co. Loc. 137. U.S.G.S. 20538, U.S.N.M. 105597.
 - 13-16. *Opertochasma renustum*, n. sp. (p. 139).
13. Top view of a paratype ($\times 2$), from Lewisville member, Timber Creek, "4 miles [3 miles] west by south of Lewisville, Denton Co." Loc. 72. U.S.G.S. 475, U.S.N.M. 105595.
 - 14-16. Views of the holotype ($\times 3$), from the same source. U.S.N.M. 105594.
 - 17-19. *Pholas' scaphoides*, n. sp. (p. 138).
 - 17, 18. Top and side views of holotype ($\times 1\frac{1}{2}$), a right valve, from Lewisville member, near a small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19015, U.S.N.M. 105591.
 19. Incomplete left valve of a paratype ($\times 1\frac{1}{2}$), from the same locality. U.S.G.S. 18972, U.S.N.M. 105592.
 - 20-23. *Terebrimya lamarana*, n. sp. (p. 141).
 20. Right and left valves, partly separated, of the holotype ($\times 2$), taken from large end of the tube shown in fig. 21, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105600.
 21. Tube ($\times 1$) from boring in fossil wood, from which the holotype was taken.
 - 22, 23. Left and right valves of the holotype ($\times 4$).
 - 24, 25. *Panope subparallela* Shumard (p. 138).
Views of a plesiotype ($\times 1$), a crushed shell, from Templeton member, Golden Bluff, Red River, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 13799, U.S.N.M. 105625.



PELECYPODS AND SCAPHOPODS FROM THE WOODBINE FORMATION

PLATE 35

- FIGURES 1-4. *Nerita ornata*, n. sp. (p. 145).
 1-3. Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105634.
 4. Aperture of a paratype ($\times 2$), from the same source. U.S.N.M. 105637.
 5. *Nerita* sp. (p. 146).
 A young incomplete shell ($\times 10$), from Lewisville member, Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 78. U.S.G.S. 7555, U.S.N.M. 105641.
 6-8. *Nerita semilevis*, n. sp. (p. 146).
 Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105639. (Note color markings.)
 9-11. *Turbo?* *serratus*, n. sp. (p. 144).
 Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105630.
 12-15. *Ambrosca nitida*, n. sp. (p. 148).
 12, 13. Views of the holotype ($\times 3$), from Lewisville member, small stream gorge, 1.9 miles S. 54° W. of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105654.
 14, 15. Views of a paratype ($\times 3$), from the same source, U.S.N.M. 105655.
 16. *Confusiscula?* sp. (p. 148).
 An incomplete shell ($\times 2$), from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105657.
 17, 18. *Epitonium stehmanni*, n. sp. (p. 149).
 Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, gully, north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 173. U.S.G.S. 20594, U.S.N.M. 105658.
 19. *Neritina (Vielotila) sp.* (p. 147).
 Incomplete internal mold of body whorl ($\times 2$), from Dexter member, 1 mile southwest of Bartonville, Denton Co. Loc. 216. U.S.G.S. 20042, U.S.N.M. 105645.
 20-23. *Neritina (Vielotila) ambrosana*, n. sp. (p. 146).
 20, 21. Views of the holotype ($\times 4$), from Lewisville member, small stream gorge, 1.9 miles S. 54° W. of center of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105643.
 22, 23. Views of a questionable example ($\times 2$), from Lewisville member, Johnson Creek, about 1.3 miles northeast of Methodist Church, Arlington, Tarrant Co. Loc. 54. U.S.G.S. ?19505, U.S.N.M. 105644.
 24-26. *Acmaca plicolus*, n. sp. (p. 144).
 24, 25. Views of the holotype ($\times 3$), from Templeton member, Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson Co. Loc. 152. U.S.G.S. 14557, U.S.N.M. 105626.
 26. A paratype ($\times 4$), from Templeton member, 1.3 miles west of the southwest end of the dam of Loy State Park Lake, Grayson Co. Loc. 162. U.S.G.S. 20275, U.S.N.M. 105628.
 27, 28. *Natica dorothiensis abrala*, n. var. (p. 151).
 Views of the holotype ($\times 2$), from Templeton member, bluff along branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105666.
 29, 30. *Natica humilis* Cragin (p. 150).
 Views of the cotypes ($\times 2$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. (Univ. of Texas Collection; see plastotypes, U.S.N.M. 105660 a, b.)
 31, 32. *Natica dorothiensis*, n. sp. (p. 150).
 Views of the holotype ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105662.
 33, 34. *Natica dorothiensis pendula*, n. var. (p. 150).
 Views of the holotype ($\times 2$), from Lewisville member, east tributary of Sheep Creek, 2.6 miles east and 3.4 miles north of Savoy, Fannin Co. Loc. 192. U.S.G.S. 20307, U.S.N.M. 105664.
 35, 36. *Natica striaticostata* Cragin (p. 150).
 Views of a cotype ($\times 2$), from Templeton member, 4 miles [less than 4 miles] east-southeast of Whitesboro, Grayson Co. (Univ. of Texas Collection; see plastotype, U.S.N.M. 105661.)
 37, 38. *Natica rivulana*, n. sp. (p. 151).
 37. Front view of holotype ($\times 1$), from Lewisville member, branch, north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18998, U.S.N.M. 105668.
 38. Back view of a paratype ($\times 1$), from the same member and locality. U.S.G.S. 18218, U.S.N.M. 105669.
 39-41. *Dathmila lineola*, n. sp. (p. 149).
 Views of the holotype ($\times 6$), from Templeton member, bluff on tributary to Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105659.
 42. *Pseudomelania?* *ferrata*, n. sp. (p. 148).
 Rubber cast of external mold of holotype ($\times 1\frac{1}{2}$), from Red Branch member, hillside north of Iron Ore Creek, 0.85 mile N. 44° W. of Star School, in northeastern Grayson Co. Loc. 102. U.S.G.S. 20316, U.S.N.M. 105652.
 43-46. *Pseudomelania?* *roanokana*, n. sp. (p. 147).
 43. Rubber cast of external mold of holotype ($\times 1\frac{1}{2}$), from Dexter member (marine facies), top of bluff overlooking Denton Creek valley, 3.7 miles northeast of Roanoke, Denton Co. Loc. 56. U.S.G.S. 18223, U.S.N.M. 105646.
 44, 45. Rubber casts of external molds of a paratype ($\times 1\frac{1}{2}$), from the same locality. U.S.G.S. 19525, U.S.N.M. 105650a-b.
 46. Rubber cast of external mold of a paratype ($\times 1\frac{1}{2}$), from the same locality. U.S.G.S. 11750, U.S.N.M. 105648.
 47. *Turbo?* sp. (p. 145).
 Rubber cast of imprint ($\times 3$), from Dexter member, road 3.5 miles south by west of Bartonville, Denton Co. Loc. 57. U.S.G.S. 19724, U.S.N.M. 105632.
 48. *Diadora?* *bartonvillensis*, n. sp. (p. 145).
 Rubber cast from external mold of holotype ($\times 2$), from the same member and locality as the preceding. U.S.N.M. 105633.

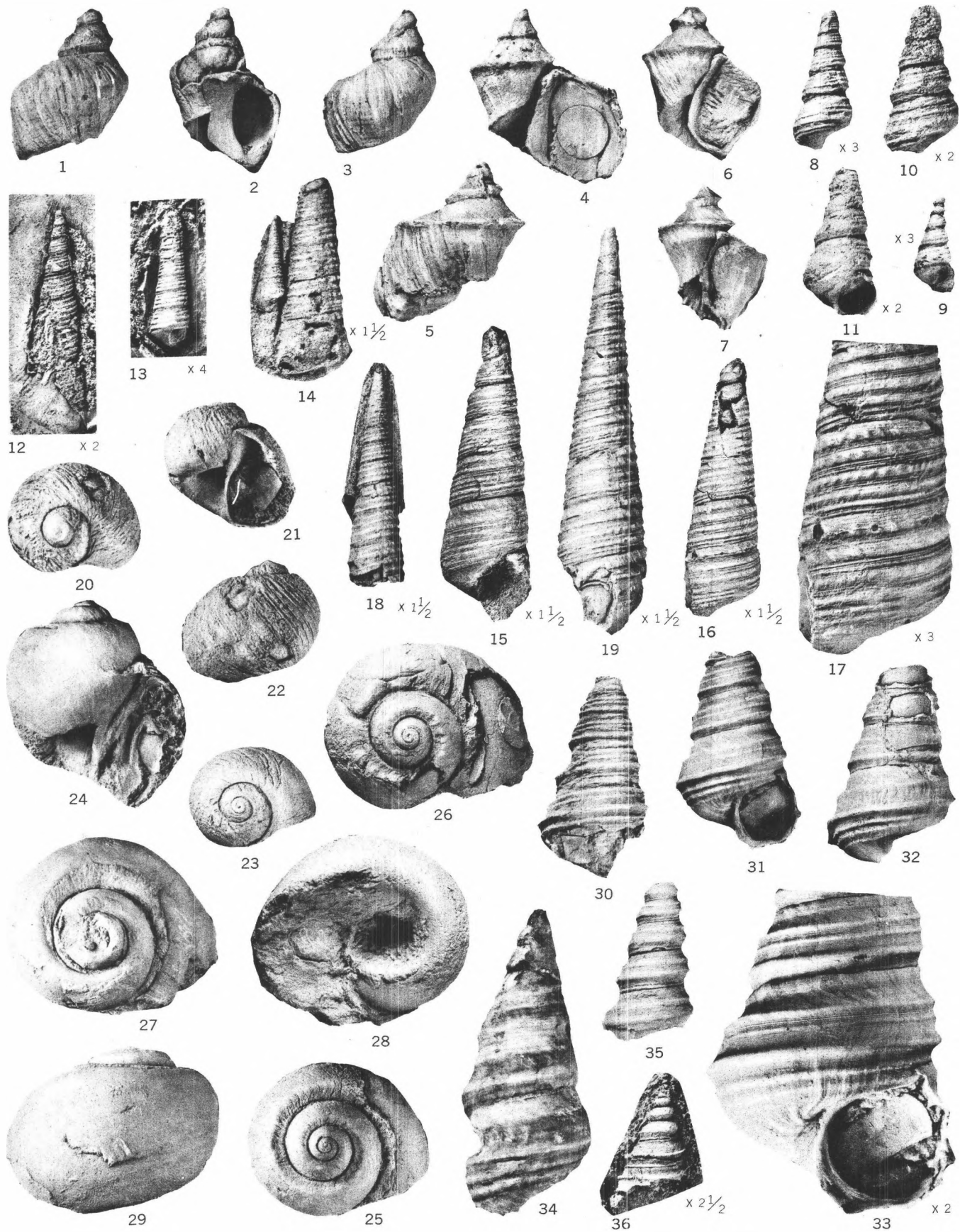


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 36

[Figures natural size except as indicated]

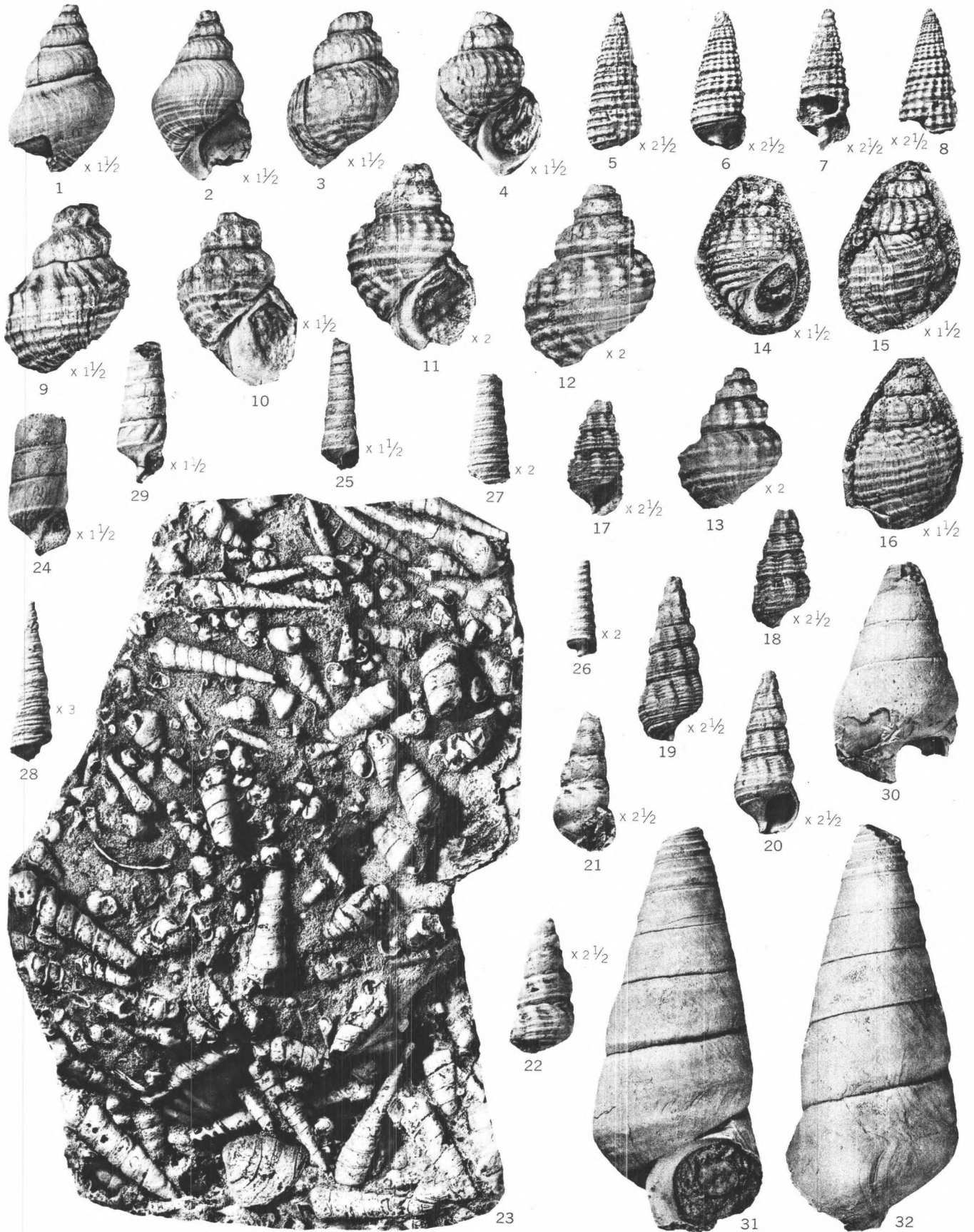
- FIGURES 1-3. *Lirpsa teres*, n. sp. (p. 153).
 1, 2. Views of the holotype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 12873, U.S.N.M. 105681.
 3. Back view of a paratype from the same source. U.S.N.M. 105680.
- 4-7. *Lirpsa cornuata*, n. sp. (p. 153).
 4, 5. Views of the holotype, from Templeton member, also from loc. 201. U.S.G.S. 14546, U.S.N.M. 105678.
 6, 7. Front views of two paratypes, from the same locality. U.S.G.S. 13797, U.S.N.M. 105679a-b.
- 8-11. *Mesalia? shumardi*, n. sp. (p. 154).
 8, 9. Views of 2 paratypes ($\times 3$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105692a-b.
 10, 11. Views of the holotype ($\times 2$), from the same source. U.S.N.M. 105691.
12. *Turritella* sp. (p. 154).
 Rubber cast of a ferruginous external mold ($\times 2$), from Dexter member (marine facies), bluff overlooking Denton Creek Valley, 3.7 miles northeast of Roanoke, Denton Co. Loc. 56. U.S.G.S. 19525, U.S.N.M. 105688a.
13. *Turritella* sp. (p. 154).
 A young shell ($\times 4$) from the Templeton member, borrow pit north of road, 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. 19012, U.S.N.M. 105690.
- 14-19. *Turritella shuleri*, n. sp. (p. 153).
 14, 15. Views of 2 paratypes ($\times 1\frac{1}{2}$), from Lewisville member (Tarrant unit of Moreman), branch of Big Bear Creek at road crossing, 1.2 miles northeast of Euless, Tarrant Co. Loc. 53. U.S.G.S. 18997, U.S.N.M. 105684a-b.
 16. Holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105683.
 17. Enlargement of part of holotype ($\times 3$), to show detail.
- 18, 19. Views of 2 paratypes ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105686a-b.
- 20-23. *Gyrodes ftuvianus*, n. sp. (p. 152).
 20-22. Views of the holotype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105674.
 23. Top view of a paratype from the same locality. U.S.G.S. 13797, U.S.N.M. 105676.
- 24-29. *Gyrodes tramitensis* (Cragin) (p. 151).
 24, 25. Views of a plesiotype, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 19504, U.S.N.M. 105671a.
 26. Top view of a plesiotype from the same source. U.S.N.M. 105671b.
- 27-29. Views of the holotype, from Lewisville member, Big Bear Creek near Dallas-Tarrant County line, in Tarrant Co. (Univ. of Texas Collection; see plastotype, U.S.N.M. 105672.)
- 30-36. *Craginia turriiformis*, n. sp. (p. 155).
 30. A paratype with thick spiral ribs, from Lewisville member, crest of north-facing slope, 3.4 miles N. 15° E. of Savoy, Fannin Co. Loc. 186. U.S.G.S. 18617, U.S.N.M. 105696.
 31, 32. Views of the holotype, from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105694.
 33. Enlargement of part of holotype ($\times 2$), to show details.
 34. A variant showing a brown spiral color band, from Lewisville member, Timber Creek, southwest of Lewisville. Loc. 66. (Coll. Bur. Econ. Geol. Austin, R17600; see plaster cast, U.S.N.M. 105695.)
 35. A variant, a paratype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 12873, U.S.N.M. 105698.
 36. Apical end of a paratype ($\times 2\frac{1}{2}$) from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105693.



GASTROPODS FROM THE WOODBINE FORMATION

PLATE 37

- FIGURES 1, 2. *Pyrgulifera costata subleris*, n. var. (p. 159).
Views of the holotype ($\times 1\frac{1}{2}$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105712.
- 3, 4. *Pyrgulifera costata tuberculata*, n. var. (p. 158).
Views of the holotype ($\times 1\frac{1}{2}$), from the same member and locality as the preceding. U.S.G.S. 507, U.S.N.M. 105710.
- 5-8. *Monroea castellana*, n. sp. (p. 159).
5, 6. Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105715.
7, 8. Views of 2 paratypes ($\times 2\frac{1}{2}$), from the same source. U.S.N.M. 105716a-b.
- 9-13. *Pyrgulifera ornata*, n. sp. (p. 157).
9, 10. Views of the holotype ($\times 1\frac{1}{2}$), from Lewisville member, gully 1,250 feet north of road, 3.5 miles N. 28° E. of Savoy, Fannin Co. Loc. 191. U.S.G.S. 19714, U.S.N.M. 105704.
- 11-13. Front and back views of a paratype ($\times 2$) and back view of a smaller paratype ($\times 2$), from the same source. U.S.N.M. 105705a-b.
- 14-16. *Pyrgulifera costata*, n. sp. (p. 158).
14, 15. Rubber casts made from external molds of two paratypes ($\times 1\frac{1}{2}$), from Euless member, cut on north-south road, 1 mile west by south of Euless, Tarrant Co. Loc. 25. U.S.G.S. 18995, U.S.N.M. 105708a-b.
16. Rubber cast made from external mold of holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105707.
- 17, 18. *Hemicerithium? insigne*, n. sp. (p. 163).
Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, 2 miles below [probably above] crossing of Dallas-Lewisville road, Denton Co. Loc. 64. (Bur. Econ. Geol., Austin: part of lot 708.)
- 19-22. *Hemicerithium? interlineatum* (Cragin) (p. 163).
19, 20. Views of a plesiotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105737.
- 21, 22. Views of lectotype ($\times 2\frac{1}{2}$), Lewisville member, Timber Creek, 2 miles below [probably above] crossing of Dallas-Lewisville road, Denton Co. Loc. 64. (Bur. Econ. Geol., Austin: part of lot 708.)
- 23-29. *Macrocerithium tramitense* (Cragin) (p. 160).
23. Numerous cotypes ($\times 1$) in piece of rock, from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 64. (Bur. Econ. Geol., Austin: part of lot 708; see plastotypes U.S.N.M. 105721a-c.)
- 24, 25. Two cotypes ($\times 1\frac{1}{2}$) from the type locality. (See plastotypes, U.S.N.M. 105721a-b.)
- 26-28. Two plesiotypes ($\times 2$), and one plesiotype ($\times 3$), from Lewisville member, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105719a-c.
29. A plesiotype ($\times 1\frac{1}{2}$), from Lewisville member, branch, north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105720.
30. *Gymnentome valida brevis*, n. var. (p. 157).
The holotype ($\times 1$) from the same member and locality as the preceding. U.S.G.S. 18218, U.S.N.M. 105702.
- 31, 32. *Gymnentome valida*, n. sp. (p. 156).
Views of the holotype ($\times 1$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105701.

