

Basal Eagle Ford Fauna (Cenomanian) in Johnson and Tarrant Counties Texas

GEOLOGICAL SURVEY PROFESSIONAL PAPER 274-C



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By LLOYD WILLIAM STEPHENSON

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

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*Descriptions and illustrations of fossils of
Late Cretaceous age, including two identified
bivalve species, two gastropod species, and
eight cephalopod species*



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1955

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 75 cents (paper cover)

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7. *Euomphaloceras*.

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BASAL EAGLE FORD FAUNA (CENOMANIAN) IN JOHNSON AND TARRANT COUNTIES, TEXAS

By LLOYD WILLIAM STEPHENSON

ABSTRACT

The basal few feet of the Eagle Ford shale in Johnson and Tarrant Counties, Tex., contains interbedded concretionary calcareous sandstones and sandy limestones, some of which are fossiliferous. The fauna obtained from the concretions includes 2 identified pelecypod species, 2 gastropod species (both new) and 8 cephalopod species (6 new). One new genus, *Tarrantoceras*, of the family Acanthoceratidae, is described. The two new gastropod species are: *Pseudomelania? basicostata* and *Lispodesthes lirata*; the new cephalopod species are: *Acanthoceras johnsonianum*, *Tarrantoceras rotatile*, *T. stantoni*, *T. lillianense*, *T. multicostatum*, and *Borissiakoceras orbiculatum*. Several additional poorly preserved mollusks are identified generically but not specifically.

Both the lithologic character of the beds and the composition of the fauna indicate that this zone is the northward extension of the flag member (later named Bluebonnet member by Adkins and Lozo) of Adkins, in Bell County, Tex. The zone is stratigraphically higher and younger than the Tarrant unit of Moreman in Tarrant County, a unit that Moreman considered correlative with the flag member in Bell County.

In terms of the classification of the Cretaceous strata of Europe the fauna here described is of late Cenomanian age.

INTRODUCTION

This report records a few molluscan species, mainly acanthoceratid ammonites (Cenomanian), from concretionary calcareous sandstones and sandy limestones interbedded with shale in the basal few feet of the Eagle Ford shale in southeastern Tarrant and northeastern Johnson Counties, Tex. The fauna is of interest partly because it includes species not previously described and partly because it confirms evidence of the synchronicity of the containing beds with the so-called flaggy member of the Eagle Ford shale in Bell and McLennan Counties. Attention was first called to the flag member by W. S. Adkins (1923, p. 67-79), at which time he interpreted these flaggy beds as forming a middle member of the Eagle Ford shale. In a later publication Adkins (1933, p. 239, 270, 417-422) treated the shale below the flag member as a unit of uncertain age, which he called the Pepper formation. However, in a recent publication Adkins and Lozo (1951, p. 117-157) present evidence that the Pepper

shale is a southward extension of the Lewisville member of the Woodbine formation, and this correlation is accepted by Stephenson (1953, p. 57-67).

It is therefore established that the flag member, which Adkins and Lozo (1951, p. 119, fig. 26), later named the Bluebonnet flag member of the Lake Waco shale, forms the basal unit of the Eagle Ford shale, as that unit is developed in McLennan and Bell Counties. These authors treat the Eagle Ford shale in that area as a group. The Lake Waco shale is the lower of two formations into which they divide the Eagle Ford group in McLennan, Bell and other counties farther south, and the South Bosque marl is the upper formation. They subdivide, the Lake Waco into three subunits: the Bluebonnet flag member, about 6 feet thick in McLennan, Bell, and Williamson Counties, at the base; the Cloice shale member, 12 to 35 feet thick, in the middle, extending from McLennan County to Travis County; and the Bouldin flag member, 8 to 13 feet thick, at the top, also extending from McLennan County to Travis County.

Among fossils described by Adkins (1928, p. 240-248) from the flag member (=Bluebonnet member) in Bell County are: *Eucalycoceras leonense*, *Acanthoceras lonsdalei*, *A. bellense*, and *A. stephensoni*. From the same source Moreman (1942, p. 203, 204) described *Acanthoceras validum* and *A. pepperense*. *Acanthoceras alvaradoense* Moreman is from the same stratigraphic position at a locality 4 miles south of Alvarado, Johnson County. It appears that the type of *Mantelliceras sellardsi* Adkins (1928, p. 239) came from the Bouldin member in Williamson County, but Adkins also recorded it from the Bluebonnet member in Bell County. All the others were from the Bluebonnet member.

It is appropriate to mention here a geologic unit in Tarrant County, originally described by Moreman (*in* Adkins, 1933, p. 424, 425) as the Tarrant sandy clay and limestone, and later (1942, p. 195) referred to by him as the Tarrant formation. He classed this 15- to 18-foot unit as the basal formation of the Eagle Ford

group, and correlated it with the flag member (=Bluebonnet member) in Bell County. Locally the Tarrant is a sharply defined unit with a thin conglomerate at the base. Stephenson (1946, p. 1764, 1770; 1952 [1953], p. 3, 4, 30) has presented evidence that the Tarrant unit is stratigraphically lower and older than the Eagle Ford shale and forms the upper part of the Lewisville member of the Woodbine formation in Tarrant County.

The correlation of the Tarrant with the flag member has led to the listing of Woodbine species with Eagle Ford species (Adkins, 1928, p. 32; 1933, p. 432-435; Moreman, 1942, p. 193-196), and consequently to confusion as to the stratigraphic relation of the upper Woodbine to the lower Eagle Ford. A careful recheck of the Tarrant fauna shows that of 74 named species (4 questionably identified), 37 (2 questionably identified) are common to the fauna of the typical Lewisville beds on Timber Creek in Denton County. So far as I have been able to determine, only one species, *Exogyra columbella* Meek, is common to the Tarrant and the Bluebonnet member. One other species, *Inoceramus arvanus* Stephenson, now known to be present in the Bluebonnet and its equivalents, was originally described from the Lewisville member in Cooke County, but it has not been recognized in the Tarrant unit. One species from the Tarrant, *Euomphaloceras eulesanum* (Stephenson), is closely related to *Euomphaloceras lonsdalei* (Adkins), but it appears to be specifically distinct. Another species in the Tarrant, *Eucalycoceras barcusi* (Jones), (= *Acanthoceras barcusi* Jones), appears to be closely allied to *Eucalycoceras leonense* Adkins from the Bluebonnet member.

FOSSILIFEROUS LOCALITIES

The fossils described on following pages were obtained from beds that represent the northward extension of the flag or Bluebonnet member of the Lake Waco formation of Adkins and Lozo, and therefore belong stratigraphically above the Tarrant unit. The fossils were collected from the basal 10 feet or less of the Eagle Ford shale at two nearby localities on Walnut Creek in Tarrant County, and at two localities in Johnson County.

The two localities in Tarrant County were discovered by the late T. W. Stanton in 1923. They are on Walnut Creek, 4.75 miles east-northeast of Mansfield. The following is quoted from his field notes dated May 18, 1923:

On Walnut Creek just below bridge (which has been washed out) a small exposure of the Eagle Ford contains many large flat concretions, one of which was very fossiliferous, containing *Inoceramus fragilis* [?], *Acanthoceras*, *Anchura* (orig. no. 1942). One hundred yards [about 165 yards] down the creek there is a good exposure showing 15 ft. of Eagle Ford with the large con-

cretions in lower 6 ft. and thin indurated sandstone bands for 5 feet higher. Some of these yielded *Ostrea* and a few thin pelécy-pods. These exposures must be within 10 feet of the top of the Woodbine. A very good series of specimens of the *Acanthoceras* was obtained here.

Stanton's collection (USGS 11740) was obtained from the large concretions.¹ He states that the concretions are within 6 feet of the base of the 15-foot section.

In March 1929, Stanton, accompanied by J. B. Reeside, Jr., and me, visited the Walnut Creek localities. I measured and described the section at the exposure about 500 feet downstream from the bridge site, as follows:

Section on left bank of Walnut Creek, 4.75 miles east-northeast of Mansfield, 500 feet downstream from an abandoned road crossing

Eagle Ford shale:	Feet
7. Clay, gray, shaly, weathering in thin flakes; contains a few thin, irregularly platy calcareous sandstone seams.....	7
6. Sandstone, platy, and sand, 1 to 6 inches thick, crossbedded, containing scattered white clay balls at base.....	1/2-1/2
5. Clay, dark, shaly, gypsiferous; a few concretionary calcareous sandstone masses about 4 feet above base.....	8
4. Sandstone, thin, platy, and interbedded shale; here and there a small to large, more or less ovate, concretionary (septarian) mass of fine calcareous sandstone reaching 1 foot in thickness, and showing effects of crushing by pressure from above; fossiliferous.....	1
3. Clay, dark, shaly.....	1
2. Sandstone, thin, coarse, calcareous, containing dark phosphatic pebbles and marcasite pebbles; contains <i>Exogyra columbella</i> Meek, and fish teeth; noted several shark teeth, one tooth of <i>Ptychodus</i> and one pavement tooth.....	1/2-1/2
Woodbine formation:	
Lewisville member:	
1. Sand and sandy clay, gray, massive, fine argillaceous, to water level.....	2
Total.....	20

At the lower end of the exposure sandstone of Woodbine aspect could be seen below water level in the creek. Reeside found the internal mold of a fragment of a large ammonite (USGS 14582), here identified as *Euomphaloceras alvaradoense* (Moreman), loose at the base of the preceding section, and probably weathered out of either layer 4 or layer 5 (pl. 7, fig. 1).

A small collection (USGS 14580) was made from a large concretion in place 6 feet above the base of the Eagle Ford formation, about 150 feet downstream from the bridge site. In a layer of coarse calcareous sand in the Woodbine formation, 5 feet below the base of the

¹ A collection made at a given locality at a given time is assigned a United States Geological Survey number (as USGS 11740). Other collections made at the same locality at later times are given separate and later collection numbers. Thus more than one collection number may pertain to the same locality.

Eagle Ford shale, were collected *Ostrea soleniscus* Meek, *Exogyra columbella* Meek, *Protarca? tramitensis* (Cragin), and *Gymnentome valida* Stephenson (USGS 14579). These are common species of the Lewisville member of the Woodbine formation.

The fossils from the basal beds of the Eagle Ford shale on Walnut Creek are listed below:

Fossils from basal beds of the Eagle Ford shale on Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County, Tex. (USGS 11740, 14580, 14582)

[The one species marked with an asterisk (*) is common to the Lewisville member of the Woodbine formation. The three species marked with a dagger (†) are common to the Bluebonnet member (=flag member) of Bell and Williamson Counties]

- *† *Inoceramus arvanus* Stephenson
- Ostrea* sp.
- Brevicardium?* sp.
- Caestocorbula?* sp.
- Cadulus* sp.
- Pseudomelania? basicostata* Stephenson, n. sp.
- Lispodesthes lirata* Stephenson, n. sp.
- Cyclichma* sp.
- Acanthoceras johnsonanum* Stephenson, n. sp.
- Tarrantoceras rotatile* Stephenson, n. sp.
- stantoni* Stephenson, n. sp.
- lillianense* Stephenson, n. sp.
- † *Euomphaloceras lonsdalei* (Adkins)
- † *E. alvaradoense* (Moreman)
- Borissiakoceras orbiculatum* Stephenson, n. sp.

One of the two localities in Johnson County, the one on the north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, was discovered by Stanton, Reeside, and Stephenson in March 1929. The outcrop consists of large calcareous sandstone concretions containing fossils, weathered out in a field. Large masses of sandstone typical of the Lewisville member of the Woodbine formation are exposed nearby in the bed of Mountain Creek topographically 20 feet lower than the fossiliferous concretions in the field. The concretions must therefore occupy a stratigraphic position low in the Eagle Ford shale, within a few feet of the top of the underlying Woodbine formation. The following fossils were obtained at this locality:

Fossils from concretions near the base of the Eagle Ford shale, in a field 2.5 miles north-northeast of Alvarado, Johnson County, Tex. (USGS 14583)

[The two species marked with an asterisk (*) are common to the Lewisville member of the Woodbine formation. The three species, marked with a dagger (†) are common to the Bluebonnet member (=flag member) of the Lake Waco formation of Bell and Williamson Counties]

- *† *Inoceramus arvanus* Stephenson
- * *Exogyra columbella* Meek
- Acanthoceras johnsonanum* Stephenson, n. sp.
- Tarrantoceras rotatile* Stephenson, n. sp.
- multicostatum* Stephenson, n. sp.
- † *Euomphaloceras lonsdalei* (Adkins)
- † *E. alvaradoense* (Moreman)

Tarrantoceras rotatile is closely related to *T. sellardsi* (Adkins), which is recorded from both the Bluebonnet

and Bouldin members of the Lake Waco formation. *Acanthoceras johnsonanum* appears to be more closely related to *A. bellense* Adkins, from the Bluebonnet member, than it is to other species in the two flaggy members.

The other locality in Johnson County is in an erosion gully in a cultivated field about a mile north of Lillian. This place was discovered by James P. Conlin, of Burleson, Tex. He reports finding the following fossils in a concretion from this gully: *Acanthoceras alvaradoense* Moreman, *Acanthoceras* sp., *Eucalycoceras* sp., and *Borissiakoceras* sp. I am referring Moreman's species *A. alvaradoense* to the genus *Euomphaloceras* Spath, and Conlin's *Eucalycoceras* to the new genus *Tarrantoceras*. Conlin has sent to me from this locality one specimen that I refer to *Tarrantoceras rotatile* and another that I am calling *T. lillianense* (USGS 24510). He has also furnished a specimen from the same source, that I am making the holotype of *T. stantoni*.