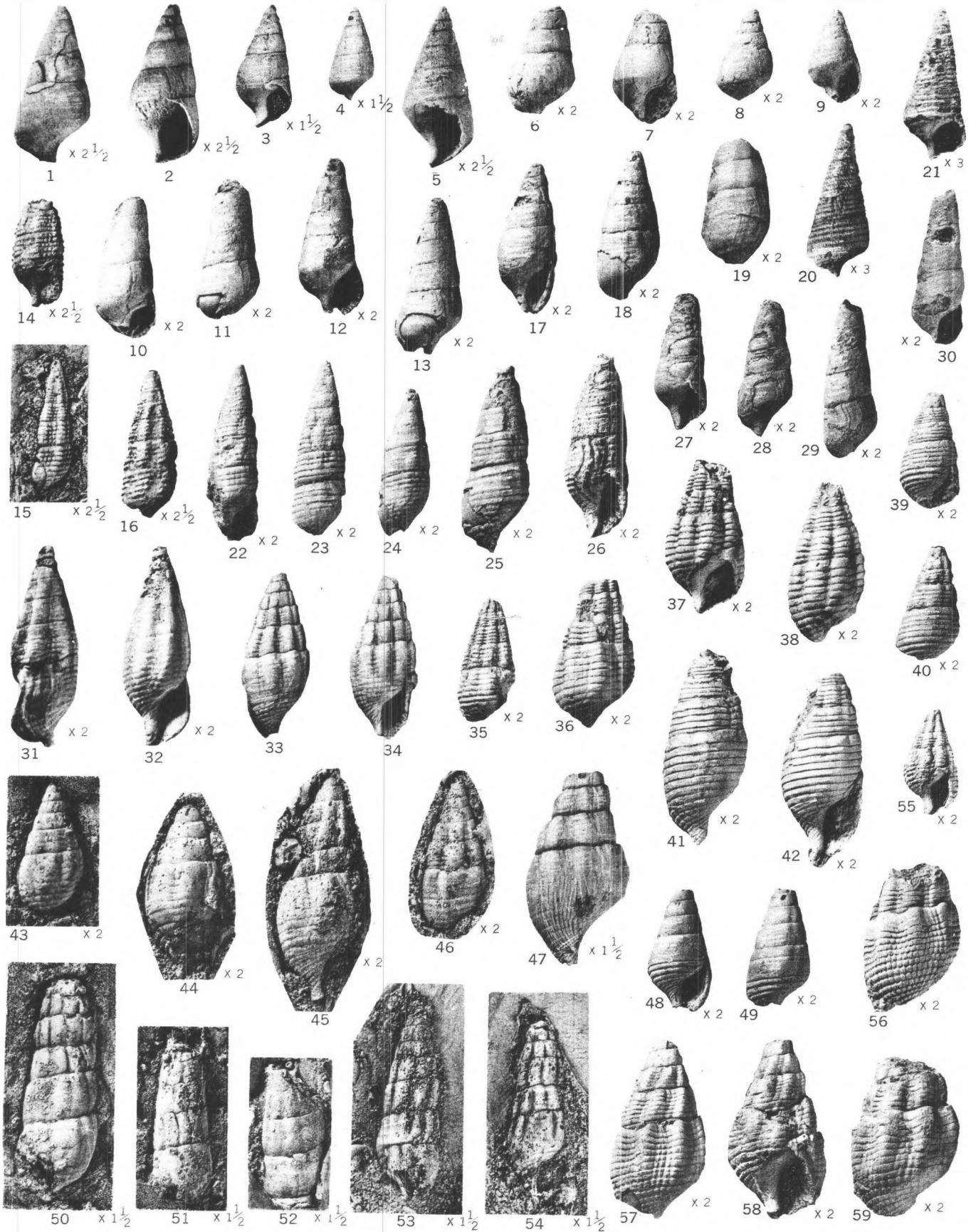


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 38

FIGURES 1-3. *Levicerithium timberanum*, n. sp. (p. 161).

- 1, 2. Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105722.
3. Front view of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105723.
- 4, 5. *Levicerithium planum*, n. sp. (p. 161).
Back view ($\times 1\frac{1}{2}$) and front view ($\times 2\frac{1}{2}$) of holotype, from Lewisville member, near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 78. U.S.G.S. 7555, U.S.N.M. 105724.
- 6, 7. *Levicerithium? microlirae*, n. sp. (p. 162).
View of the holotype ($\times 2$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105730.
- 8, 9. *Levicerithium breviforme*, n. sp. (p. 161).
Views of the holotype ($\times 2$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105728.
- 10, 11. *Levicerithium? altum*, n. sp. (p. 162).
Views of the holotype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105732.
- 12, 13. *Levicerithium? subaltum*, n. sp. (p. 162).
Views of the holotype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105734.
- 14-16. *Vascellum minusculum*, n. sp. (p. 169).
15. Rubber cast of holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105778.
- 14, 16. Views of two paratypes ($\times 2\frac{1}{2}$) from same locality. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105780a-b.
- 17-19. *Vascellum subleve*, n. sp. (p. 167).
17, 18. Views of the holotype ($\times 2$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105769.
19. Back view of a paratype ($\times 2$), from the same source. U.S.N.M. 105770.
- 20, 21. *Vascellum? rivanum*, n. sp. (p. 169).
Views of the holotype ($\times 3$), from Lewisville member, small stream gorge, 1.9 miles S. 54° W. of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105782.
- 22, 23. *Vascellum fortispirae*, n. sp. (p. 168).
Views of the holotype ($\times 2$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105772.
- 24-26. *Vascellum procerum*, n. sp. (p. 167).
24. Back view of a paratype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18627, U.S.N.M. 105763.
- 25, 26. Views of the holotype ($\times 2$), from the same locality. U.S.G.S. 18256, U.S.N.M. 105762.
- 27-30. *Vascellum leve*, n. sp. (p. 167).
27, 28. Views of a paratype ($\times 2$), from Lewisville member, gully near fence, 1,250 feet north of east-west road, 3.5 miles N. 28° E. of Savoy, Fannin Co. Loc. 191. U.S.G.S. 19714, U.S.N.M. 105766.
- 29, 30. Views of the holotype ($\times 2$), from the same source. U.S.N.M. 105765.
- 31, 32. *Vascellum elegans*, n. sp. (p. 164).
Views of the holotype ($\times 2$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105748.
- 33, 34. *Vascellum magnum*, n. sp. (p. 166).
Views of the holotype ($\times 1$), from Lewisville member, small stream gorge, 1.9 miles S. 54° W. of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105754.
- 35-38. *Vascellum vascellum*, n. sp. (p. 164).
35, 38. Back views of 2 paratypes ($\times 2$), from Lewisville member, Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin Co. Loc. 189. U.S.G.S. 18650, U.S.N.M. 105740a-b.
- 36, 37. Views of the holotype ($\times 2$) from the same source. U.S.N.M. 105739.
- 39-42. *Vascellum mundum*, n. sp. (p. 168).
39, 40. Views of a paratype ($\times 2$), from same source as the preceding. U.S.G.S. 18650, U.S.N.M. 105774.
- 41, 42. Views of the holotype ($\times 2$), from the same source. U.S.N.M. 105773.
- 43, 44. *Vascellum vascellum pressutum*, n. var. (p. 164).
43. Rubber cast of external mold of the holotype ($\times 2$), from Eules member, cut on Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant Co. Loc. 25. U.S.G.S. 18995, U.S.N.M. 105742.
44. Rubber cast of external mold of a paratype ($\times 2$), from the same source. U.S.N.M. 105743.
- 45, 46. *Vascellum vascellum subornatum*, n. var. (p. 164).
45. Rubber cast of external mold of the holotype ($\times 2$), from the same locality as the preceding. U.S.G.S. 18995, U.S.N.M. 105745.
46. Rubber cast of external mold of a paratype ($\times 2$), from the same source. U.S.N.M. 105746.
47. *Vascellum pingue*, n. sp. (p. 165).
Back view of holotype ($\times 1\frac{1}{2}$), from Lewisville member, Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin Co. Loc. 189. U.S.G.S. 18650, U.S.N.M. 105752.
- 48, 49. *Vascellum mundum subteres*, n. var. (p. 168).
Views of the holotype ($\times 2$), from the same locality as the preceding. U.S.G.S. 18650, U.S.N.M. 105776.
- 50-52. *Vascellum tensum*, n. sp. (p. 166).
50. Rubber cast from external mold of holotype ($\times 1\frac{1}{2}$), from Lewisville member, bed of Johnson Creek, 1.3 miles north-east of Methodist Church, Arlington, Tarrant Co. Loc. 54. U.S.G.S. 19505, U.S.N.M. 105759.
- 51, 52. Rubber casts from external molds of 2 paratypes ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105760a-b.
- 53, 54. *Vascellum vianum*, n. sp. (p. 166).
53. Rubber cast from external mold of a paratype ($\times 1\frac{1}{2}$), from Eules member, cut on Arlington-Grapevine highway, 1 mile west by south of Eules, Tarrant Co. Loc. 25. U.S.G.S. 18995, U.S.N.M. 105757.
54. Rubber cast from external mold of holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105756.
- 55-59. *Vascellum robustum*, n. sp. (p. 165).
- 55, 56, 59. Views of incomplete paratypes ($\times 2$), from Lewisville member, Sheep Creek, 4.1 miles N. 36° E. of Savoy, Fannin Co. Loc. 189. U.S.G.S. 18650, U.S.N.M. 105750a-c.
- 57, 58. Views of the holotype ($\times 2$), from the same source. U.S.N.M. 105749.

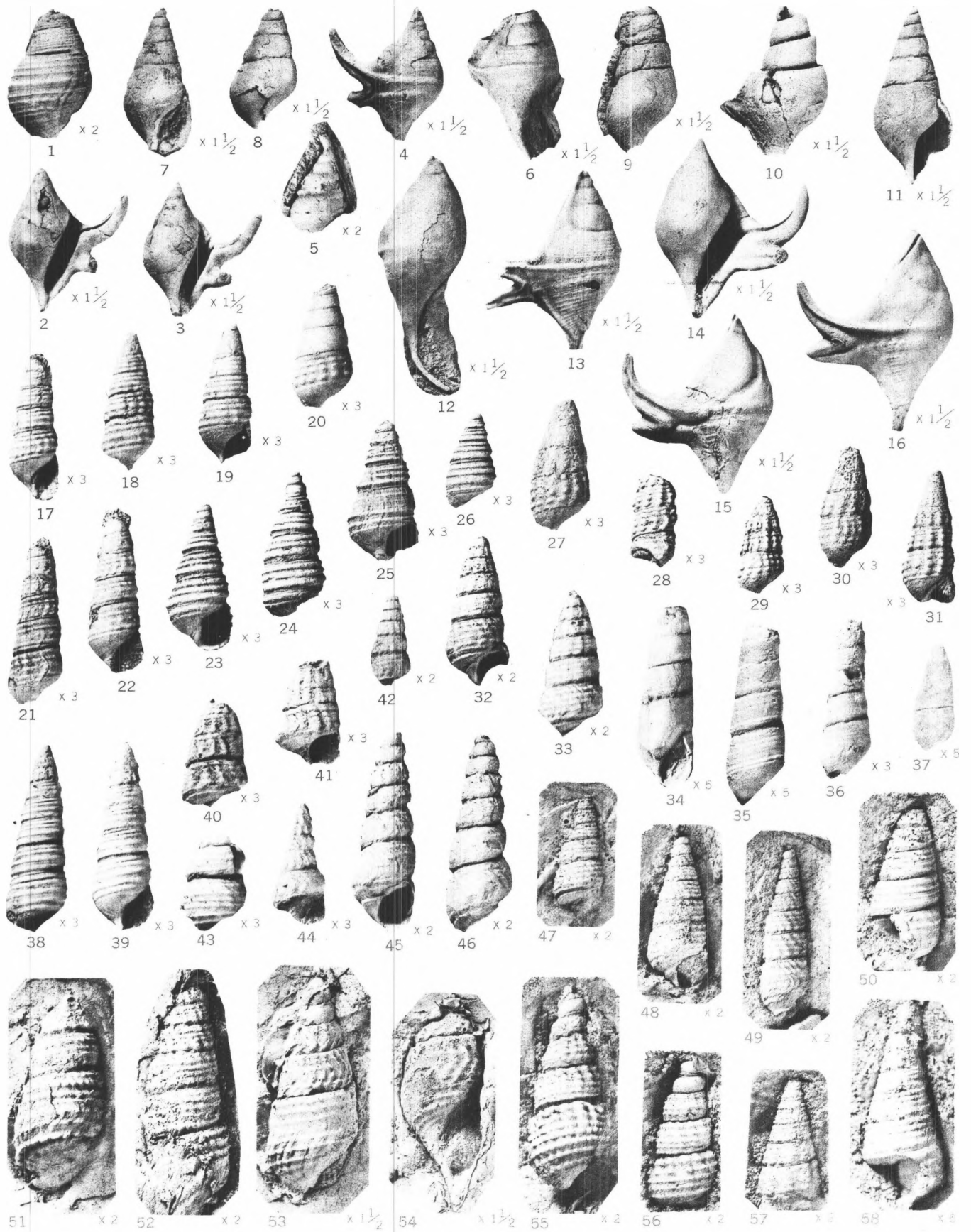


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 39

FIGURES 1-6. *Lispodesthes panda*, n. sp. (p. 180).

1. Back view of an immature paratype ($\times 2$), to show spiral ribs, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105854a.
2. Front view of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105854b.
- 3, 4. Views of the holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105853.
5. Apical portion of a paratype ($\times 2$) showing callus rising above tip of spire, from the same source. U.S.N.M. 105854c.
6. Back view of a paratype ($\times 1\frac{1}{2}$), to show curved anterior canal (beak), from the same source. U.S.N.M. 105854d.
- 7-11. "*Anchura*" *modesta* Cragin (p. 179).
- 9, 11. Views of two plesiotypes ($\times 1\frac{1}{2}$), from Templeton member, Martins Spring Branch, 2.9 miles west by north of Pottsboro, Grayson Co. Loc. 152. U.S.G.S. 14557, U.S.N.M. 105851a-b.
- 7, 8, 10. Views of 3 cotypes ($\times 1\frac{1}{2}$), from Templeton member, "4 miles [less than 4 miles] east of Whitesboro, Grayson Co." (Univ. of Texas Collection: see plastotypes, U.S.N.M. 105852a-c.)
- 12-16. *Lispodesthes patula*, n. sp. (p. 180).
12. Back view of a paratype ($\times 1\frac{1}{2}$), to show extension and curvature of anterior canal (beak), from Templeton member, gully 300 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 173. U.S.G.S. 20594, U.S.N.M. 105857a.
- 13, 16. Back views of 2 paratypes ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105857b-c.
- 14, 15. Views of the holotype ($\times 3$), from the same source. U.S.N.M. 105856.
- 17-20. *Voysa varia*, n. sp. (p. 172).
17. Front view of a paratype ($\times 3$), from Lewisville member, near mouth of small branch of Timber Creek, 2.5 miles southwest of Lewisville, Denton Co. Loc. 79. U.S.G.S. 14565, U.S.N.M. 105804.
- 18, 19. Views of holotype ($\times 3$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105800.
20. Back view of a paratype ($\times 3$), a variant, from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 7552, U.S.N.M. 105802.
- 21, 22. *Voysa varia extensa*, n. var. (p. 173).
- Views of the holotype ($\times 3$), from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 19015, U.S.N.M. 105810.
- 23-26. *Voysa? craticula*, n. sp. (p. 174).
- 23, 24. Views of the holotype ($\times 3$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18627, U.S.N.M. 105815.
- 25, 26. Views of 2 paratypes ($\times 3$), the larger one a variant, from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105816a-b.
- 27-31. *Voysa varia nodosa*, n. var. (p. 173).
- 27-30. Views of 4 paratypes ($\times 3$), showing variations in form and sculpture, from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 75. U.S.G.S. 18647, U.S.N.M. 105808 a-d.
31. Holotype ($\times 3$), from the same source. U.S.N.M. 105807.
- 32, 33. *Voysa compacta*, n. sp. (p. 171).
- Views of the holotype ($\times 2$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105792.
- 34-37. *Voysa minor*, n. sp. (p. 174).
- 34, 35. Views of holotype ($\times 5$), from Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 105812.
- 36, 37. Back views of 2 paratypes ($\times 3$ and $\times 5$), from the same source. U.S.N.M. 105813a-b.
- 38, 39. *Voysa varia levicostae*, n. var. (p. 173).
- Views of the holotype ($\times 3$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105806.
- 40, 41. *Voysa? constricta*, n. sp. (p. 175).
- Views of the holotype ($\times 3$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105818.
- 42-46. *Voysa savoiana*, n. sp. (p. 170).
- 42, 43. Views of 2 incomplete paratypes ($\times 2$ and $\times 3$), from the same locality as the preceding. U.S.G.S. 18256, U.S.N.M. 105788a-b.
44. An incomplete paratype ($\times 3$), from the same source. U.S.G.S. 19494, U.S.N.M. 105790.
- 45, 46. Views of the holotype ($\times 2$), from the same locality. U.S.G.S. 18256, U.S.N.M. 105787.
- 47-50. *Voysa planolata*, n. sp. (p. 170).
- 47, 50. Rubber casts made from external molds of 2 paratypes ($\times 2$), the larger one a variant, from Lewisville member, Johnson Creek, 1.5 miles northeast of Methodist Church at Arlington, Tarrant Co. Loc. 47. U.S.G.S. 18639. U.S.N.M. 105785a-b.
- 48, 49. Rubber casts made from opposite sides of the external mold of the holotype ($\times 2$), from Lewisville member, Johnson Creek, "2 miles [probably 1.5 miles], northeast of Arlington, Tarrant Co." Loc. 34. U.S.G.S. 506, U.S.N.M. 105784.
- 51, 52. *Voysa lepida*, n. sp. (p. 171).
- Rubber casts made from opposite sides of the external mold of the holotype ($\times 2$), from Euless member, State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant Co. Loc. 28. U.S.G.S. 19040, U.S.N.M. 105794.
- 53, 54. *Voysa speciosa*, n. sp. (p. 171).
53. Rubber cast made from external mold of holotype ($\times 1\frac{1}{2}$), from Lewisville member, field, 0.5 mile north of U. S. Highway 82, 0.5 mile west of Grayson County line, in Cooke Co. Loc. 180. U.S.G.S. 20270, U.S.N.M. 105796.
54. Rubber cast made from external mold of a paratype ($\times 1\frac{1}{2}$), from the same source, U.S.N.M. 105797.
- 55, 56. *Voysa eulessana*, n. sp. (p. 172).
- Rubber casts made from opposite sides of external mold of holotype ($\times 2$), from Euless member, State Highway 183, within 1.2 miles west-southwest of Euless, Tarrant Co. Loc. 28. U.S.G.S. 19040, U.S.N.M. 105799.
57. *Voysa*, sp. (p. 175).
- Rubber cast made from external mold of a specimen ($\times 2$), from Lewisville member, U. S. Highway 82, 0.35 mile west of Grayson County line, in Cooke Co. Loc. 98. U.S.G.S. 20259, U.S.N.M. 105820.
58. *Voysa* sp. (p. 175).
- Rubber cast made from external mold of a specimen ($\times 5$), from Lewisville member, Johnson Creek, 1.5 miles northeast of Arlington, Tarrant Co. Loc. 47. U.S.G.S. 19526, U.S.N.M. 105819.