SYSTEMATIC DESCRIPTIONS

Class PELECYPODA

Genus INOCERAMUS Sowerby, 1822

Inoceramus arvanus Stephenson

Plate 4, figures 1-3

1952 [1953]. *Inoceramus arvanus* Stephenson, U. S. Geol. Survey Prof. Paper 242, p. 65, pl. 12, figs. 6-9.

The basal beds of the Eagle Ford shale yielded specimens of a small *Inoceramus* that appear to be identical in essential shell characters with *I. arvanus* Stephenson from the Lewisville member of the Woodbine formation in Texas. As is generally true of this genus the shells of any given species show considerable individual variation, but the variations in form outline and surface features of the shells here under consideration agree essentially with those exhibited by the Lewisville species, and the average size is about the same.

Shell rather small for the genus, roughly subcircular to subquadrate in outline, moderately inflated. Form and outline showing marked individual variations. Anterior slope steep, in some specimens at right angles to the plane of contact of the two valves, and in some overhanging a little toward the front. The postero-dorsal, posterior and ventral slopes descend more gently and the latter may be modified by a broad, shallow radial depression. Beaks prosogyrate, strongly incurved, situated at the anterior extremity of the hinge, and at or near the anterior margin of the shell. The anterior margin descends steeply and may be at right angles to the straight hinge line. Surface marked only with fine growth lines and with irregularly developed growth undulations.

The right valve shown in plate 4, figure 3, measures: Length 43 mm, height 43 mm, convexity about 13 mm. The larger left valve shown in plate 4, figure 1, measures: Length 53 mm, height 57 mm, convexity about 17 mm.

None of the available specimens from the flaggy limestones forming the base of the Eagle Ford shale show the hinge or ligamental pits. As seen in paratypes from the Woodbine formation (Stephenson, 1952 [1953], pl. 12, figs. 8, 9), the ligamental area is long, 3 or 4 mm wide in adults, and is crossed transversely by a series of shallow ligamental pits that are nearly twice as wide as the spaces separating them.

Types.—Holotype, USNM 105157; 3 figured paratypes, USNM 105158 a-c, and 12 unfigured paratypes, USNM 105159; 3 plesiotypes from basal calcareous concretions of the Eagle Ford shale, USNM 108840, 108849, and 108864.

Occurrence.—The species was originally recorded from the Lewisville member of the Woodbine formation, in Cooke County, Tex., at a locality half a mile north of U. S. Highway 82, half a mile west of the Grayson County line (type locality); from Grayson County on a branch of Walnut Creek, 0.7 mile north of Gordonville; and on a branch of Sandy Creek, 2.5 miles north of Sadler.

The species is present in basal calcareous concretions of the Eagle Ford shale at the following localities in Texas:

Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740 (1 figured)).

Walnut Creek, 150 feet downstream from the old piers at a bridge site, about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 14580).

North-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County (USGS 14583 (1 figured)).

Bird Creek, south of Belton-Temple Highway, about 4 miles east-northeast of Belton, Bell County (USGS 11845 (1 figured), 13577).

Genus *OSTREA* Linné, 1758

Ostrea sp.

Many small and fragmentary shells of a poorly preserved, undetermined oyster are present in one of the collections from Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County, Tex. The containing matrix is a fine calcareous sandstone (USGS 11740, USNM 108839).

Genus *EXOGYRA* Say, 1820

Exogyra columbella Meek

1876. *Exogyra columbella* Meek, in Macomb, Rept. Expl. Exped. Santa Fe, N. Mex., to junction of Grand and Green Rivers, p. 124, pl. 1, figs. 3 a-d. (See synonymy in U. S. Geol. Survey Prof. Paper 242, 1952 [1953], p. 77.)

This species is represented by one small internal mold in basal calcareous concretions of the Eagle Ford shale at the locality on the north-facing slope of

Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, Texas (USGS 14583). It occurs at the same stratigraphic position in a branch west of the Missouri-Kansas-Texas Railroad, 1.25 miles south of Grandview, Johnson County (USGS 14145), and in a road ditch 0.75 mile east of Lloyd, 0.5 mile north of Pleasant Home School, Denton County. For synonymy, description, types, and occurrence and range in Texas (see Stephenson, (1952 [1953], p. 77). The basal beds of the Eagle Ford shale is the highest stratigraphic position from which this species has been recorded in Texas. USNM 108865.

Genus *BREVICARDIUM* Stephenson, 1941

Brevicardium? sp.

One shell, a right valve, from the locality on Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, Tex. (USGS 11740), is questionably referred to *Brevicardium* Stephenson. In size and form the specimen agrees well with that genus. The shell, which is thin and frail, is embedded in fine hard calcareous sandstone in such a manner that only its interior surface and margin are observable. Obscure radial lining on the internal surface and fine crenulations on the margin suggest the presence on the exterior surface of fine radial ribs such as characterize the genus *Brevicardium*. The hinge features are obscure. The shell measures: Length 8.4 mm, height 7.5 mm, convexity about 2 mm. USNM 108850.

Genus *CAESTOCORBULA* Vincent, 1910

Caestocorbula? sp.

In the collections from two localities on Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740 and 14580), are several internal molds of a small bivalve mollusk belonging to the family Corbulidae, and questionably referred to the genus *Caestocorbula* Vincent. Remnants of shell substance adhere to the molds over parts of their surfaces. The molds are plump centrally and anteriorly, and strongly constricted posteriorly, with a short truncation at the posterior end. The right valve bears small distinct, rather closely spaced concentric ribs on its lateral surface; the left valve is nearly smooth, but has weak concentric ribs. The reference of the molds to *Caestocorbula* Vincent is based on similarity in form and on the concentric ribbing on the right valve which, though finer, resembles that on, *Caestocorbula crassiplica* (Gabb) from the Ripley formation of Mississippi and Tennessee. A selected right valve measures: Length 4 mm, height 2.8 mm, convexity about 1.5 mm. USGS 108851 and 108852.

Class SCAPHOPODA

Genus CADULUS Philippi, 1844

Cadulus sp.

One small smooth incomplete tube partly embedded in hard matrix, from Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740), is referred to *Cadulus* Philippi. The tube as preserved is about 6 mm long, about 0.5 mm in diameter at the small end, increases to a maximum of 1.1 mm about 4 mm from the small end, and apparently becomes slightly constricted as it nears the incomplete large end. The tube is gently and evenly curved and appears to be slightly compressed, with long axis at right angles to the plane of curvature. The specimen may be compared with the closely similar species, *Cadulus praetenuis* Stephenson, from the Templeton member of the Woodbine formation in Grayson County, Tex. (1952 [1953], p. 143). USNM 108860.

Class GASTROPODA

Genus PSEUDOMELANIA Pictet and Campiche, 1862

Pseudomelania? *basicostata* Stephenson, n. sp.

Plate 4, figures 4, 5

The three available specimens of this species are from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740). Shell small, spire of medium height with apical angle of about 34°, decreasing to about 25° on the larger whorls below. Protoconch not preserved. Suture sharply but not deeply impressed. Whorls 6 or 7; whorls of spire nearly flat on the sides, smooth except for obscure, microscopic spiral lining. Body whorl with a weak obtuse subangulation at the periphery. Basal slope steep, rounded in cross section, bearing on its lower two-thirds 3 or 4 flattish to round-crested spiral ribs, separated by narrower interspaces. Growth lines broadly convex in trend forward on the base, broadly concave forward above the periphery, slightly deflected backward just before reaching the suture above. Aperture not well preserved but apparently rather broadly lanceolate, with an acute angle at the rear and sharply rounded, though not channeled or notched at the front.

Dimensions of the incomplete holotype, the largest of the three shells: Height 10+ mm, diameter 4.5 mm.

The species is very much smaller than either *P.?* *roanokana* Stephenson or *P.?* *ferrata* Stephenson, from the Woodbine formation of Texas, and also differs in having spiral costae on the base.

Types.—Holotype, USNM 108847; 2 unfigured paratypes, USNM 108858.

339390—55—2

Genus LISPODESTHES White, 1877

Lispedesthes lirata Stephenson, n. sp.

Plate 4, figures 6–11

The individuals of this species are present in considerable numbers in collections from two nearby localities on Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740 and 14580). The shell substance is very thin and fragile and it is impossible to separate any one individual in complete form from the hard matrix. However, nearly all the features needed for description can be seen in a selected series of more or less fragmentary shells.

Shell small, with plump body whorl and spire of medium height. Spiral angle about 46°, though somewhat variable on different individuals. Protoconch apparently low turbinate, with about 1½ coils. Suture closely appressed in a shallow depression. Whorls 4 or 5, gently convex on the side, expanding rather rapidly, bearing spiral lirae that may become covered with callus in adults. The body whorl of adults bears eight to twelve thin, low, threadlike spiral lirae, ranging from distinct to obscure and on different individuals from regularly to very irregularly spaced; those low on the base are most obscure. The growth lines are sinuous, being broadly convex in trend toward the front on the base and broadly concave forward on the side above the periphery.

The periphery and base are broadly rounded, the latter becoming rather steep below. Aperture long-lanceolate, acutely angular at the rear, and passing in front into a rather long, narrow curved siphonal canal (beak). Outer lip broadly arched in the younger stages, expanding in adults into two pronglike projections. The upper of the projections is long and narrow and curves upward spurlike; on the body whorl one of the upper lirae, usually the third one below the suture, becomes more prominent as it approaches the aperture, and extends as a sharply upraised ridge out on the upper projection to its tip. The lower projection is broader, shorter, and may end in a blunt, inbent point; one of the basal lirae extends as a slightly raised ridge out onto this projection. A groove on the inner surface of each projection, the upper one the deepest, is a reflection of the ridge on the outer surface. In the adult the mantle of the living organism spread outward away from both the inner and the outer lip and secreted a layer of callus on the outer surface; in fully mature individuals callus may cover the entire shell, concealing the spiral lirae. In mature shells an anal channel incised in callus extends from the posterior angle of the aperture up the outer side of the spire to the apex.

Dimensions of the incomplete holotype; Height 14+mm, diameter, exclusive of the expanded lip, about 8.5 mm. A larger incomplete paratype (pl. 4, fig. 9), whose expanded wing is not uncovered, measures: Height 17+mm, diameter 7+mm.

The species is similar to, and closely related to *Lispodesthes panda* Stephenson, from the Templeton member of the Woodbine formation, but the spire of *L. lirata* is a little higher, the sides of the whorls are plumper, the upper spur of the expanded lip is more slender and its degree of upward curvature is less, and there is less of a tendency for the shell to become completely covered with callus in the mature stage. *L. patula* Stephenson, also from the Templeton member, is larger and bears more numerous, finer, and more closely spaced spiral lirae.

A closely related species in the western interior is *Lispodesthes nuptialis* White, from beds that are correlated by J. B. Reeside, Jr., with the Carlile shale. It is there associated with the ammonite *Collignonicerias woolgari* (Meek) (= *Prionotropsis woolgari* Meek) in a paleontologic zone (Turonian) that is stratigraphically higher and younger than the basal beds of the Eagle Ford shale.

Types.—Holotype, USGS 11740, USNM 108856; 3 figured paratypes, USGS 11740, USNM 108862; 2 figured paratypes, USGS 14580, USNM 108857; 15 selected unfigured paratypes, USGS 14580, USNM 108867; 15 unfigured paratypes, USGS 11740, USNM 108837.

Occurrence.—At two adjacent localities on Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, Tex.

Genus CYLICHNA Loven, 1846
Cylichna? sp.

At one of the localities on Walnut Creek about 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740) several examples of a small gastropod having the form of *Cylichna* Loven occur. These are mostly internal molds with a thin film of soft calcareous shell material covering parts of them. No indication of spiral lirae can be detected. The shell is subcylindrical, broadly bulging in profile, the body whirl enveloping all the earlier whorls. One specimen about maximum size measures: Height 3 mm, diameter 1.5 mm. USNM 108859.

Class CEPHALOPODA
Family DESMOCERATIDAE
Genus DESMOCERAS Zittel, 1884
Desmoceras? sp.

Plate 4, figures 12, 13

Two small incomplete ammonites from Walnut Creek, Tarrant County (USGS 11740), appear to belong to the Desmoceratidae, but are too immature to permit of their definite assignment to any one of the many

genera into which that family group has been subdivided. The shell is rather plump and smooth, the venter rather narrowly rounded, and the umbilicus small, though the coiling is not as close as it is in some members of the group. The ventral lobe is narrow and deep and the ventral saddle small and bluntly pointed. There are four relatively narrow complexly denticulate lateral saddles and four corresponding lobes; both lobes and saddles decrease rapidly in size from the venter to the line of involution. The figured specimen measures: Greatest diameter 9.5 mm, maximum radius center to venter 5.5 mm, dorsoventral diameter about 3.5 mm, corresponding transverse diameter about 4.5 mm. USNM 108830.

Family ACANTHOCERATIDAE

Genus ACANTHOCERAS Neumayr, 1875
Acanthoceras johnsonanum Stephenson, n. sp.

Plate 4, figures 14–17

This species is represented by one incomplete medium-sized specimen from Johnson County, which apparently includes little, if any, of the living chamber. The shell is plump, subsquarish in cross section, flattened a little on the flanks; the adult volution embraces one-fourth or less of the preceding one. The ribs range from weak to moderately strong, becoming more prominent in the adult stage; they tend to alternate in prominence, about half of them reaching the umbilical shoulder in strength, where each bears a radially elongated, rather prominent node; the intervening ribs become weaker inward, some of them fading out before reaching the umbilical shoulder. The venter is broadly convex.

Each of the stronger ribs bears seven nodes, and most of the weaker intermediate ribs bear five nodes; the weakest rib noted bears only one very low midventral node. The nodes in the median row on the venter are of medium strength and slightly elongated in the younger stages, but become very weak and scarcely observable in the late adult stages. On each ventral angle there is a pair of nodes connected by a raised part of the supporting rib; in the early stages of growth the two paired nodes are cone shaped and subequal in strength and are a little more prominent than the midventral nodes; in the adult stage the outer node of each pair is a little the stronger and is slightly elongated radially. The suture is partly and not very clearly revealed. Enough can be seen to show that it is essentially acanthoceratid in pattern.