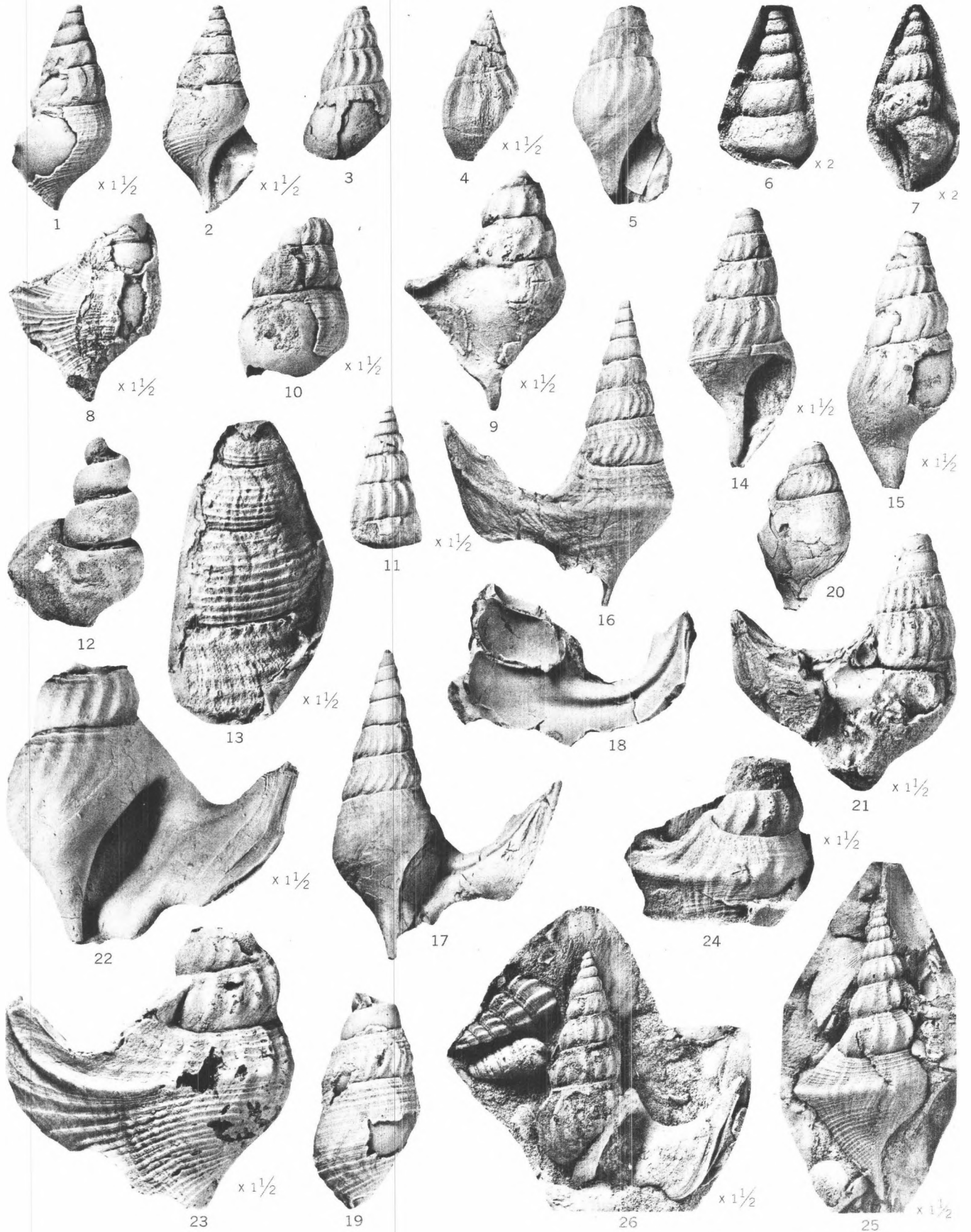


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 40

[Figures natural size except as indicated]

- FIGURES 1, 2. *Anchura* sp. d (p. 178).
Views of a specimen ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River near Old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105840a.
- 3-5. *Anchura* sp. a (p. 177).
3, 5. Two incomplete shells, from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105835a-b.
4. A smaller shell ($\times 1\frac{1}{2}$), showing the apical portion, from the same source. U.S.N.M. 105835c.
- 6, 7. *Anchura?* sp. (p. 179).
Rubber casts made from external molds ($\times 2$) of 2 questionably identified shells, from Lewisville member, Hillsboro road, 2 miles east of Whitney, Hill Co. Loc. 3. U.S.G.S. 11836, U.S.N.M. 105849a-b.
- 8, 9. *Anchura* sp. f (p. 178).
Two incomplete shells ($\times 1\frac{1}{2}$), from Templeton member, Golden Bluff, Red River, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 19498, U.S.N.M. 105844a-b.
- 10, 11. *Anchura* sp. e (p. 178).
10. An incomplete shell ($\times 1\frac{1}{2}$), from Templeton member, road, 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18978, U.S.N.M. 105843.
11. A shell ($\times 1\frac{1}{2}$) showing apical portion, from the same locality. U.S.G.S. 18257, U.S.N.M. 105842.
12. *Anchura* sp. b (p. 178).
An internal mold, from Templeton member, branch near Anthony road, 2 miles north of Savoy, Fannin Co. Loc. 198. U.S.G.S. 18254, U.S.N.M. 105838a.
13. *Anchura?* sp. (p. 179).
Rubber cast made from external mold ($\times 1\frac{1}{2}$), from scar of attachment on shell of *Ostrea soleniscus* Meek, from Templeton member, bed of Red River near Old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105859.
- 14, 15. *Anchura* sp. g (p. 178).
Views of an incomplete shell ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105845.
- 16-19. *Anchura turricula*, n. sp. (p. 175).
16, 17. Views of the holotype, from Templeton member, bed of Red River near Old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105824.
18. Interior of expanded lip of a paratype, from the same source. U.S.N.M. 105825a.
19. Back view of an incomplete paratype from the same source. U.S.N.M. 105825b.
20. *Anchura* sp. c (p. 178).
Back view of an incomplete shell from the same locality as the preceding. U.S.G.S. 13797, U.S.N.M. 105839.
21. *Anchura* sp. h (p. 179).
Back view of an incomplete shell ($\times 1\frac{1}{2}$), from Lewisville member, branch of Sheep Creek, 2.5 miles east and 3.35 miles north of the railroad station at Savoy, Fannin Co. Loc. 193. U.S.G.S. 20308, U.S.N.M. 105848.
- 22, 23. *Anchura horreana*, n. sp. (p. 176).
Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, gully south of barn 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105827.
- 24-26. *Anchura whitneyensis*, n. sp. (p. 177).
24. Rubber cast made from incomplete external mold of a paratype ($\times 1\frac{1}{2}$), from Lewisville member, Hillsboro road, 2 miles east of Whitney, Hill Co. Loc. 3. U.S.G.S. 14589, U.S.N.M. 105829.
25. Rubber cast made from external mold of holotype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105828.
26. Rubber cast made from external mold of a paratype ($\times 1\frac{1}{2}$), from the same locality. U.S.G.S. 11836, U.S.N.M. 105831.

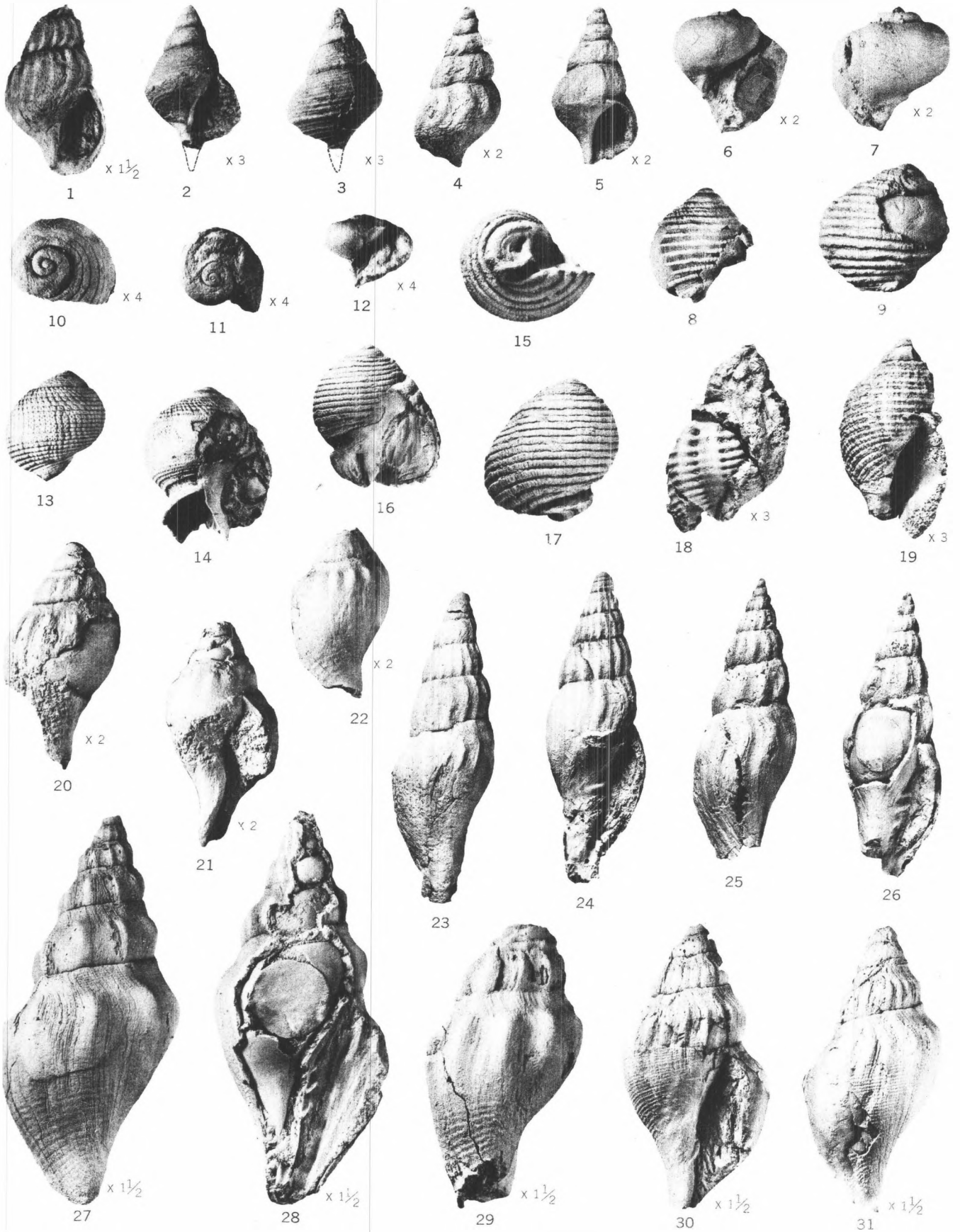


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 41

[Figures natural size except as indicated]

- FIGURE 1. *Trachytriton?* sp. (p. 181).
 Front view of an incomplete shell ($\times 1\frac{1}{2}$), from Templeton member, gully 250 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 170. U.S.G.S. 20550, U.S.N.M. 105861.
- 2, 3. "*Fusinus*" *cornelianus*, n. sp. (p. 183).
 Views of the holotype ($\times 3$), from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105874.
- 4, 5. "*Fusinus*" *fluminis*, n. sp. (p. 182).
 Views of the holotype ($\times 2$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105873.
- 6-9. *Hillites septarianus* (Cragin) (p. 182).
 6, 7. Views of the holotype ($\times 2$), from Templeton member, 4 miles [less than 4 miles] east of Whitesboro, Grayson Co. (Univ. of Texas Collection; red ticket no. 43; see plastotype, U.S.N.M. 105872.)
 8, 9. Views of plesiotypes, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105871a-b.
- 10-17. *Hillites multilirae*, n. sp. (p. 181).
 10. Top view of a young paratype ($\times 4$), from Lewisville member, branch of Sheep Creek, 2.6 miles east and 3.4 miles north of the railroad station at Savoy, Fannin Co. Loc. 192. U.S.G.S. 20307, U.S.N.M. 105868.
- 11, 12. Views of a young paratype ($\times 4$), from the same member on the same branch, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105867.
13. Back view of a paratype, from Lewisville member, Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105866.
14. Front view of a paratype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13569, U.S.N.M. 105870.
- 15-17. Views of the holotype, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 19504, U.S.N.M. 105862.
- 18, 19. "*Fasciolaria*" sp. (p. 183).
 Views of a shell ($\times 3$), from Templeton member, gully 300 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 173. U.S.G.S. 20594, U.S.N.M. 105877.
- 20-22. *Aliofusus balaniformis*, n. sp. (p. 184).
 20, 21. Views of the holotype ($\times 2$), from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105879.
22. Back view of a paratype ($\times 2$), from the same locality. U.S.G.S. 19500, U.S.N.M. 105881.
- 23, 24. *Paleopsephaea decorosa*, n. sp. (p. 187).
 Views of the holotype, from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105897.
- 25, 26. *Paleopsephaea patens*, n. sp. (p. 187).
 Views of the holotype, from Templeton member, road, 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105899.
- 27-29. *Paleopsephaea vadoana*, n. sp. (p. 187).
 27, 28. Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105894.
29. Back view of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105895.
- 30, 31. *Bellifusus?* *parvilirae*, n. sp. (p. 183).
 Views of the holotype ($\times 1\frac{1}{2}$), from the same locality as the preceding. U.S.G.S. 13797, U.S.N.M. 105878.



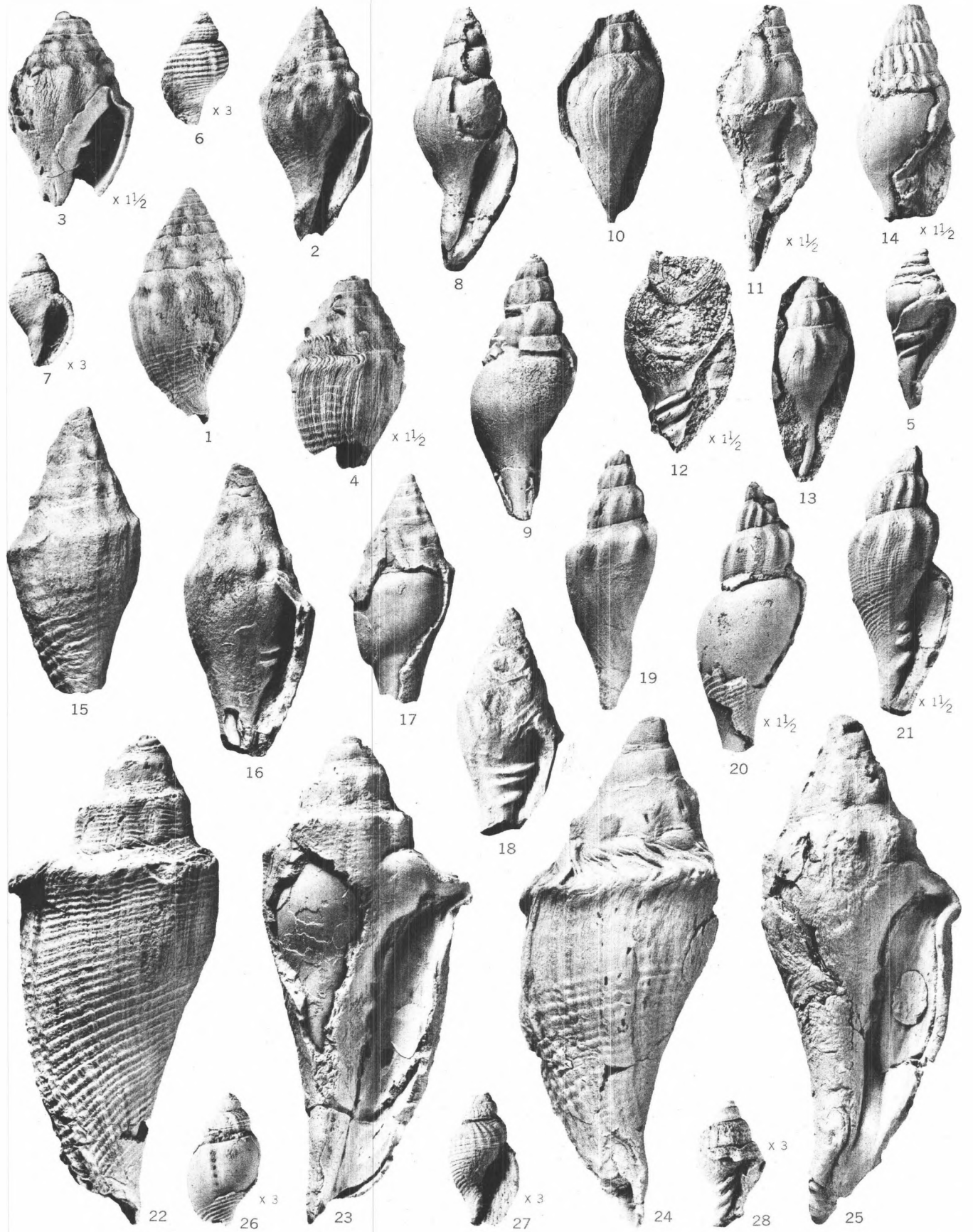
GASTROPODS FROM THE WOODBINE FORMATION

PLATE 42

[Figures natural size except as indicated]

FIGURES 1-5. *Carota? biplicata*, n. sp. (p. 186).