Diameter of holotype, as preserved 110 mm (estimated) maximum radius center to venter about 60 mm; the dorsoventral diameter appears to be a little less than the corresponding transverse diameter at both the early and adult stages of growth.

The species is similar in size and form to *Acanthoceras bellense* Adkins, but in general is more strongly ornamented, having more numerous and more prominent ribs and nodes; a striking difference is the relative smoothness of *A. bellense*, especially in the area of the umbilical shoulder, on which the radially elongated nodes on the larger ribs are not only very weak but are set farther out on the flank from the line of involution than are the corresponding nodes on *A. johnsonianum*. Another difference is the cone-shaped outer node of the ventral pair on the adult of *A. bellense* in contrast to the radial elongation of the corresponding node on *A. johnsonianum*.

Holotype.—From north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, USGS 14583, USNM 108846.

Occurrence.—Recorded from the type locality only.

Genus TARRANTOCERAS Stephenson, n. gen.

Type species: *Tarrantoceras rotatile* Stephenson.

Etymology: Tarrant County; Greek *κερας*, a horn.

The features that characterize this new genus are: relatively small size; strong lateral compression; numerous, closely spaced radiating ribs that cross the venter with little or no diminution in size; seven rows of nodes on the earlier whorls, including a weak row of median nodes that fades out in adult stages; a row of nodes on each ventral angle; a row of weak nodes on each flank about one-third the width of the flank inward from the ventral angle, this row fading out forward on later stages; radially elongated nodes on the main ribs at the umbilical shoulder; suture with a moderately deep ventral lobe and short blunt ventral saddle, a broad, relatively low, bifid first lateral saddle with rounded, nondigitate subelements, a broad, shallow digitate lateral lobe, and a second lateral saddle similar to the first, but protruding farther forward on the flank; umbilicus one-third to two-fifths the total diameter of the shell.

The shell of *Tarrantoceras*, though similar in form and ribbing to that of *Ammonites mantelli* J. Sowerby, the genotype of *Mantelliceras* Hyatt, is more compressed than that species and possesses a different and simpler suture pattern. According to Wright and Wright (1951, p. 24, 37), *Mantelliceras mantelli* is restricted to the specimen figured by Sharp (1853, p. 40) in his plate 18, figures 7a-c; the suture shown in his figure 7c includes 3+ relatively narrow, high digitate saddles and part of a fourth saddle; in contrast the exposed suture of *Tarrantoceras* includes only two relatively low broad lateral saddles, the elements of which are rounded (nondigitate), separated by a relatively broad, shallow digitate lobe. Apparently *Mantelliceras* does not possess a medium row of ventral nodes.

In form and ornamentation *Tarrantoceras rotatile*, the genotype of this new genus, is very similar to *Eucalycoceras pentagonum* (Jukes-Browne), the genotype of *Eucalycoceras* Spath. The sutures, however, are markedly different in the two species, so different in fact that, in my opinion, they cannot be considered as congeneric. This opinion is based on a comparison of *T. rotatile* with an incomplete topotype of *E. pentagonum* from the *Holaster subglobosus* zone (Cenomanian) of England; in this English species the first and second lateral saddles are high and narrow and are separated by a deep, narrow, digitate lobe; the subelements of the saddles are narrowly rounded, almost digitate. In strong contrast the first and second lateral saddles of *T. rotatile* are low and broad, with broadly rounded subelements, and the intervening lobe is broad and shallow; this type of suture is consistent in the holotype and in five of the paratypes of *T. rotatile*, and also in the three other species of *Tarrantoceras* here recognized in the basal Eagle Ford of Tarrant and Johnson Counties. In other words, here is a group of four species possessing closely similar suture patterns, which differ markedly from the suture of the topotype of *Eucalycoceras pentagonum* cited above.

Tarrantoceras rotatile Stephenson, n. sp.

Plate 5, figures 1-10

Shell small, coiled in one plane, each whorl embracing about the outer one-third of the flanks of the preceding whorl. Flanks compressed, being only slightly convex in cross section. Radial ribs closely spaced, numbering 44 on the largest whorl of the holotype; of these only 14 reach the umbilical shoulder in strength and bearing prominent shoulder nodes; the others are intercalated between the strong ribs and either die out well down on the flank, or reach the umbilical shoulder with weak unnoded termini. All the ribs are about equal in strength at the ventral angle. The number of smaller and weaker ribs between two strong ribs ranges from one to three. The ribs are gently sinuous, there being a slight curvature in trend backward well out on the flank and a slight bend forward as the ribs approach the ventral angle. Each rib as a whole is inclined a little forward, and all the ribs cross the venter with no diminution in strength.

In the earlier stages each strong rib bears seven nodes. There is a median row of ventral nodes that becomes weaker toward the front and dies out at a shell diameter of about 50 mm. Each rib bears a strong, beadlike node at each ventral angle; in the holotype these nodes tend to become weaker in the forward direction, but are still observable at its largest stage. On the ribs of each flank there is a row of

lateral nodes spaced about one third the width of the flank inward from the ventral angle; these nodes are much weaker than the nodes on the ventral angle and become weaker toward the front, disappearing at shell diameters of 30 mm or more on different individuals; this row is too far away from the ventral angle to be considered as paired with the row on that angle. A fairly prominent node elongated slightly in the radial direction is present on each strong rib at the umbilical shoulder.

In the holotype the living chamber is nearly completely represented and includes more than half the last whorl. The sutures nearest the inner end of the living chamber are well preserved. The ventral lobe is deep and broad, and has three principal and several minor digitations on each side, the lower ones forming a pair embracing the ventral saddle. The ventral saddle is short, rising about one-fourth as high as the lobe is deep; it is weakly trifold on its forward blunt end. The first lateral saddle is broad and relatively short and is divided by a short, narrow sublobe; each subsaddle thus formed is weakly trifold and the elements are broadly rounded, that is, nondigitate. The lateral lobe is smaller than the ventral lobe, and is short, broad and digitate. The second lateral saddle is nearly as large as the first, is similarly divided, protrudes forward on the flank, and extends to the line of involution.

Dimensions of the holotype: Diameter 61 mm; maximum radius center to venter 36 mm; dorsoventral diameter 21 mm; transverse diameter about 18 mm; maximum diameter of umbilicus 21 mm.

The species is closely related to *Tarrantoceras sellardsi* (Adkins), (= *Mantelliceras sellardsi* Adkins), from the Bouldin member of the Lake Waco formation (of Adkins and Lozo). It differs from that species in having more prominent ribs, wider umbilicus and smaller, beadlike nodes in the median ventral row in contrast to the coarser, more elongated nodes in the median ventral row of Adkin's species.