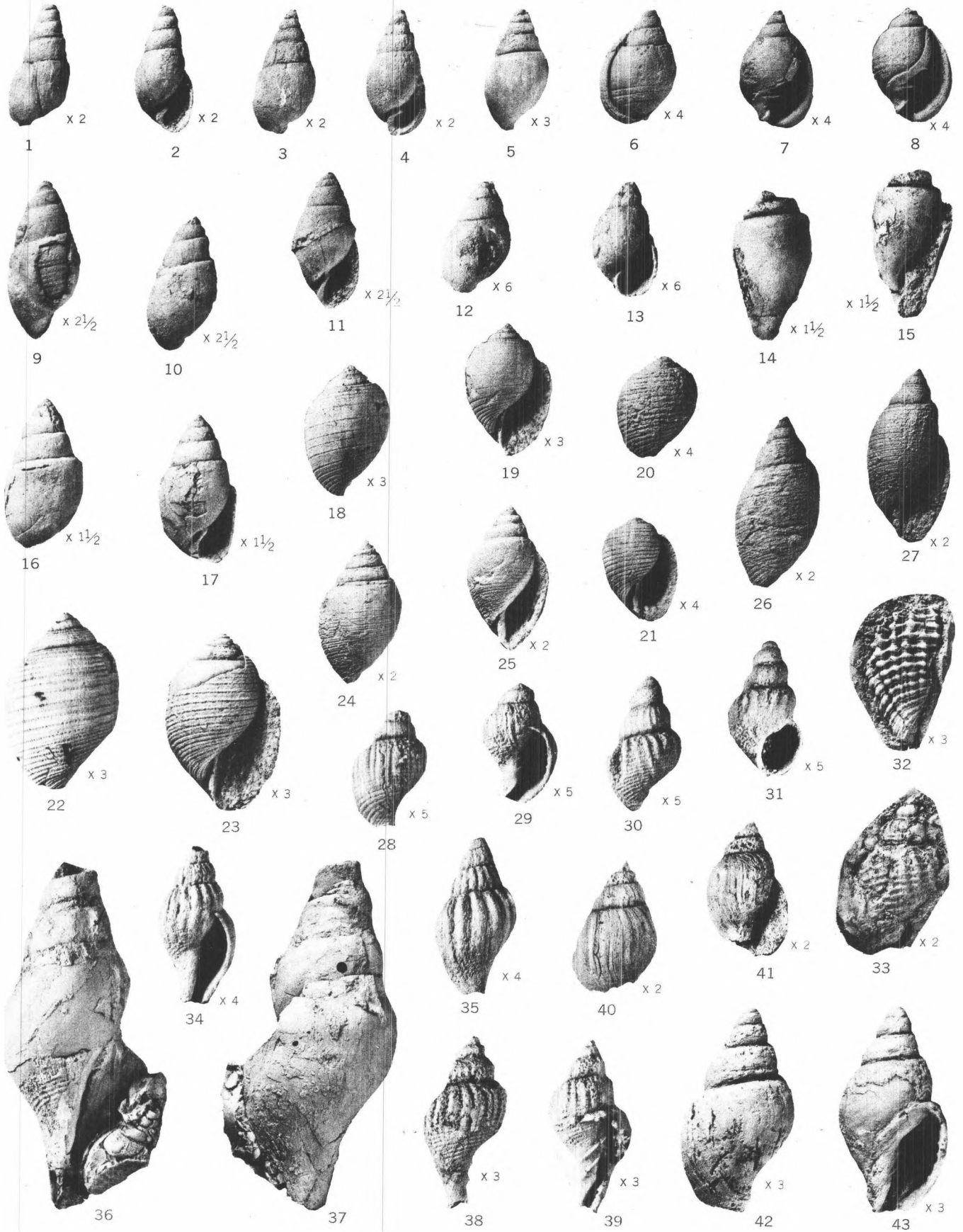
- 1, 2. Views of the holotype, from Templeton member, bluff on branch of Cornelius Creek, 3.35 miles north, 0.5 mile west of Bells, Grayson Co. Loc. 163. U.S.G.S. 20311, U.S.N.M. 105891.
- 3, 4. Views of a paratype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105893a.
5. Front view of a paratype, to show columellar folds, from the same source. U.S.N.M. 105893b.
- 6, 7. *Caveola pinguis*, n. sp. (p. 190).
Views of the holotype ($\times 3$), from the same locality as the preceding. U.S.G.S. 14546, U.S.N.M. 105915.
- 8-13. *Paleopsephaea sinuosa*, n. sp. (p. 188).
8, 9. Views of the holotype, from Lewisville member, near small branch, 0.3 mile southeast of Dugans Chapel, 1.05 miles east and 0.2 mile south of Penland (Terrace station), Grayson Co. Loc. 122. U.S.G.S. 18972, U.S.N.M. 105901.
- 10-12. Rubber cast made from external mold of a paratype ($\times 1$), and views of 2 paratypes ($\times 1\frac{1}{2}$), showing columellar folds, from the same source. U.S.N.M. 105902a-c.
13. Rubber cast made from external mold of a paratype, from the same locality. U.S.G.S. 19500, U.S.N.M. 105905.
14. *Paleopsephaea* sp. (p. 188).
An incomplete shell ($\times 1\frac{1}{2}$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105907.
- 15-18. *Carota pendula*, n. sp. (p. 185).
15, 16. Views of the holotype, from Templeton member, road 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18257, U.S.N.M. 105886.
- 17, 18. Views of a paratype, from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105887.
- 19-21. *Carota? nodosa*, n. sp. (p. 186).
19. Back view of holotype (surface badly worn or corroded), from Templeton member, gully 250 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 170. U.S.G.S. 20550, U.S.N.M. 105889.
- 20, 21. Views of a paratype ($\times 1\frac{1}{2}$) with better preserved sculpture, from Templeton member, gully south of barn, 0.5 mile south, 0.75 mile west of Star School, Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105890.
- 22-25. *Carota robusta*, n. sp. (p. 185).
22, 23. Views of the holotype, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105883.
- 24, 25. Views of a paratype, from the same locality. U.S.G.S. 12873, U.S.N.M. 105884.
- 26-28. *Caveola bellsana*, n. sp. (p. 190).
26, 27. Views of the holotype ($\times 3$), from Templeton member, bluff on branch of Cornelius Creek, 3.3 miles N. 16° W. of Bells, Grayson Co. Loc. 165. U.S.G.S. 20315, U.S.N.M. 105916.
28. Front view of a paratype ($\times 3$), showing columellar folds, from the same source. U.S.N.M. 105917.



GASTROPODS FROM THE WOODBINE FORMATION

PLATE 43

- FIGURES 1, 2. *Pirsila tensa*, n. sp. (p. 194).
Views of the holotype ($\times 2$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105937.
- 3-5. *Pirsila simpla*, n. sp. (p. 195).
3, 4. Views of the holotype ($\times 2$), from Lewisville member, borrow pit, south of Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 50. U.S.G.S. 18992, U.S.N.M. 105939.
5. Back view of a paratype ($\times 3$), from Templeton member, road 3 miles northeast of Sherman Junction, Grayson Co. Loc. 160. U.S.G.S. 18978, U.S.N.M. 105940.
- 6-8. *Ringicula arlingtonensis*, n. sp. (p. 196).
6, 7. Views of the holotype ($\times 4$), from Lewisville member, Johnson Creek, 2 miles [probably 1.5 miles] northeast of Arlington, Tarrant Co. Loc. 34. U.S.G.S. 476, U.S.N.M. 105949.
8. Front view of a paratype ($\times 4$), from the same source. U.S.N.M. 105950.
- 9-11. *Pirsila decora*, n. sp. (p. 195).
9. Back view of a paratype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, 3 miles west by south of Lewisville, Denton Co. Loc. 76. U.S.G.S. 7553, U.S.N.M. 105942.
10, 11. Views of the holotype ($\times 2\frac{1}{2}$), from Lewisville member, Timber Creek, southwest of Lewisville, Denton Co. Loc. 73. U.S.G.S. 505, U.S.N.M. 105941.
- 12, 13. *Pirsila* sp. (p. 196).
Views of a young shell ($\times 6$), from Lewisville member, Sheep Creek, 4.2 miles N. 35° E. of Savoy, Fannin Co. Loc. 184. U.S.G.S. 18256, U.S.N.M. 105947.
- 14, 15. *Rhytiphorus?* sp. (p. 197).
Views of an internal mold ($\times 1\frac{1}{2}$), from Dexter member, east-west road, 2.4 miles west by north of Retta, Tarrant Co. Loc. 12. U.S.G.S. 18982, U.S.N.M. 105953.
- 16, 17. *Pirsila obtusa*, n. sp. (p. 195).
Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 12873, U.S.N.M. 105943.
- 18, 19. *Fictoacteon paucistriata*, n. sp. (p. 194).
Views of the holotype ($\times 3$), from Templeton member, gully south of barn, 0.5 mile south, 0.75 mile west of Star School, in northeastern Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105929.
- 20, 21. *Fictoacteon humilispira*, n. sp. (p. 193).
Views of the holotype ($\times 4$), from Templeton member, gullies south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 14560, U.S.N.M. 105932.
- 22, 23. *Fictoacteon alveolanus*, n. sp. (p. 193).
Views of the holotype ($\times 3$), from Templeton member, gully south of barn, 0.5 mile south, 0.75 mile west of Star School in northeastern Grayson Co. Loc. 171. U.S.G.S. 20553, U.S.N.M. 105927.
- 24, 25. *Fictoacteon imlayi*, n. sp. (p. 193).
Views of the holotype ($\times 2$), from Lewisville member, branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18218, U.S.N.M. 105931.
- 26, 27. *Fictoacteon saxanus*, n. sp. (p. 192).
Views of the holotype ($\times 2$), from Lewisville member, branch, north of the old road to Keller, 1.4 miles west of Grapevine, Tarrant Co. Loc. 49. U.S.G.S. 19512, U.S.N.M. 105926.
- 28, 29. *Cancellaria?* sp. (p. 192).
Views of a young shell ($\times 5$), from Templeton member, gully 300 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 173. U.S.G.S. 20594, U.S.N.M. 105924.
- 30, 31. *Paladmete? turbiformis*, n. sp. (p. 191).
Views of the holotype ($\times 5$), from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105919.
32. *Paladmete?* sp. (p. 191).
Rubber cast from part of external mold ($\times 3$), from Dexter member, crossroads, 1.4 miles northeast of Handley. Tarrant Co. Loc. 11. U.S.G.S. 18979, U.S.N.M. 105922.
33. *Paladmete?* sp. (p. 191).
Rubber cast from external mold ($\times 2$), from Lewisville member, gully east of Whitesboro road, 1.75 miles south of Sandusky, Grayson Co. Loc. 117. U.S.G.S. 18966, U.S.N.M. 105921.
- 34, 35. *Parrivoluta? venusta*, n. sp. (p. 188).
Views of the holotype ($\times 4$), from Lewisville member, branch of Sheep Creek, 4.2 miles N. 37° E. of Savoy, Fannin Co. Loc. 183. U.S.G.S. 18253, U.S.N.M. 105909.
- 36, 37. "*Volutomorpha? graysonensis* (Cragin) (p. 189).
Views of a cotyle ($\times 1$), from Templeton member, "4 miles [less than 4 miles] east of Whitesboro, Grayson Co." (Univ. of Texas Collection; see plastotype, U.S.N.M. 105910.)
- 38, 39. *Cancellaria?* sp. (p. 192).
Views of a small incomplete shell ($\times 3$), from Templeton member, bluff, 1 mile north, 1.85 miles east of Sadler, Grayson Co. Loc. 167. U.S.G.S. 20542, U.S.N.M. 105925.
- 40, 41. *Torula teres*, n. sp. (p. 190).
Views of the holotype ($\times 2$), from Templeton member, gully 250 feet north of road, 0.65 mile south, 1 mile west of Star School, in northeastern Grayson Co. Loc. 170. U.S.G.S. 20550, U.S.N.M. 105913.
- 42, 43. *Torula microlirae*, n. sp. (p. 189).
Views of the holotype ($\times 3$), from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells. Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105911.

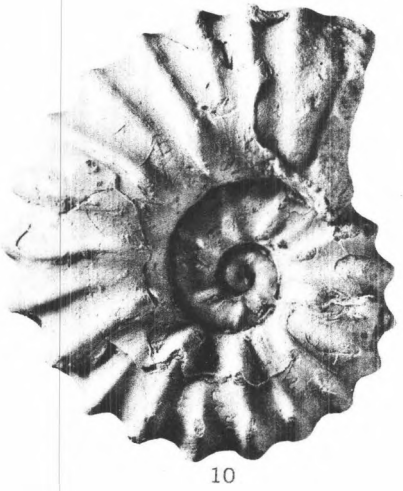
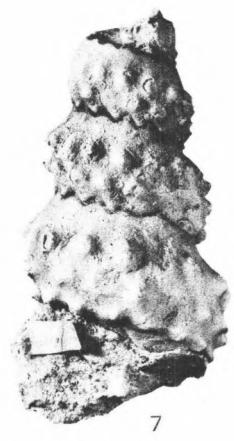
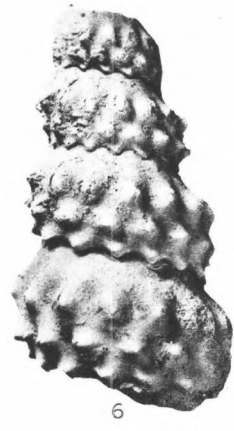
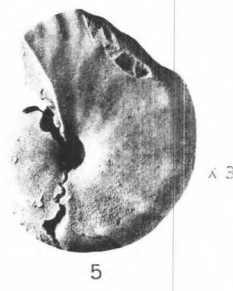
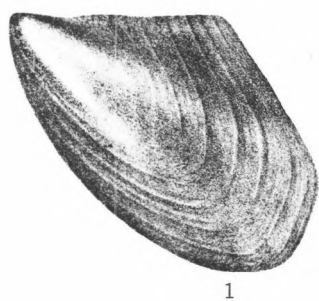


GASTROPODS FROM THE WOODBINE FORMATION

PLATE 44

[Figures natural size except as indicated]

- FIGURE 1. *Pseudoptera gregaria* (Shumard) (p. 73).
Reproduction of a figure published by C. A. White (U.S. Geol. and Geog. Survey Terr. 12th Ann. Rept., for 1878, pt. 1, pl. 18, fig. 3a, 1883). White's figure was based on a photographic copy of a drawing, made by A. R. Roessler under Shumard's direction, which was furnished to F. B. Meek of the Hayden Survey by Shumard.
2. *Inoceramus eulessanus*, n. sp. (p. 65).
Rubber cast from exterior mold of holotype, from Euless (?) member, in loose piece of sandstone near State Highway 183, 1.4 miles west-southwest of Euless, Tarrant Co. Loc. 32. U.S.G.S. 20789, U.S.N.M. 105160.
- 3-5. *Metococeras?* sp. (p. 210).
Views of a young shell ($\times 3$), from Templeton member, right side of Red River bottom, 1.5 miles north of Ragtown, Lamar Co. Loc. 202. U.S.G.S. 14551, U.S.N.M. 106004.
- 6-8. *Turrilites dearingi*, n. sp. (p. 197).
6, 7. Views of the holotype, from Lewisville member (Tarrant unit of Moreman), small branch of Big Bear Creek, 1.5 miles east of Euless, Tarrant Co. Loc. 55. U.S.G.S. 20788, U.S.N.M. 105956.
8. Front view of a worn paratype, from the same locality. (Private collection of James P. Conlin, Fort Worth, Tex.)
- 9-11. *Acanthoceras barcusi* Jones (p. 203).
Views of a plesiotype (essentially a topotype), from Lewisville member (Tarrant unit of Moreman), a branch of Big Bear Creek, 1.5 miles east of Euless, Tarrant Co. (Private collection of James P. Conlin, Fort Worth, Tex.: see plastotype, U.S.N.M. 105977.)

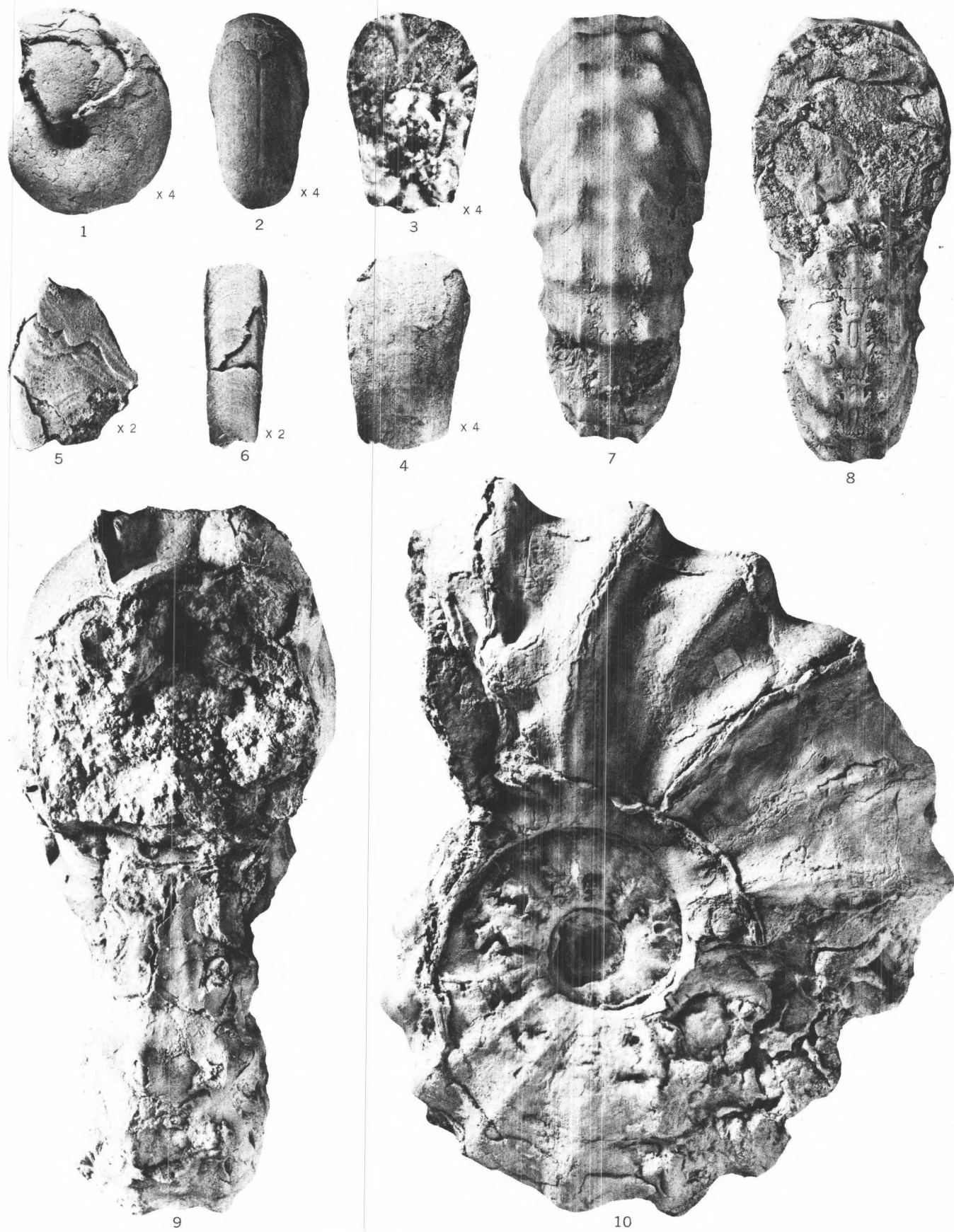


PELECYPODS AND CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 45

[Figures natural size except as indicated]

- FIGURES 1, 2. *Desmoceras?* sp. (p. 197).
Views of a small specimen ($\times 4$), from Templeton member, gullies south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 14560, U.S.N.M. 105959.
- 3, 4. *Desmoceras?* sp. (p. 197).
Views of a fragment ($\times 4$), from Golden Bluff, Red River, 3 miles east of Arthur City, Lamar Co. Loc. 203. U.S.G.S. 13799, U.S.N.M. 105960.
- 5, 6. *Euhoplites?* sp. (p. 198).
Views of a small fragment ($\times 2$), from Lewisville member. Timber Creek, about 2.25 miles south-southwest of Lewisville, Denton Co. Loc. 81. U.S.G.S. 19501, U.S.N.M. 105961.
- 7, 8. *Acanthoceras wintoni* Adkins (p. 200).
Views of a plesiotype, from Lewisville member (Tarrant unit of Moreman), old road west of bridge over Big Bear Creek, 2.7 miles northeast of Tarrant Station, Tarrant Co. Loc. 40. U.S.G.S. 13581, U.S.N.M. 105966.
- 9, 10. *Acanthoceras tarrantense* (Adkins) (p. 198).
Views of the holotype, from Lewisville member (Tarrant unit of Moreman), "2 miles [not more than 1.5 miles] east of Tarrant Station, Tarrant Co." (Bur. Econ. Geol. Austin, Tex., no. 2424.)



CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 46

[Figures natural size]

FIGURE 1. *Acanthoceras wintoni* Adkins (p. 200).

Side view of the plesiotype shown on the preceding plate (figs. 7, 8).

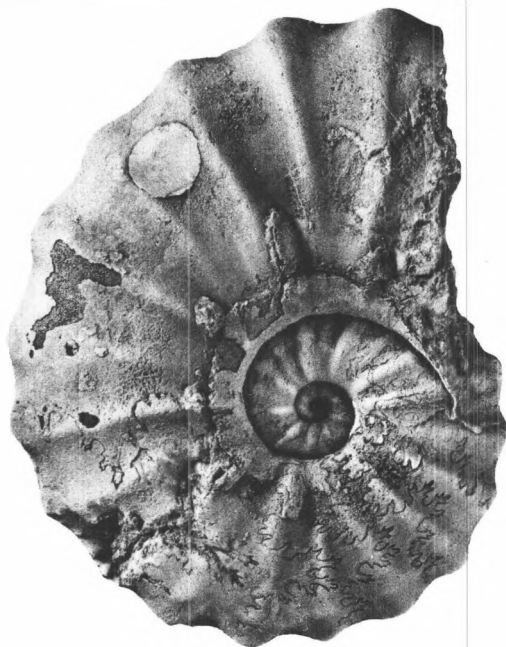
2-4. *Acanthoceras tarrantense* (Adkins) (p. 198).