Types.—Holotype from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740, USNM 108835; 2 figured paratypes from the same source, USNM 108854; 7 unfigured paratypes from the same source, USNM 108863; 1 unfigured paratype, USGS 14580, USNM 108853; 1 unfigured paratype, USGS 11740, USNM 108855.

Occurrence.—Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740 (3 figured), 14580.

***Tarrantoceras stantoni* Stephenson, n. sp.**

Plate 5, figures 11–21

In the collection from Walnut Creek, Tarrant County (USGS 11740) are 15 more or less incomplete and fragmentary specimens that resemble *Tarrantoceras rotatile* Stephenson except that they differ in the details of their ornamentation, and slightly in form. The

largest specimen is nearly as large as *T. rotatile* but the shell is plumper, the radial ribs are fewer and not so closely spaced, the nodes are stronger in all the rows, presenting a subspinose effect, especially in the younger stages. The holotype is a specimen from near Lillian, Johnson County, furnished by J. P. Conlin.

The species is similar to *T. rotatile* in form and general appearance, in the number and spacing of the node rows, and in the pattern of the sutures. As in that species the nodes in the row on the flank become weaker forward and fade out in the later stages, and the nodes in the median row on the venter become weaker toward the front, and are wanting on the largest stage represented in the collection. The nodes on the ventral angles continue strong on all but the latest stage of adults. Several specimens representing young stages of growth indicate initial close coiling with an envelopment of more than half the preceding coil. In late stages the envelopment is one-fourth or less of the preceding coil.

Approximate dimensions of the holotype: Greatest diameter 60 mm, maximum radius center to venter 36 mm, maximum dorsoventral diameter 25 mm, corresponding transverse diameter 18 mm. The diameter of the smallest specimen in the collection, which lacks the living chamber, is 7.5 mm.

Fragments among the paratypes from Johnson County indicate that individuals may attain somewhat larger size than the holotype, and may become plumper in late stages of growth. On one fragment of the large end of an adult (plate 5, fig. 21), senility is indicated by the weakening and closer spacing of the ribs and the shortening of the dorsoventral diameter.

The species is named in honor of the late Dr. Timothy W. Stanton.

Types.—The holotype, the most complete available specimen of this species, was generously supplied by J. P. Conlin, by exchange of the best, though less complete, specimen of the same species in the collection from Walnut Creek. Conlin found his specimen in a gully in a cultivated field about 1 mile north of Lillian, Johnson County, Tex. (USGS 24510, USNM 108866). Three figured paratypes, USGS 11740, USNM 108861; 11 unfigured paratypes, USGS 11740, USNM 108836. One figured paratype, USGS 14583, USNM 108845; 3 unfigured paratypes, USNM 108843.

Occurrence.—Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740; north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, USGS 14583; an erosion gully in a cultivated field about 1 mile north of Lillian, Johnson County (J. P. Conlin's loc. no. 4551).

***Tarrantoceras lillianense* Stephenson, n. sp.**

Plate 5, figures 22–27

This species is represented by nine specimens that possess features of form and sculpture intermediate between those of *Tarrantoceras rotatile* and those of

T. stantoni. Compared with the former the flanks are plumper, and in the adult stage the ribs are fewer, a little coarser and more widely spaced, and the nodes on the ventral angles and on the umbilical shoulders are a little coarser; the sutures are essentially identical, presenting shallow lateral lobes and broad, low saddles with rounded forward elements. Compared with *T. stantoni* the flanks are of about the same plumpness but the ribs are more numerous and weaker, and the nodes are much less conspicuous, lacking a spinose effect; on this species the ventrolateral rows of nodes are more closely spaced than they are on *T. stantoni*.

The holotype is an incomplete internal mold (about half a volution) having some shell adhering, representing mainly the living chamber and bearing 22 radiating ribs. The imprint of part of the venter of the preceding volution is present on the inner curve of the specimen and a rubber cast of this imprint is shown in plate 5, figure 25. Dimensions of the holotype are: Greatest diameter 56 mm, dorsoventral diameter 20 mm, corresponding transverse diameter 19 mm, diameter of umbilicus 20 mm. The figured paratype, representing a younger stage, measures: Greatest diameter 33 mm, radius center to venter 21 mm, dorsoventral diameter about 14 mm, corresponding transverse diameter about 14 mm, diameter of umbilicus 10 mm.

Types.—Holotype from a gully in a field 1 mile north of Lillian, Johnson County (J. P. Conlin, collector), USGS 24510, USNM 108841; 1 figured paratype, USGS 11740, USNM 108848; 7 unfigured paratypes, USGS 11740, USNM 108838.

Occurrence.—Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County; a concretion in an erosion gully about 1 mile north of Lillian, Johnson County.

***Tarrantoceras multicoatum* Stephenson, n. sp.**

Plate 6, figures 21–23

Two incomplete internal molds that possess the essential characters of *Tarrantoceras* Stephenson, differ specifically from *T. rotatile* Stephenson. The adults are somewhat larger than *T. rotatile*, are plumper on the flanks, more rounded on the venter and have smaller and weaker ventral nodes. The most striking difference, however, is the greater number of costae; 30 costae can be counted on the large incomplete volution of the holotype (pl. 6, fig. 21), which includes less than half a turn; it is estimated that the complete volution must have possessed 60 or more costae, in contrast to the 44 counted on *T. rotatile*. The umbilical nodes on the larger costae are prominent and radially elongated. In the mold of the holotype of *T. multicoatum* a little more than half the living chamber is represented, back of which are parts of 2 or 3 badly corroded sutures. In the paratype, which probably includes about half the living chamber, part

of the last suture is more clearly preserved than are the sutures in the holotype; as thus revealed the sutures appear to be essentially like those of *T. rotatile*. Except for their greater number and the smaller size of their nodes the costae of the present species are similar to those of *T. rotatile*; the number of smaller costae between the larger costae ranges from 2 to 4.

The approximate dimensions of the holotype as preserved are: Diameter, 67 mm, dorsoventral diameter 25 mm, corresponding transverse diameter, 23 mm, maximum radius center to venter 41 mm, and maximum diameter of the umbilicus 28 mm.

Types.—Holotype, USNM 108844; paratype, USNM 108842.

Occurrence.—The holotype and paratype, the only available specimens, are from the north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, Tex. (USGS 14583).

Genus EUOMPHALOCERAS Spath, 1923

Type species: *Ammonites euomphalus* Sharpe

1923. *Euomphaloceras* Spath, Great Britain Geol. Survey Summary of Progress (1922), App. 2, p. 144.
 1951. *Euomphaloceras* Spath. Wright and Wright, Paleont. Soc., Mon., London (revision of Sharpe's Mollusca of Chalk of England), p. 29, 36. (Includes synonymy of the genus.)