2. Ventral view of holotype at largest stage. (See preceding plate, figs. 9, 10.)

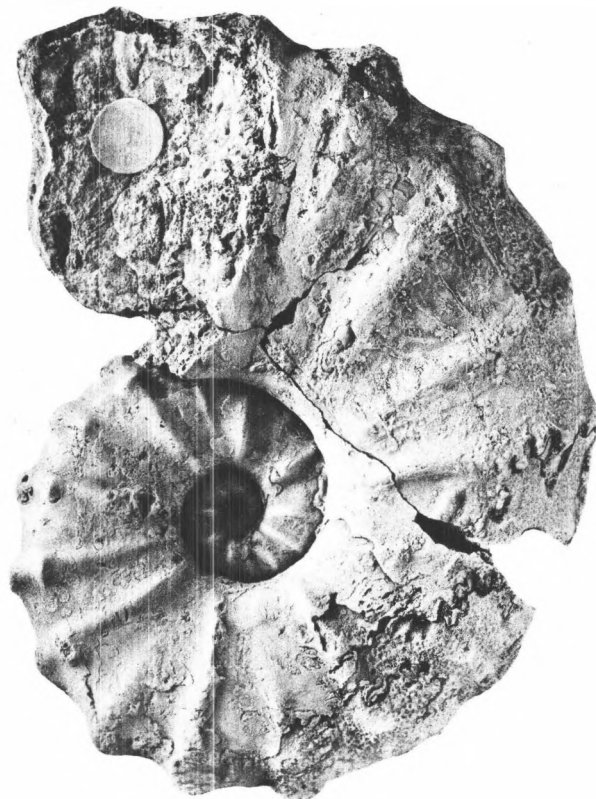
3, 4. Views of a plesiotype, from Lewisville member (Tarrant unit of Moreman), Chicago, Rock Island and Pacific Railroad, 0.9 mile west of Dallas County line, in Tarrant Co. Loc. 38. U.S.G.S. 11736, U.S.N.M. 105962.

5, 6. *Acanthoceras* sp. (p. 204).

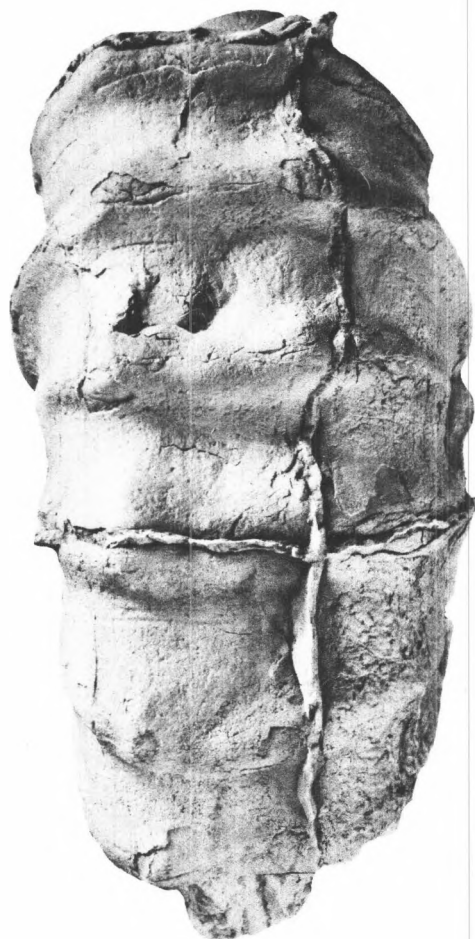
Views of a fragment, from Templeton member, gullies, south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 17163, U.S.N.M. 105979.



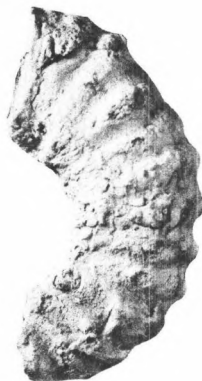
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3



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5



6



4

CEPHALOPODS FROM THE WOODBINE FORMATION

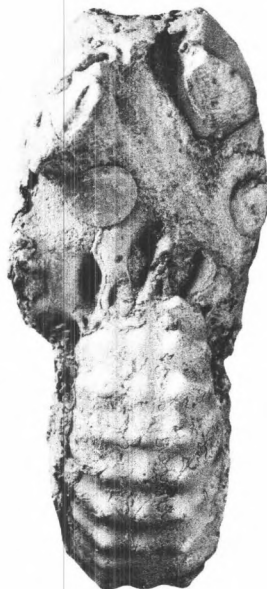
PLATE 47

[Figures natural size]

- FIGURES 1, 2. *Acanthoceras wintoni* Adkins (p. 200).
Views of the holotype, from Lewisville member (Tarrant unit of Moreman), Big Bear Creek near Dallas County line, in Tarrant Co. (Bur. of Econ. Geol. Austin, Tex., no. 2426; see plastotype, U.S.N.M. 105967.)
- 3, 4. *Acanthoceras adkinsi*, n. sp. (p. 200).
Views of the holotype, from Lewisville member (Tarrant unit of Moreman), branch north of Chicago, Rock Island and Pacific Railroad, near Dorothy Siding, Tarrant Co. Loc. 44. U.S.G.S. 18638, U.S.N.M. 105968.
5. *Acanthoceras? eulesanum*, n. sp. (p. 201).
Front ventral view of the holotype, from Lewisville member, "9 miles north of Arlington [probably within 3 miles of Euless], Tarrant Co." Loc. 36. U.S.G.S. 508, U.S.N.M. 105970.



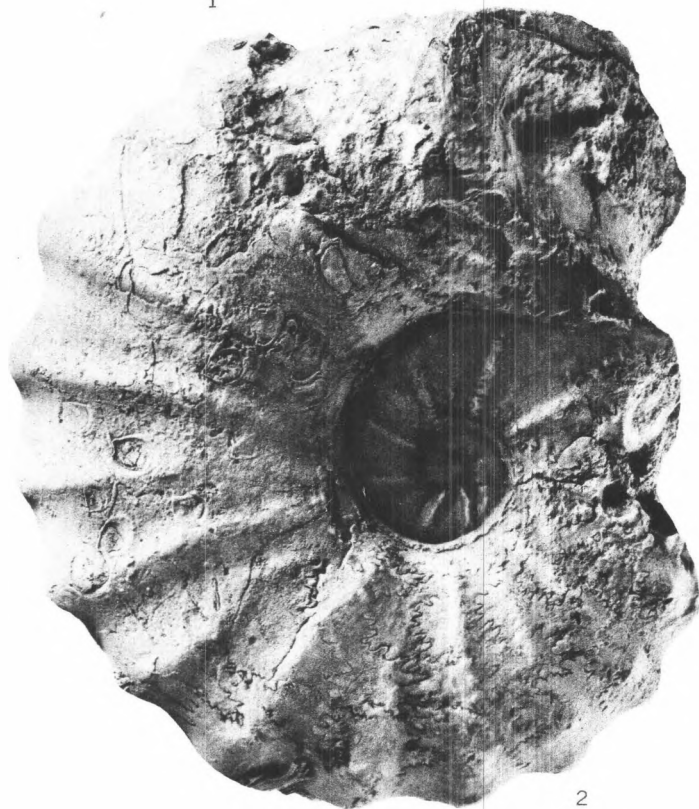
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CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 48

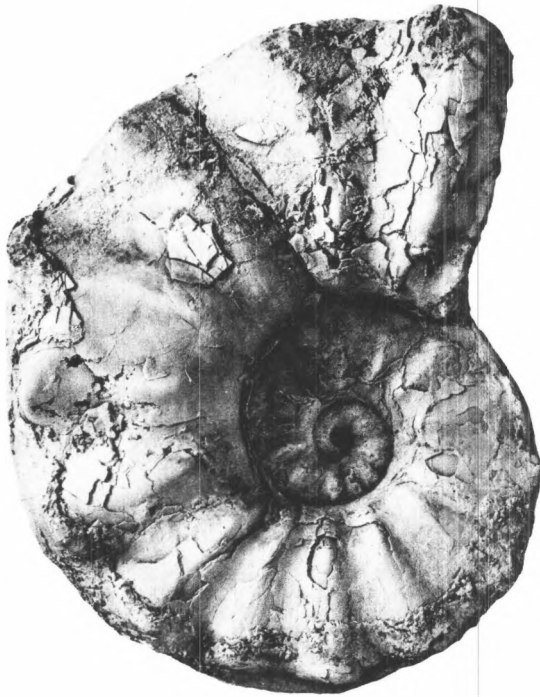
{Figures natural size}

FIGURES 1, 2. *Acanthoceras hazzardi*, n. sp. (p. 201).

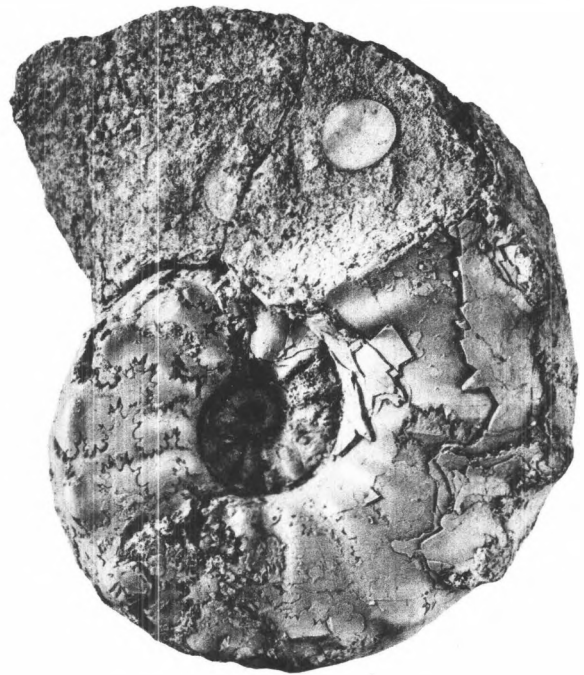
Views of the holotype, from Lewisville member, small headwater branch of Walnut Creek, 0.3 mile north of Gordonville, Grayson Co. Loc. 125. U.S.G.S. 18975, U.S.N.M. 105971.

3, 4. *Acanthoceras? eulessanum*, n. sp. (p. 201).

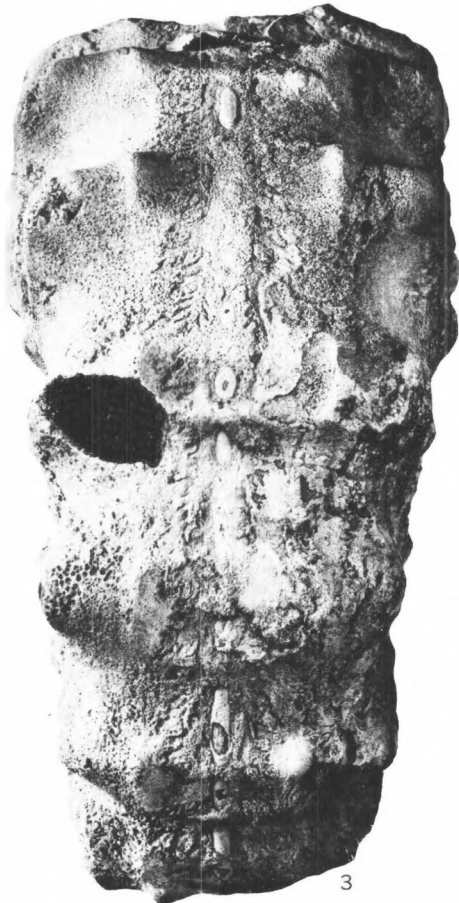
Views of the holotype, from Lewisville member, 9 miles north of Arlington [probably within 3 miles of Euless], Tarrant Co. Loc. 36. U.S.G.S. 508, U.S.N.M. 105970.



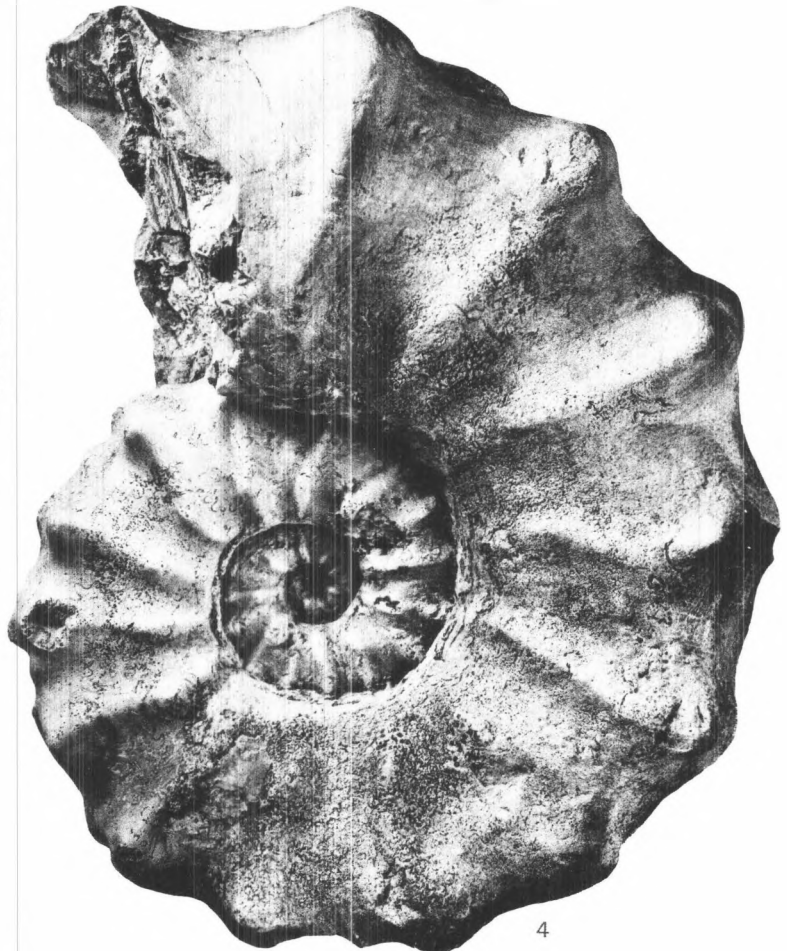
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CEPHALOPODS FROM THE WOODBINE FORMATION

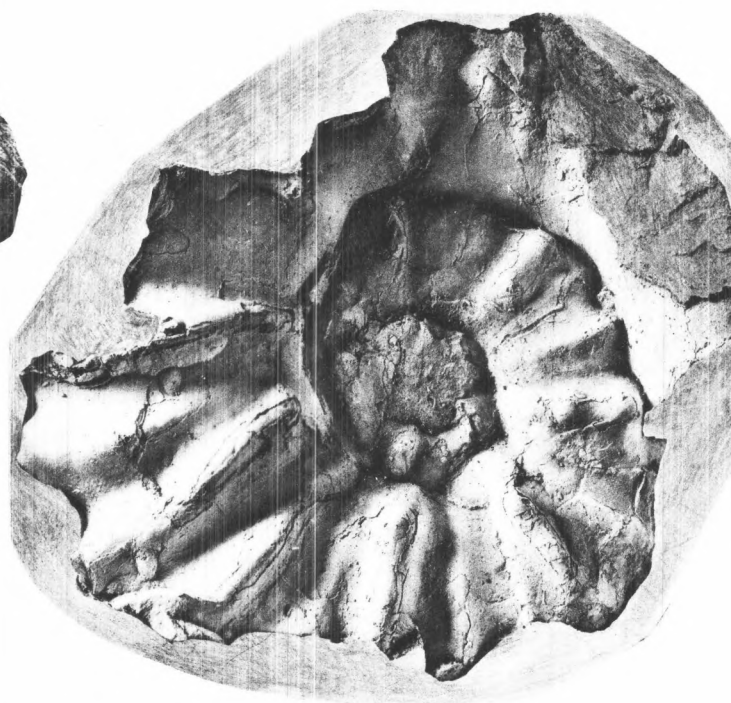
PLATE 49

[Figures natural size]

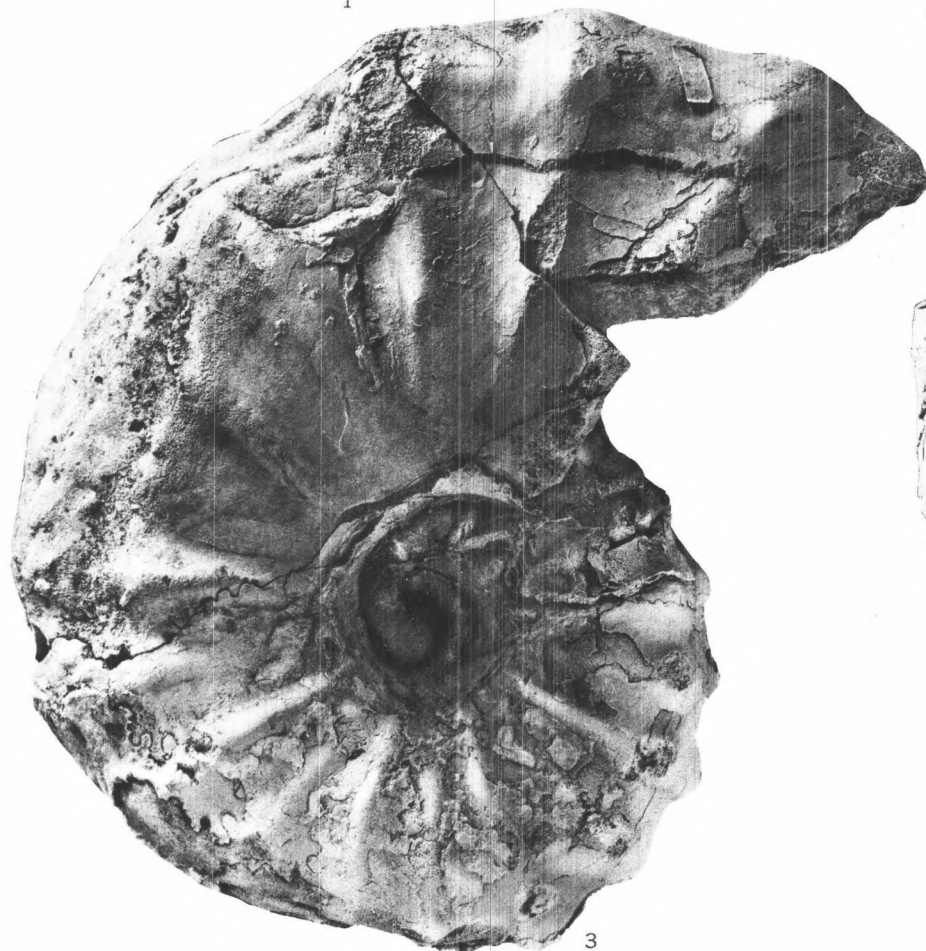
- FIGURES 1, 2. *Acanthoceras?* sp. (p. 204).
Fragment of internal mold and rubber cast made from part of external mold, of a specimen from Templeton member, small branch, on land of Charles Price, 3 miles east-southeast of Arthur City, Lamar Co. Loc. 204. U.S.G.S. 14549, U.S.N.M. 105980.
3. *Mammites? bellsanus*, n. sp. (p. 204).
Side view of a paratype, from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105985.
4. *Acanthoceras hazzardi*, n. sp. (p. 201):
Front ventral view of the holotype. (See preceding plate, figs. 1, 2.) U.S.N.M. 105971.



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CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 50

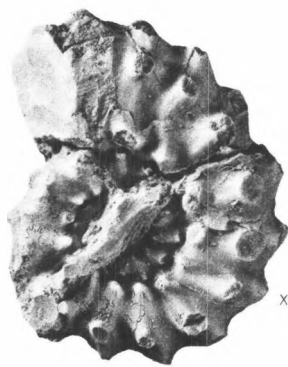
FIGURES 1-4. *Acanthoceras cuspidum*, n. sp. (p. 202).

1, 3, 4. Views of the holotype ($\times 1\frac{1}{2}$), from Templeton member, gullies, south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 18971, U.S.N.M. 105974.

2. View of a paratype ($\times 1\frac{1}{2}$), from the same source. U.S.N.M. 105975.

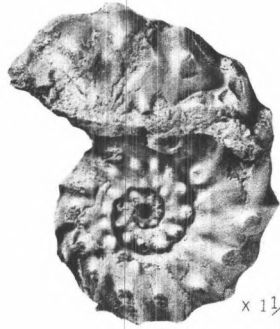
5, 6. *Acanthoceras tarrantense nitidum*, n. var. (p. 199).

Views of the holotype ($\times 1$), from Lewisville member, 9 miles north of Arlington [probably within 3 miles of Euless], Tarrant Co. Loc. 36. U.S.G.S. 508, U.S.N.M. 105964.



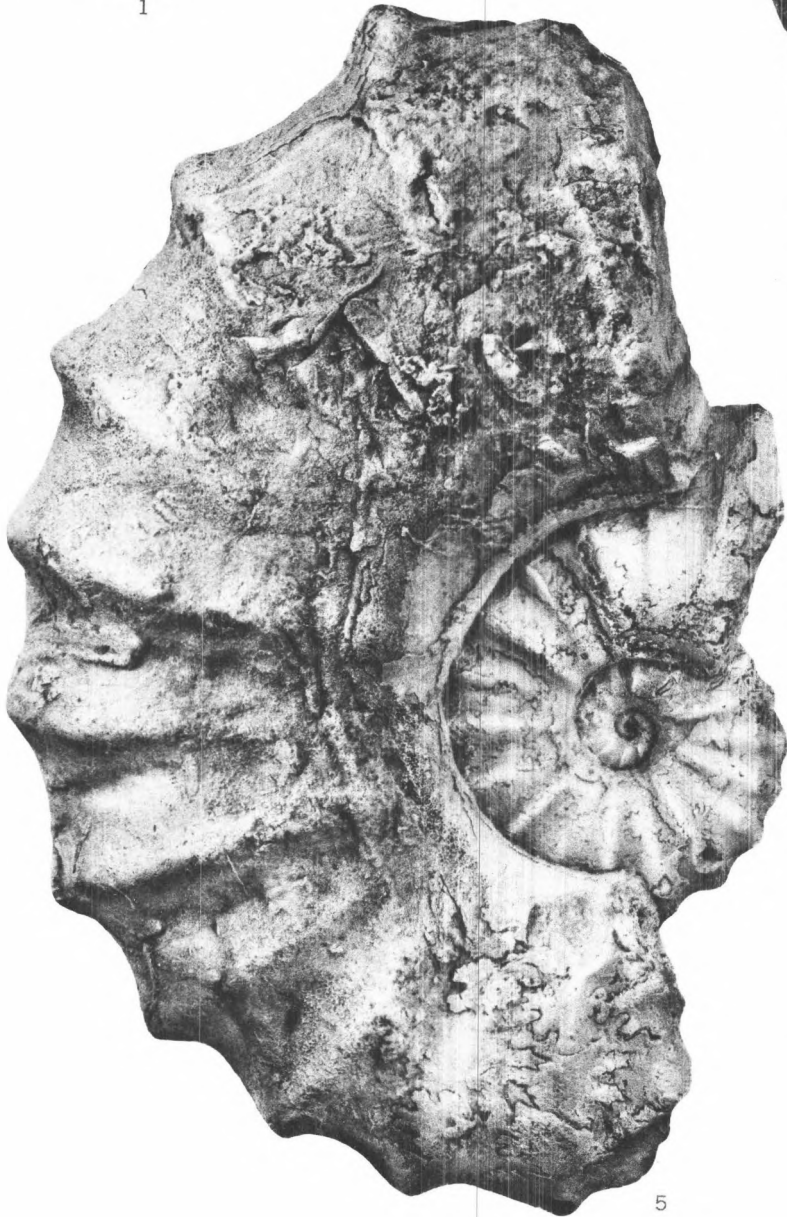
x 1½

1

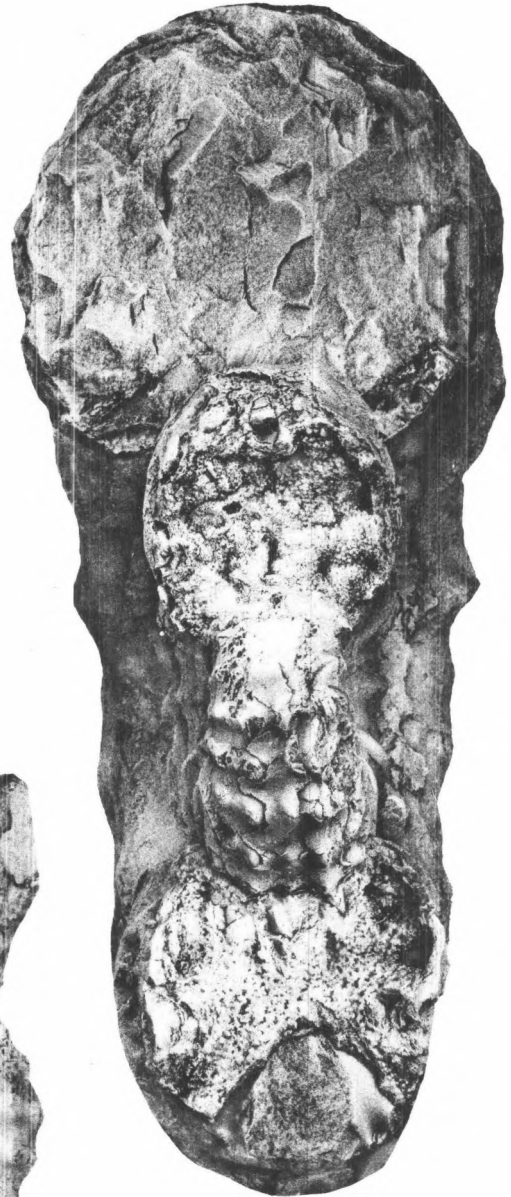


x 1½

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x 1½ x 1½

CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 51

[Figures natural size]

FIGURES 1-3. *Metoicoceras swallowii* (Shumard) (p. 207).

1, 2. Views of a plesiotype, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105992a.

3. Side view of another plesiotype from the same source. U.S.N.M. 105992b.

4-7. *Metoicoceras swallowii macrum*, n. var. (p. 209).

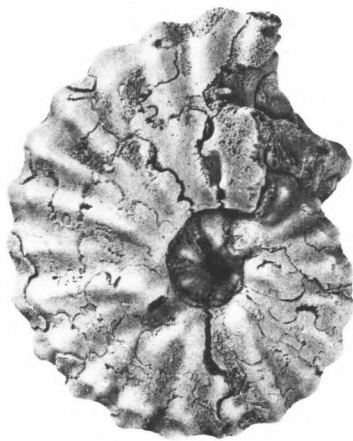
4, 5. Views of the holotype, from the same locality as the preceding. U.S.G.S. 14546, U.S.N.M. 105993.

6, 7. Views of a small paratype, from Templeton member, borrow pit, north of road, 2.2 miles west of Arthur City, Lamar Co. Loc. 207. U.S.G.S. ?18274, U.S.N.M. 105994.

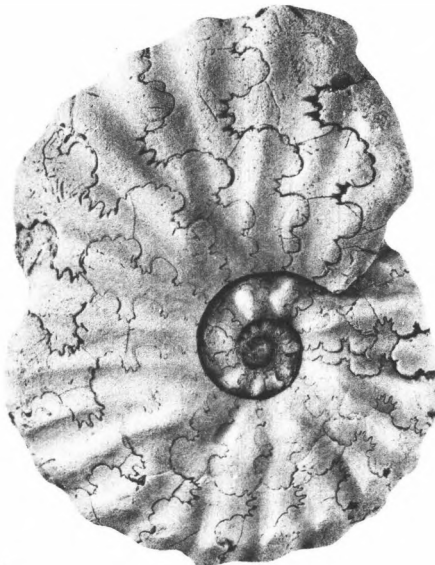
8-11. *Mammites? bellsanus*, n. sp. (p. 204).

8-10. Views of the holotype, from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105983.

11. Broken cross section of a paratype from the same source. U.S.N.M. 105984.



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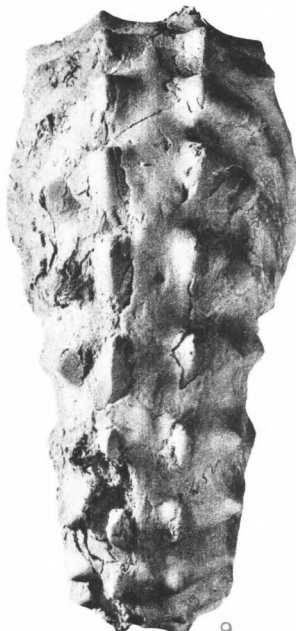
5



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8



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11

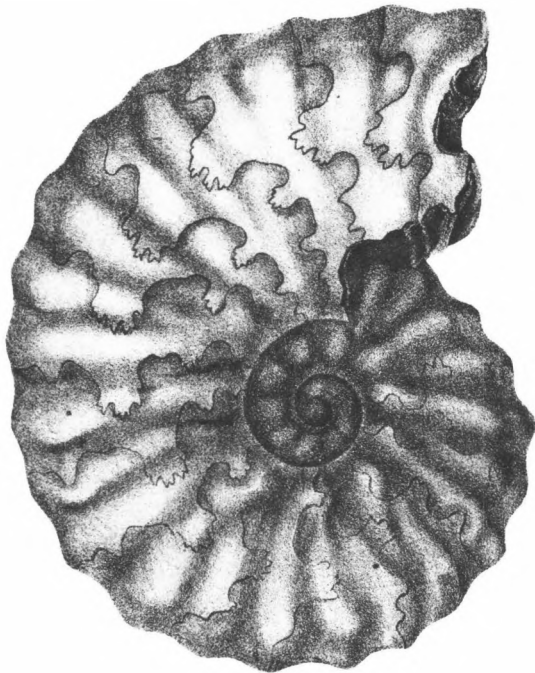
CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 52

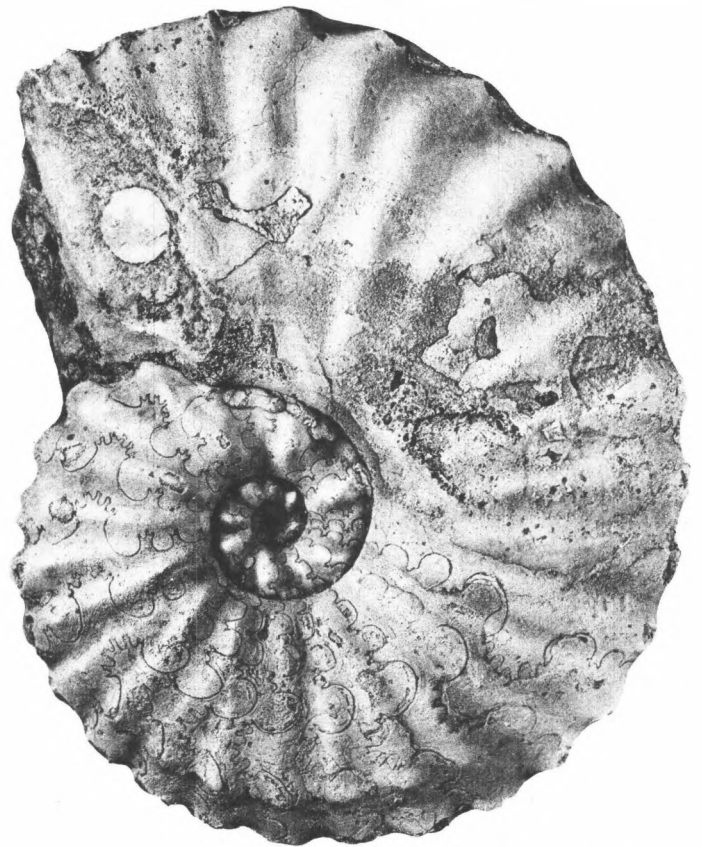
[Figures natural size]

FIGURES 1-5. *Metioceras swallowii* (Shumard) (p. 207).

1. Reproduction of a figure published by C. A. White (U. S. Geol. and Geog. Survey Terr. 12th Ann. Rept. for 1878. pt. 1, pl. 18, fig. 3a, 1883). White's figure was based on a photographic copy of a drawing, made by A. R. Roesler under Shumard's direction, which was furnished to F. B. Meek by Shumard.
- 2-5. Views of a plesiotype, from Templeton member, bed of Red River, near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 13797, U.S.N.M. 105991.



1



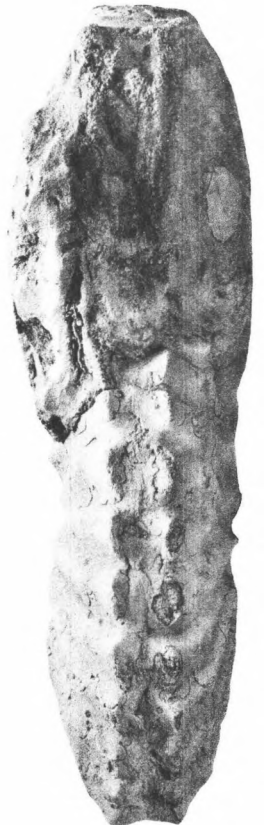
2



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CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 53

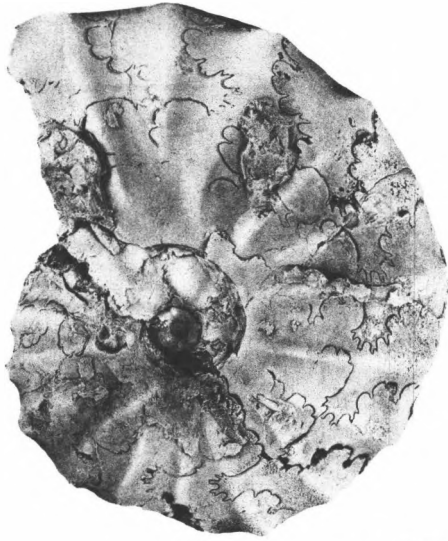
[Figures natural size except as indicated]

FIGURES 1-9. *Metacoecras latoventer*, n. sp. (p. 209).

1-4. Views of a paratype, from Templeton member, gullies, south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 17163, U.S.N.M. 106000.

5-7. Views of a young paratype ($\times 2$), from the same source. U.S.G.S. 14560, U.S.N.M. 105999.

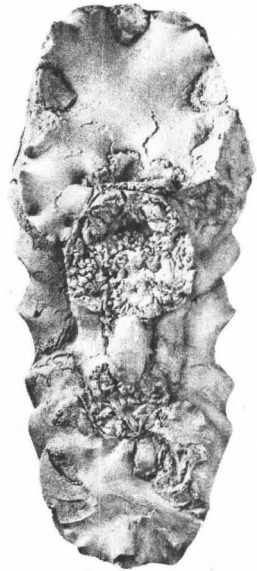
8, 9. Views of a paratype, from the same locality. U.S.G.S. 14092, U.S.N.M. 105998.



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2

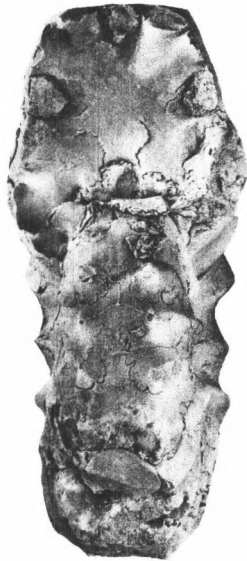


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x 2

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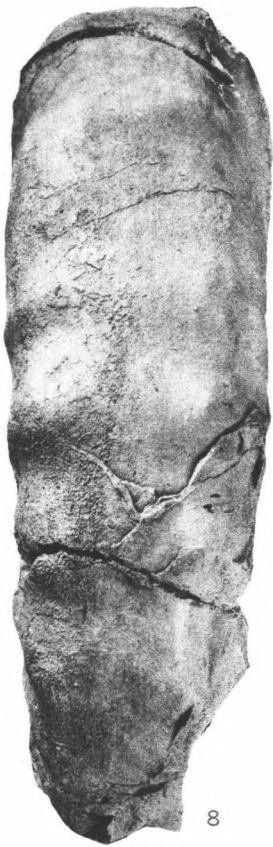
x 2

6



x 2

7



8



9

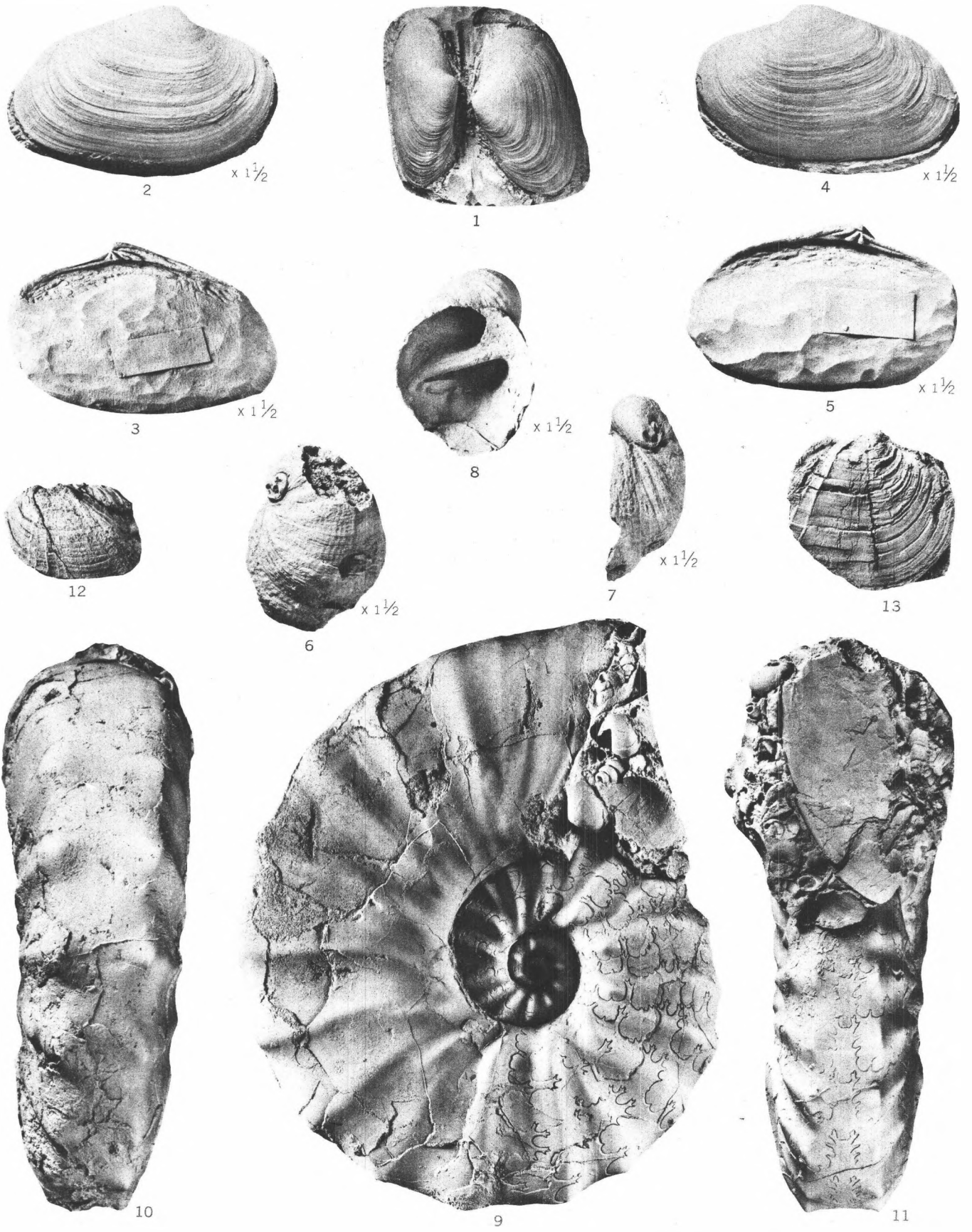
CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 54

[Figures natural size except as indicated]

FIGURES 1-5. *Sinonia levis*, n. sp. (p. 111).

1. The two valves of the holotype in their original positions in the matrix, from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 105420.
- 2, 3. Exterior and hinge of right valve of holotype ($\times 1\frac{1}{2}$). U.S.N.M. 105420.
- 4, 5. Exterior and hinge of left valve of holotype ($\times 1\frac{1}{2}$). U.S.N.M. 105420.
- 6-8. *Neritina insolita*, n. sp. (p. 146).
- 6, 7. Exterior and front edge views of holotype ($\times 1\frac{1}{2}$), from Templeton member, drainage bed about 100 feet south of old Pottsboro-Gordonville road, 2.1 miles west and 0.6 mile north of Pottsboro, Grayson Co. Loc. 176. U.S.G.S. 20880, U.S.N.M. 105642.
8. Aperture of holotype ($\times 1\frac{1}{2}$). U.S.N.M. 105642.
- 9-11. *Metioceras latoventer*, n. sp. (p. 209).
Side and edge views of holotype, from Templeton member, "4 miles [sic] east of Whitesboro, and 1 mile south of old Whitesboro-Sherman road, Grayson Co." (Bur. Econ. Geol., Austin, 2574; see plastotype, U.S.N.M. 105996.)
12. *Anatimya?* sp. (p. 91).
An internal mold from the Lewisville member on Sheep Creek, on line between Taylor and Williams farms, about 4 miles N. 37° E. of center of Savoy, Fannin Co. Loc. 181. U.S.G.S. 13857, U.S.N.M. 105313.
13. *Anatimya* sp. (p. 91).
Incomplete internal mold with external sculpture impressed upon it, from the Eules member in a shallow road cut, 1 mile northeast of Kennedale, Tarrant Co. Loc. 22. U.S.G.S. 18983, U.S.N.M. 105314.