Acanthoceras lonsdalei Adkins (1928, p. 244) from the base of the Eagle Ford shale in Bell County, *A. alvaradoense* Moreman (1942, p. 205) from the same stratigraphic position in Johnson and Tarrant Counties, and *A. eulesanum* Stephenson (1952 [1953], p. 201) from the Lewisville member of the Woodbine formation in Tarrant County, appear to be American representatives of the genus *Euomphaloceras* Spath. The features that distinguish this genus from *Acanthoceras* Neumayr are: a median row of small ventral nodes that fade out in later stages; typically these nodes number two or more times as many as the nodes in either of the two adjacent rows of ventrolateral nodes; however, the comparative number of the small nodes in the median row is extremely variable in different species; the nodes in the outer ventrolateral row (farthest from the midline of the venter) are much more prominent than those of the corresponding row in *Acanthoceras*, and these outer nodes increase in prominence in the later stages of growth becoming strikingly prominent in large adults; in general the system of ribs and nodes in *Acanthoceras* is more regular than in *Euomphaloceras*.

J. P. Conlin, of Burleson, Tex., has shown me a fragment of a large ammonite (specimen 4621 in his private collection), which possesses an unusual ventral feature. The large prominent nodes of this specimen seem to ally it with the genus *Euomphaloceras*, but its specific identity was not determined. The fragment

pertains to the living chamber probably just back of the aperture. The specimen is subquadrate in cross section, with dorsoventral diameter of about 105 mm and corresponding transverse diameter between the ribs of about 95 mm. The ribs on the flank are non-prominent and widely separated and bear moderately prominent, somewhat elongated nodes on the umbilical shoulder. The fragment includes two ribs on the flank, each bearing a large prominent node on the ventral angle, with a third rib, the one farthest forward partly broken away on the flank, but with the ventral portion intact. The two pairs of nodes farthest from the aperture are connected by broad, gentle swells of the otherwise smooth ventral surface. In striking contrast the two nodes farthest forward are connected by a prominent transverse ridge that rises wall-like across the venter.

Another large specimen in Conlin's private collection (5560), probably also a species of *Euomphaloceras*, from the classic Bird Creek locality in Bell County, possesses a closely similar wall-like feature on the venter between the two nodes farthest forward. Conlin also reports a poorly preserved specimen, probably *Euomphaloceras alvaradoense* (Moreman), from 4 miles south of Alvarado, which shows the same wall-like feature between the two anterior nodes. This feature, having been observed in three specimens from three widely separated basal Eagle Ford localities, is obviously not rare in large ammonites at that stratigraphic position. The location of the feature near the aperture of the shell suggests that it may be some sort of a gerontic manifestation; since, however, gerontic features usually take the form of constrictions, rather than expansions, the real biologic meaning of the wall-like ventral ridge connecting the two anterior ventral nodes remains to be determined.

Euomphaloceras lonsdalei (Adkins)

Plate 6, figures 6-20

1928. *Acanthoceras lonsdalei* Adkins, Tex. Univ. Bull. 2838, p. 244, pl. 26, fig. 5; pl. 27, fig. 3.
 1942. *Acanthoceras lonsdalei* Adkins. Moreman, Jour. Paleontology, v. 16, no. 2, p. 204.

The holotype of *Euomphaloceras lonsdalei* (Adkins) is a medium-sized specimen having a diameter of 110+ mm; the specimens from Tarrant and Johnson Counties are smaller than the holotype; one fragment from Bell County, a topotype, pertains to a specimen larger than the holotype. The largest available measurable topotype is 44+ mm in diameter and the diameter of the smallest specimen, from Tarrant County is 8.5 mm; the available specimens present a nearly complete range in size between these extremes. Assuming that all these specimens are correctly referred to Adkin's

species, a considerable individual variation in the size and distribution of the nodes and costae, and in minor details of the suture patterns, is indicated.

The holotype as now available to me is incomplete; the anterior part of the holotype as shown in Adkins original figure presumably is lost; it probably included part of the living chamber; at any rate the broken large end of the holotype in its present condition shows traces of a septum that may have been the last one immediately back of the living chamber.

Using the available part of the holotype, two topotypes, and 20 or more smaller specimens from sandy limestone at the base of the Eagle Ford shale in Tarrant and Johnson Counties, a more detailed description of the species may be given than was possible with the original material. The shell is medium sized, exceeding a measured diameter of 110 mm. It is plump, broad and broadly rounded on the venter, and flattish on the flanks. In the early stages of growth the advancing shell envelopes more than half of the preceding volution, but in the later stages the degree of envelopment may be one-third or less the width of the flank. The ribs are weak to medium strong except as they are made prominent by nodes on the ventral angles and flanks. The ribs present on the flanks number 14 or 15 to the volution; in adults they trend nearly directly across the flanks, but in the younger stages they bend forward at the ventral angles; 7 or 8 larger ribs extend inward in strength to the umbilical shoulder, but in larger specimens the number reaching the shoulder may increase to 12 or 13; intermediate smaller ribs, which may be weak or of ordinary strength at the ventral angles, die out on the flanks before reaching the umbilical shoulder, or about at the shoulder. On the venter in each space between the larger ribs of adults are one or two additional weak transverse ribs; these are few or wanting in the small, early stages of the shell.

The larger ribs that reach the umbilical shoulder bear prominent, radially elongated nodes at their inner ends. Each of the larger ribs bears a pair of rather widely separated nodes at each ventral angle; the inner node of each pair (nearest the midline of the venter) is the smaller and is slightly elongated parallel to the venter; the outer node is prominent, cone shaped, and the successive nodes of this row increase in prominence in the forward direction; the nodes in the median row on the venter are smaller and more numerous than those in either of the lateral ventral rows; in this median row there is one small node on each rib, whether large or small, that crosses the venter; on the smaller ribs on the venter there may or may not be a small ventrolateral node in line with the inner lateral row of nodes.

The sutures are not observable on the holotype nor on the smaller of the two topotypes. Traces only of

the sutures appear on the larger topotype. Sutures are well preserved on the small plesiotypes and on several of the selected examples. Ventral lobe deep and rather wide, with parallel digitate sides, ending below in two longitudinal prongs that enclose a squarish ventral saddle; the latter rises about one-third as high as the lobe is deep, its blunt forward end indented with one or more small notches; first lateral saddle broad, about as high as the ventral lobe is deep, and rendered bifid by a small, narrow sublobe; each sub-saddle thus formed is subdivided into three parts by small lobules; each of the small elements of the saddle formed by the sublobe and lobules is simple and rounded on its front; the first lateral lobe is rather broad, digitate, and shallower than the ventral lobe; the second lateral saddle is much smaller than the first and in the early stages of the shell is broken into three small, simple elements by lobules; the second lateral lobe is small with three digitations; two small, simple saddles separated by a small, pointed lobe intervene between the second lateral lobe and the line of involution; in the stage reached by the largest of the four plesiotypes from Tarrant County the saddles are rendered somewhat less simple by the appearance of additional small lobules or notches.

Dimensions of the part of the holotype that is available for measurement: Diameter 85 mm; maximum radius from center to venter about 53 mm; dorso-ventral diameter of volution at broken end 35 mm; corresponding transverse diameter about 45 mm; diameter of umbilicus about 28 mm. The maximum diameter of the holotype, including the part at the large end that appears on the original illustration and now presumed to be lost, is 110+ mm.