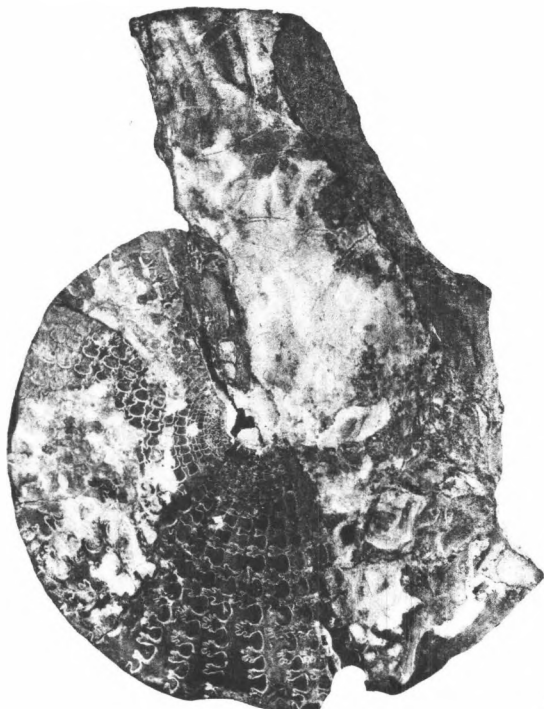
PELECYPODS, GASTROPODS, AND CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 55

[Figures natural size except as indicated]

FIGURES 1-4. *Metengonoceras dumbli* (Cragin) (p. 206).

1. Side view of one of Cragin's types, from Templeton member, "4 miles east of Whitesboro [probably less than 4 miles]. Grayson Co." Loc. 150. U.S.N.M. 29403.
- 2, 3. Views of a plesiotype (essentially a topotype), from Templeton member, gullies, south of the old Sherman highway, 2.8 miles east of Whitesboro, Grayson Co. Loc. 154. U.S.G.S. 14092, U.S.N.M. 105990.
4. View of part of the flank of the plesiotype ($\times 3$) adjacent to the venter, showing the ventral lobe (at top of figure) eccentric to the left.



1

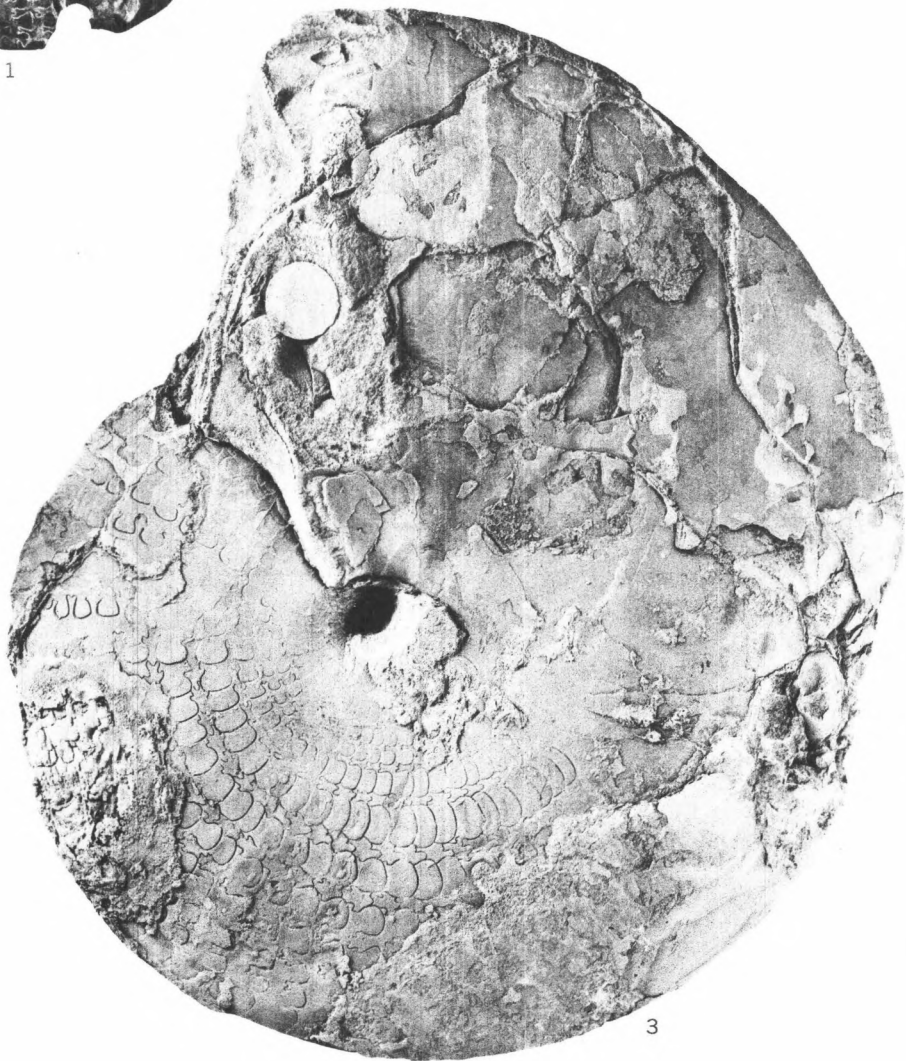


4

x 3



2



3

CEPHALOPODS FROM THE WOODBINE FORMATION

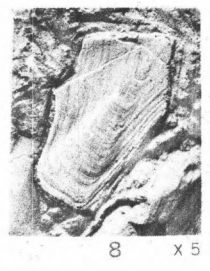
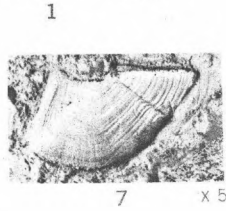
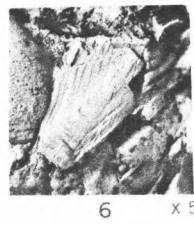
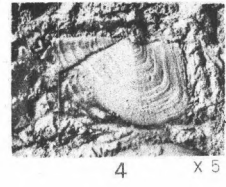
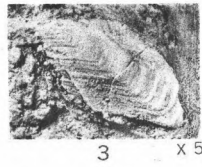
PLATE 56

FIGURE 1. *Forbesiceras conlini*, n. sp. (p. 205).

Side view of a large paratype ($\times 1$), from Lewisville member (Tarrant unit of Moreman), branch of Big Bear Creek, 1.5 miles east of Euless, Tarrant Co. Loc. 55. (Private collection of James P. Conlin, Fort Worth, Tex.: see plastotype, U.S.N.M. 105988.)

2-8. *Scalpellum?* sp. (p. 211).

Views of parts ($\times 5$) of the capitulum of a small goose barnacle, from the Lewisville member, Johnson Creek, 1 mile east of Arlington, Tarrant Co. Loc. 35. U.S.G.S. 507, U.S.N.M. 106011a-g.



CEPHALOPOD AND CRUSTACEANS FROM THE WOODBINE FORMATION

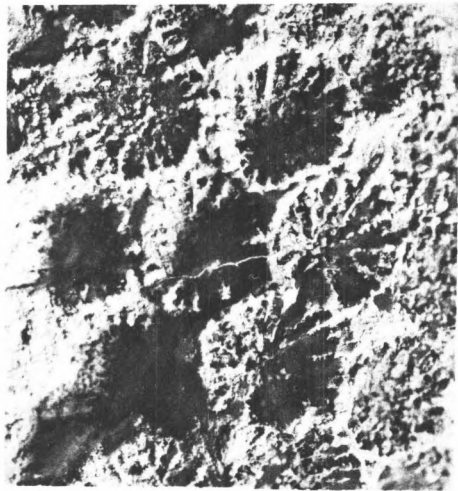
PLATE 57

[Figures natural size except as indicated]

- FIGURE 1. *Astrangia* (*Coenangia*) *lamarensis* Wells (p. 51).
Calices of holotype ($\times 8$), from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 104171.
- 2-6. *Forbesiceras conlini*, n. sp. (p. 205).
- 2-4. Views of a small paratype, from Lewisville member (Tarrant unit of Moreman), branch of Big Bear Creek, 1.5 miles east of Euless, Tarrant Co. Loc. 55. (Private collection of James P. Conlin, Fort Worth, Tex.); see plastotype, U.S.N.M. 105989.)
- 5, 6. Views of the holotype, from the same locality. U.S.G.S. 20787, U.S.N.M. 105987.



2

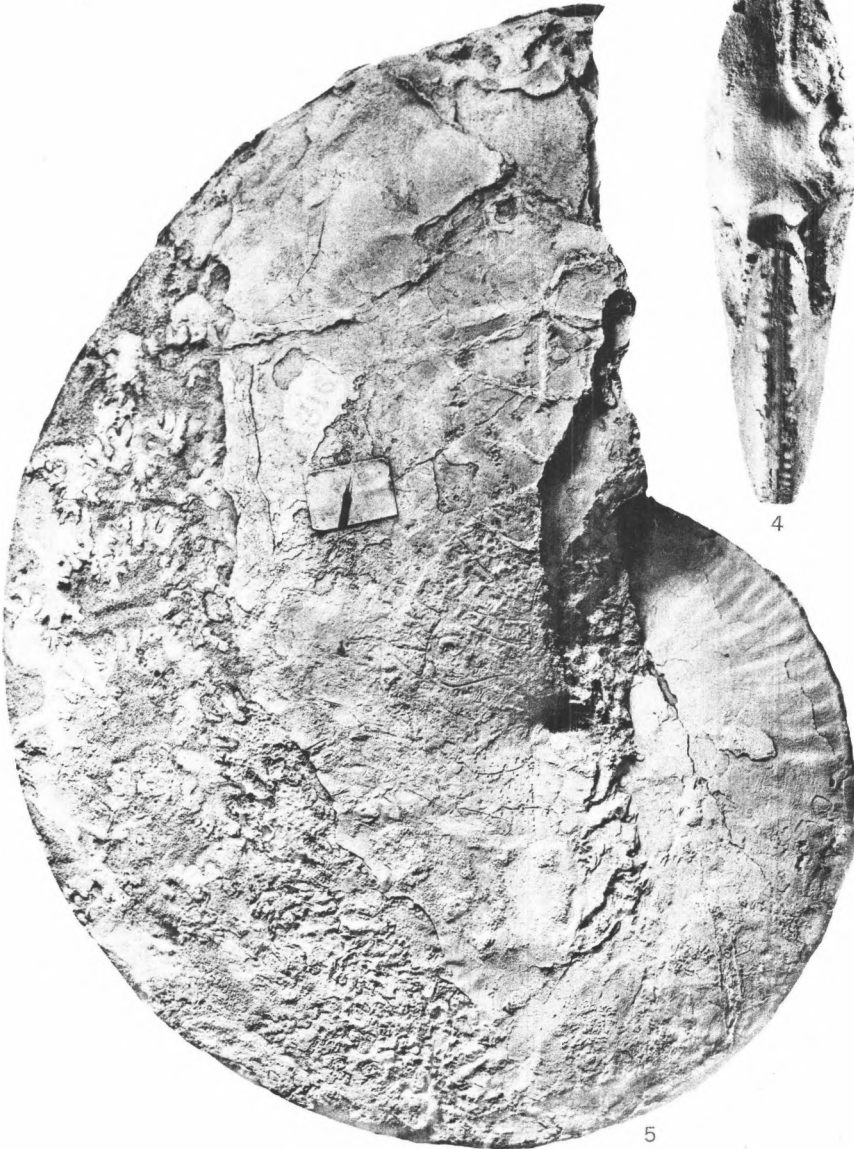


1

x 8



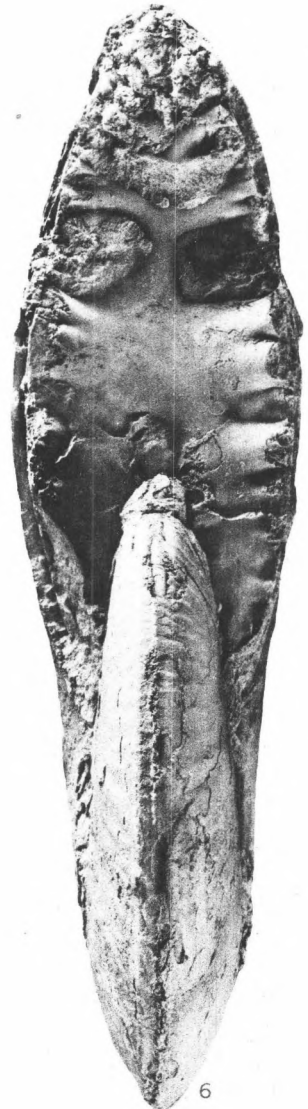
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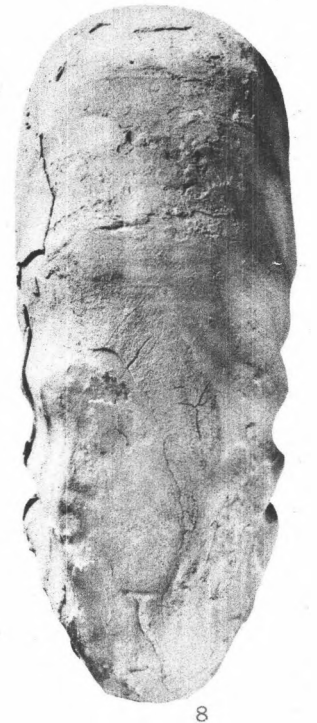
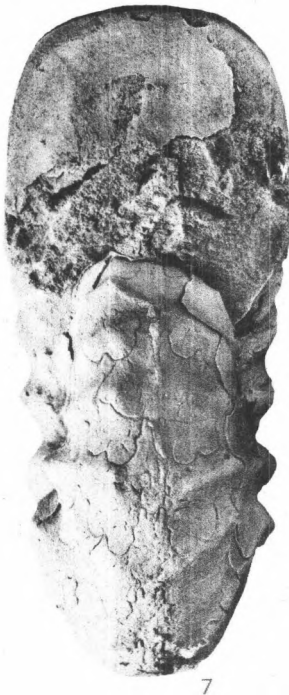
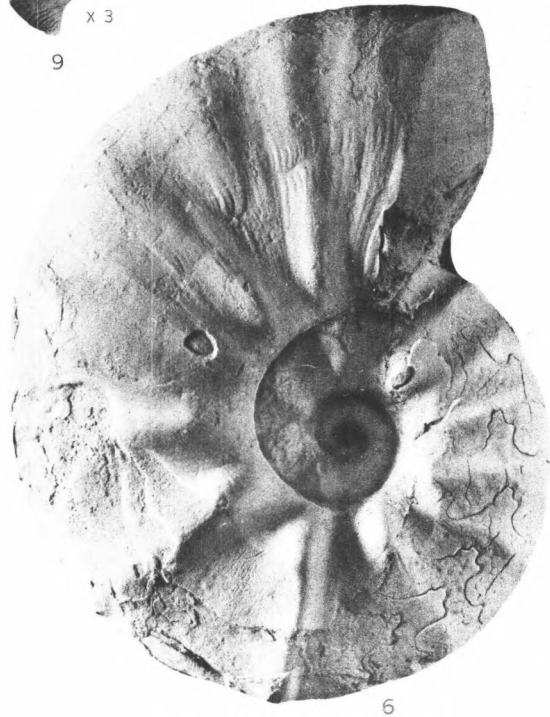
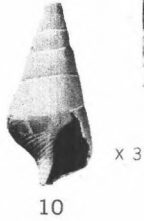
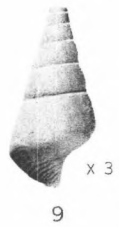
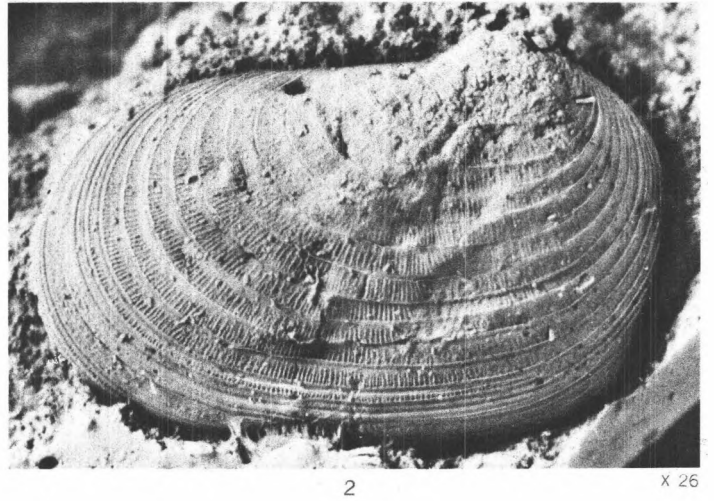
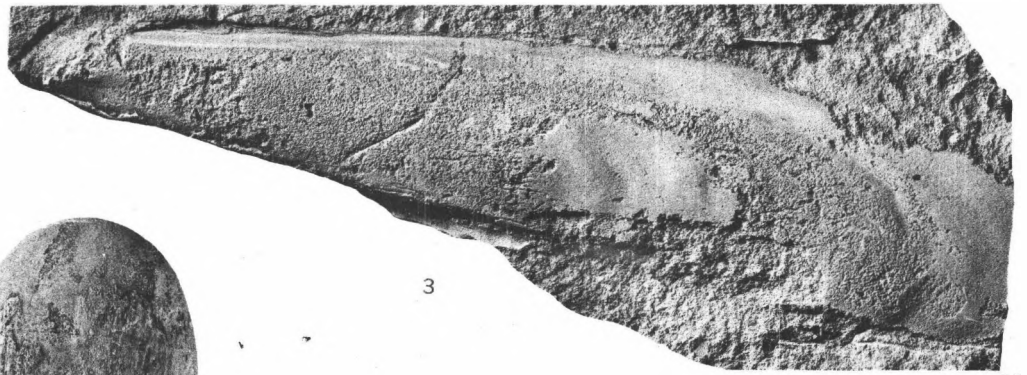
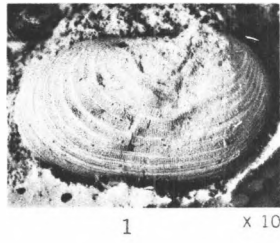
ANTHOZOA AND CEPHALOPODS FROM THE WOODBINE FORMATION

PLATE 58

[Figures natural size except as indicated]

FIGURES 1, 2. *Cyzicus? shupeii*, n. sp. (p. 211).

1. Rubber cast made from external mold of the holotype ($\times 10$), from Red Branch member, east-west road, 2.8 miles S. 70° E. of Callisburg, Cooke Co. Loc. 96. U.S.G.S. 20262, U.S.N.M. 106008.
2. The same ($\times 26$), to show details of sculpture.
3. *Gerrillella?* sp. (p. 68).
Incompletely preserved internal mold of left valve, from Templeton member, bed of Red River near old Slate Shoals, 8 miles east of Arthur City, Lamar Co. Loc. 201. U.S.G.S. 14546, U.S.N.M. 105167.
- 4, 5. *Terebrimya lamarana*, n. sp. (p. 141).
4. Paratype, a large tube, from Lewisville member (Tarrant unit of Moreman), small branch of Big Bear Creek, 1.5 miles east of Euless, Tarrant Co. Loc. 55. (Private collection of James P. Conlin, Fort Worth, Tex.: see plastotype. U.S.N.M. 105602a.)
5. A smaller paratype with large end partly broken away, revealing internal mold of the shell, from the same source.
- 6-8. *Meloicoceras crassicoxae*, n. sp. (p. 210).
Views of the holotype, from Templeton member, bluff on branch of Cornelius Creek, 2.7 miles N. 5° E. of Bells, Grayson Co. Loc. 164. U.S.G.S. 20314, U.S.N.M. 106003.
- 9, 10. *Levicerithium basicostae*, n. sp. (p. 161).
Views of the holotype ($\times 3$), from Lewisville member, in a small stream gorge, 1.9 miles S. 54° W. of the center of Ambrose, Grayson Co. Loc. 135. U.S.G.S. 20309, U.S.N.M. 105726.

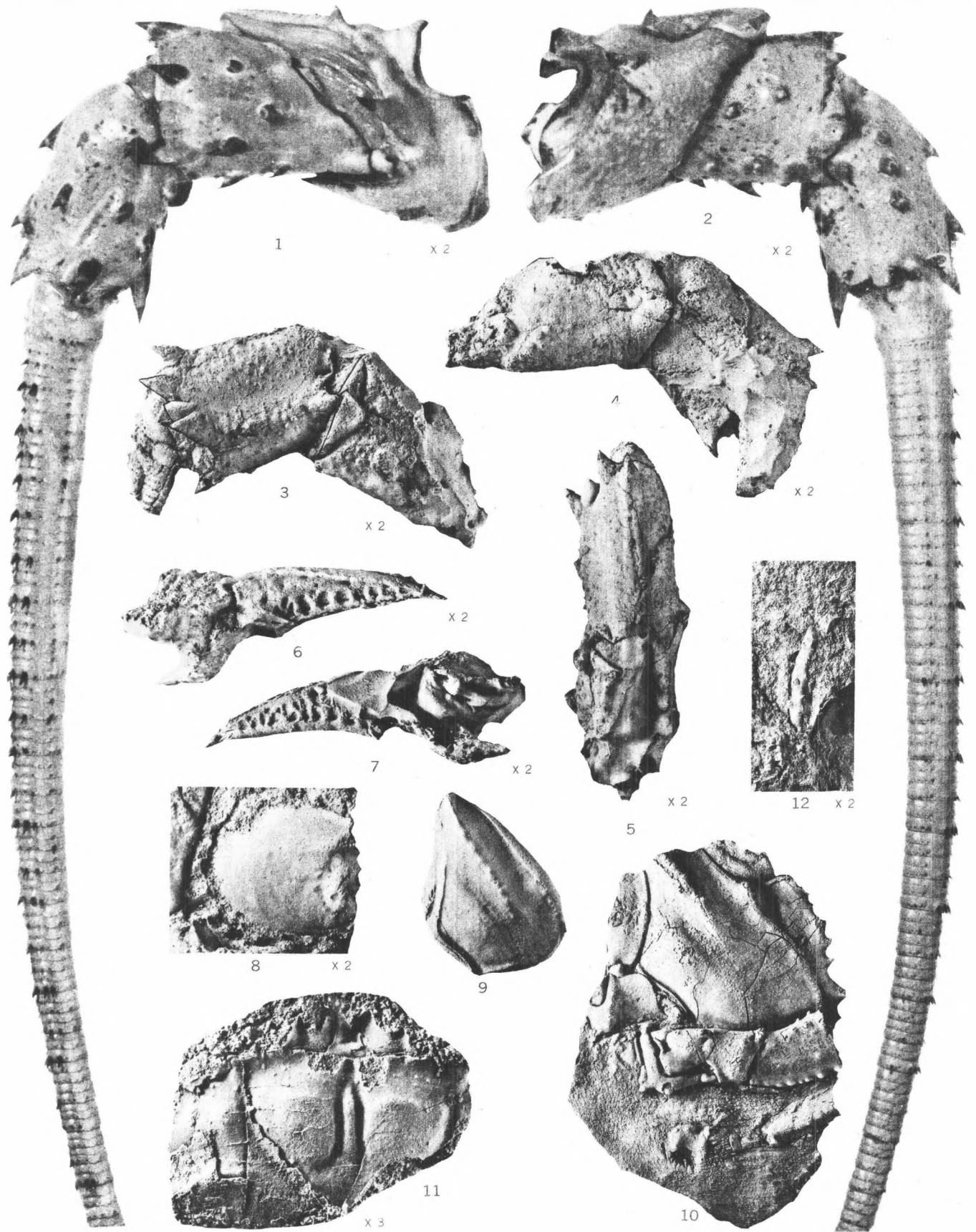


FOSSILS FROM THE WOODBINE FORMATION

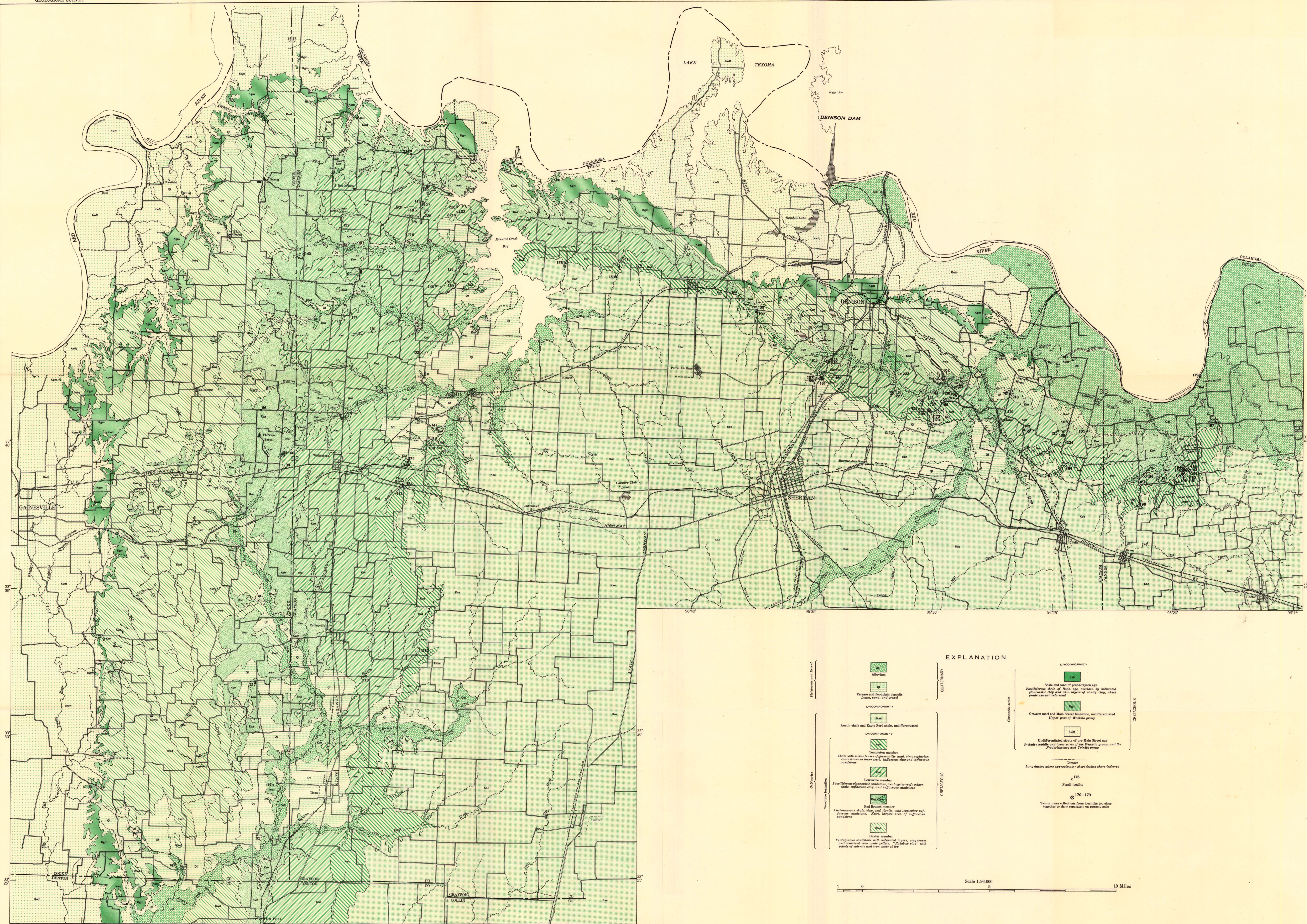
PLATE 59

FIGURES 1. 2. *Panulirus interruptus* (Randall) (p. 212).

1. Dorsal view of left antenna ($\times 2$). Recent, from coast of California.
2. Ventral view of left antenna ($\times 2$).
- 3-7. Palinurid genus undet. (p. 212).
3. Dorsal view of part of left antenna ($\times 2$), from Eules member, State Highway 183, within 1.2 miles west-southwest of Eules, Tarrant County. Loc. 28. U.S.G.S. 19040, U.S.N.M. 108230.
4. Ventral view of part of left antenna ($\times 2$), from same locality.
5. Anterior view of part of left antenna ($\times 2$), from same locality.
6. 7. Views of the dactylus of a walking leg ($\times 2$), from same locality.
8. *Callianassa?* sp. (p. 214).
Interior cast of incomplete manus ($\times 2$), from Dexter member, 4 to 5 feet above top of Grayson marl, road ditch just north of crossroad, 1.4 miles northeast of Handley, east-central Tarrant County. Loc. 11. U.S.G.S. 19508, U.S.N.M. 108227.
9. 10. *Cenomanocarcinus vanstraeleni* Stenzel (p. 215).
9. Left pterygostomian region of the ventral face of the carapace ($\times 1$), from Templeton member, bluff on tributary to Cornelius Creek, 0.4 mile downstream from road corner, 0.9 mile east of underpass of Missouri-Kansas-Texas Railroad, 3.3 miles N. 16° W. of the junction of this railroad with the Texas and Pacific Railway in Bells, Grayson County. Loc. 165. U.S.G.S. 20315, U.S.N.M. 108228.
10. Ventral view of syntype 5 from Eagle Ford shale at California Crossing, Dallas County.
11. *Woodbinax texanus* Stenzel, n. gen., n. sp. (p. 216).
Monotype ($\times 3$), dorsal view of carapace, from Lewisville member, north-flowing branch of Brushy Creek intersecting east-west road, 0.9 mile east of Sandusky, Grayson County. Loc. 115. U.S.G.S. 18964, U.S.N.M. 108226.
12. Crustacean fragment (p. 217).
Apparently a leg fragment ($\times 2$), 14 mm long and 2 mm in diameter, from the Lewisville member, east tributary of Sheep Creek about 150 yards downstream from waterfall over tuffaceous sandstone, 0.35 mile south of east-west country road and 0.4 mile west of north-south road, 2.6 miles east and 3.4 miles north of railroad station in Savoy, Fannin County. Loc. 192. U.S.G.S. 20307, U.S.N.M. 108229.



STENZEL: DECAPODS FROM THE WOODBINE FORMATION



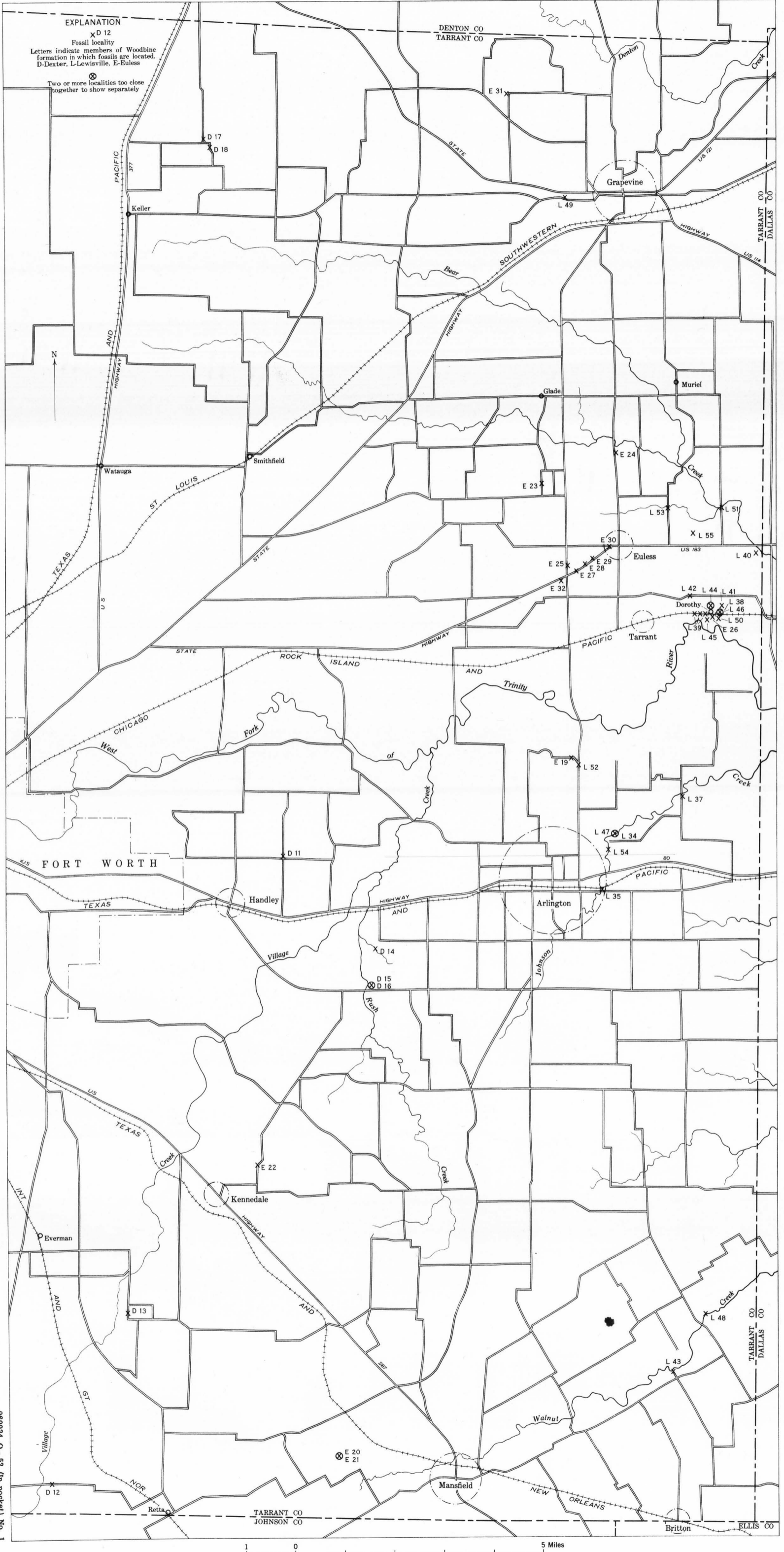
EXPLANATION

Pleistocene and Recent Alluvium Terrace and floodplain deposits Loam, sand, and gravel	UNCONFORMITY Austin chert and Eagle Ford shale, undifferentiated UNCONFORMITY Terlington member Shale with minor lenses of glauconitic sand; limy spherular concretions in lower part; buffaceous clay and buffaceous sandstone Limestone member Fossiliferous glauconitic sandstone, fossiliferous reef; minor shale, buffaceous clay, and buffaceous sandstone Red Branch member Carbonaceous shale, clay, and lignite with irregularly bedded sandstone. Kurt, largest area of buffaceous sandstone Dexter member Ferruginous sandstone with indurated layers; clay lenses and scattered iron oxide pellets. "Rainbow clay" with pellets of siderite and iron scale at top	UNCONFORMITY Shale and sand of post-Crayson age Fossiliferous shale of this age, overlain by indurated glauconitic clay and thin layers of sandy clay, which grade upward into sand Grayson marl and Main Street limestone, undifferentiated Upper part of Washita group UNCONFORMITY Undifferentiated strata of pre-Main Street age Includes middle and lower parts of the Washita group, and the Fredericksburg and Trinity groups Contact Long dashes where approximate; short dashes where inferred Fossil locality x 176 170-173 Two or more sections from localities too close together to show separately on present scale	QUATERNARY CRETACEOUS CRETACEOUS			
				UNCONFORMITY Shale and sand of post-Crayson age	CRETACEOUS CRETACEOUS	
				UNCONFORMITY Grayson marl and Main Street limestone, undifferentiated		CRETACEOUS CRETACEOUS
				UNCONFORMITY Undifferentiated strata of pre-Main Street age		

Scale 1:96,000
10 Miles

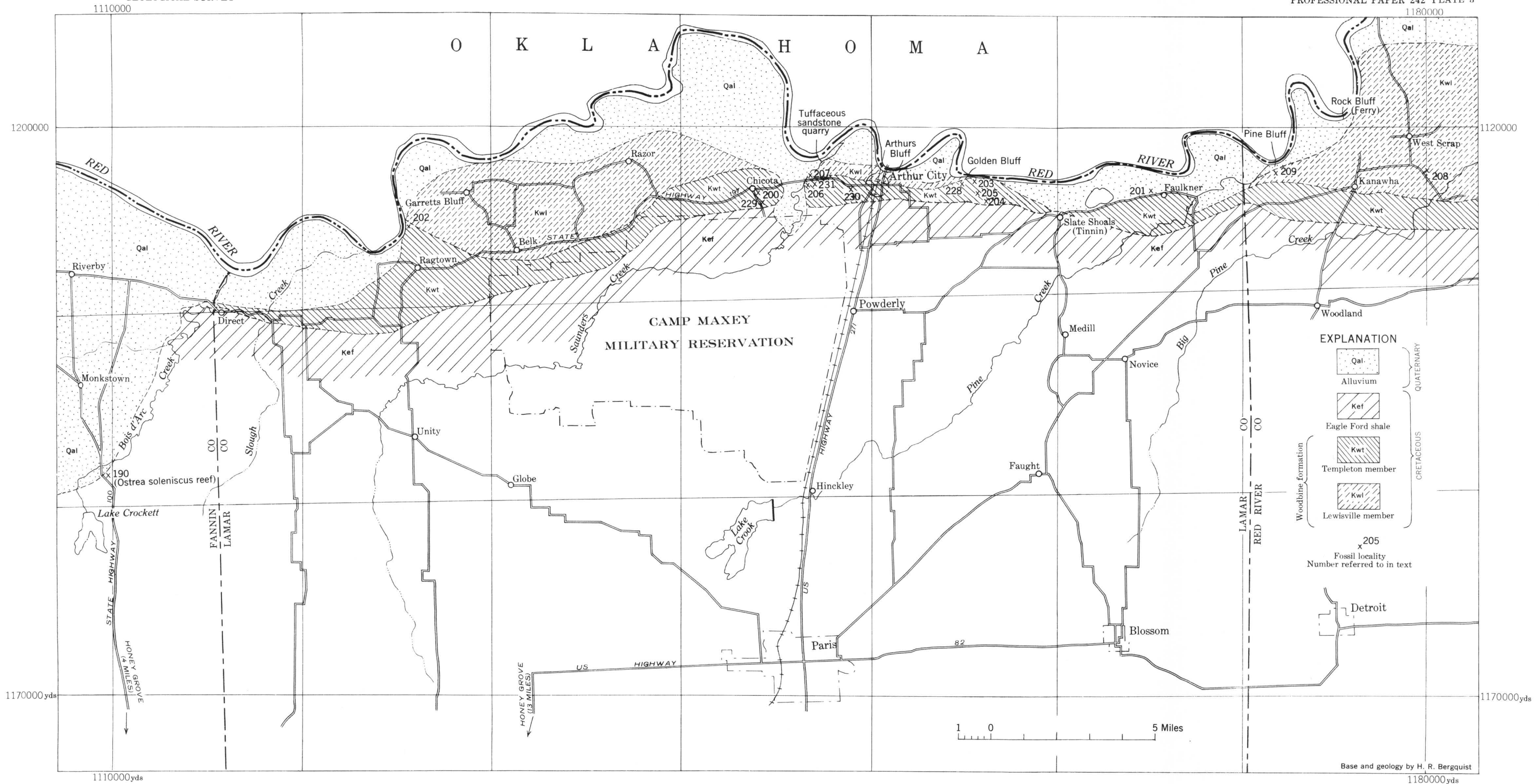
GEOLOGIC MAP OF PARTS OF COOKE, GRAYSON, AND FANNIN COUNTIES, TEXAS, SHOWING THE FOSSIL COLLECTING LOCALITIES

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. Adapted from map prepared by H. B. Burgess, 1949
Oil and Gas Investigation, Preliminary Map 98



968924 O - 52 (in pocket) No. 1

SKETCH MAP OF PART OF TARRANT COUNTY, SHOWING FOSSIL-COLLECTING LOCALITIES IN THE WOODBINE FORMATION



GEOLOGIC MAP OF PARTS OF FANNIN, LAMAR, AND RED RIVER COUNTIES, TEXAS, SHOWING FOSSIL-COLLECTING LOCALITIES