Types.—Holotype, Bureau of Economic Geology, Austin, Tex., 2410; 2 plesiotypes (=topotypes), USGS 11845, USNM 108831; 4 plesiotypes, USGS 11740, USNM 108824; 9 selected examples, USGS 11740, USNM 108823.

Occurrence.—Holotype and two topotypes, Bird Creek near Belton-Temple Highway, about 4 miles east-northeast of Belton, Bell County; north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, USGS 14583; Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740.

Euomphaloceras alvaradoense (Moreman)

Plate 7, figures 1-9

1942. *Acanthoceras alvaradoense* Moreman, Jour. Paleontology, v. 16, no. 2, p. 205, pl. 32, fig. 6; text fig. 2, O, T.

This species occurs in considerable numbers at two localities (USGS 11740, 14580) in Tarrant County and at a locality (USGS 14583) in Johnson County about 6.5 miles north of the type locality of the species. The specimens range from fragmentary to nearly complete in form, and from a minimum diameter of

about 16 mm to about 100 mm. However, one large internal mold of about the posterior half of a living chamber, found loose in the bed of Walnut Creek at one of the outcrops of the basal beds of the Eagle Ford shale in Tarrant County (USGS 14582), is interpreted to represent an adult stage of the species; the dorsoventral diameter of the volution at the large end of this fragment is 78 mm and the corresponding transverse diameter is about 80 mm.

The features that indicate the closer relationship of the species to *Euomphaloceras* Spath than to *Acanthoceras* Neumayr are the large nodes composing the outer of the two ventrolateral rows of nodes, which increase regularly to large size as growth proceeds, and occasional small intermediate ribs and nodes between the regular ribs on the venter. Of the two species of *Euomphaloceras* in the basal beds of the Eagle Ford shale this species is least like the genotype, *E. euomphalum*, in that there is only a meager development of small medial ventral nodes.

Form plump, cross section subquadrate, flanks and venter gently convex; ribs nearly direct, 16 or more to the volution in early stages, 12 or 13 in later stages, ranging from weakly developed to medium strong on different individuals. In the early stages a pair of ventrolateral nodes is present on each ventral angle of each main rib, the inner one (nearest the midline of the venter) slightly elongated and equal to or larger than the outer one, which is cone shaped or slightly elongated; the nodes of each pair are joined by a slightly higher swelling of the rib on which it stands, and the outer node leans away from the venter at an angle of about 45 degrees; as growth proceeds the inner nodes on the inner row gradually become weaker and eventually coalesce with those in the outer row to form large cone-shaped nodes that continue to increase in strength to the largest observed stage of growth. The complete coalescence is accomplished on different individuals at shell diameters ranging from 65 to 90 mm. A median row of ventral nodes is present in early stages; these nodes are cone shaped or slightly elongated, weak, and die out on different individuals at different stages of growth, usually at a shell diameter of 65 mm or less, but may be represented by weak swellings at diameters as great as 125 mm; most of the nodes in the median row lie in alinement with nodes in the ventrolateral rows on the main ribs, but additional weaker nodes may be present on weak intermediate ventral ribs. Nearly all the main ribs bear radially elongated nodes on the umbilical shoulders.

The suture pattern is not observable on some of the specimens but may be clearly seen on others, especially on some of the smaller ones. The suture is of the acanthoceratid pattern. There is a deep, quadrangular,

digitate ventral lobe; a short quadrangular ventral saddle enclosed between two straight terminal prongs of the ventral lobe, the forward end divided by one, two, or three shallow notches; first lateral saddle broad, divided into two subsaddles by a small digitate sublobe, the subsaddles further divided by lobules into three small denticulate elements rounded on the front; first lateral lobe relatively small, digitate; second lateral saddle relatively small with three or four rounded small denticulate elements; another very small lobe or lobule is followed by two or three small saddles separated by small lobes, to the line of involution.

Dimensions of holotype: Diameter 125 mm; maximum radius center to venter about 76 mm; dorsoventral diameter 45 mm; transverse diameter measured on ribs 52 mm; between ribs 45 mm; diameter of umbilicus 37 mm. A medium-sized incomplete individual, with about half the living chamber represented, measures: Diameter 89 mm; maximum radius center to venter about 52 mm; dorsoventral diameter at large broken end 34 mm; corresponding transverse diameter of volution measured on ribs about 40 mm; maximum diameter of umbilicus about 28 mm. The large fragment of an internal mold representing about half of the living chamber, previously mentioned, probably indicates that adults of the species attained a diameter of 270 mm or more.

Types.—The holotype, from Johnson County, 4 miles south of Alvarado, the only specimen available at the time of the original description, is in the Moreman collection at the Bureau of Economic Geology, University of Texas, Austin, Tex. (BEG 19801). Two plesiotypes, USGS 11740, USNM 108822; 1 plesiotype, USGS 14582, USNM 108828; 1 plesiotype, USGS 14583, USNM 108825; 12 selected examples, unfigured, USGS 14583, USNM 108826; 4 selected examples, unfigured, USGS 14580, USNM 108827; 6 selected examples unfigured, USGS 11740, USNM 108829.

Occurrence.—Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740, 14580, and 14582; north-facing slope of Mountain Creek Valley, 2.5 miles north-northeast of Alvarado, Johnson County, USGS 14583; 4 miles south of Alvarado (holotype).

Genus **BORISSIAKOCERAS** Arkhanguelsky, 1916

1916. *Borissiakoceras* Arkhanguelsky, Com. geol. Petrograd Mém., (N. S.), v. 152, p. 55, pl. 8, figs. 2, 3.
 1935. *Borissiakoceras* Arkhanguelsky. Morrow, Jour. Paleontology, v. 9, No. 6, p. 463–465. (Genus discussed in connection with the description of the species, *B. reesidei* Morrow.)

In its general form, its rounded venter, the presence of a row of short, oblique nodes on the ventral angle, the essential similarity of its sutures, and the presence of lateral and ventral crests, the species *Borissiakoceras orbiculatum* Stephenson agrees closely enough with the genotype, *B. mirabile* Arkhanguelsky, to indicate a congeneric relationship. In Grayson County, Tex., the

genus has been recognized stratigraphically as high as the *Metoicoceras whitei* zone of the Eagle Ford shale (USGS 14555). One fragment of an ammonite from the Lewisville member of the Woodbine formation, identified as *Euhoplites?* sp. (Stephenson 1952 [1953], p. 198, pl. 45, figs. 5, 6) should have been referred to *Borissiakoceras*.

Morrow (1935, p. 463–465) referred two species from the Upper Cretaceous of the western interior to *Borissiakoceras*, one, *B. reesidei*, from the upper part of the Graneros shale, south of Wilson, Elsworth County, Kans., and the other, *B. aplatum*, from the upper part of the Blue Hill shale member of the Carlile shale, south of Tipton, Mitchell County, Kans. As figured, both of these species are less compressed and more rounded on the venter than *B. orbiculatum*, and they both lack ventrolateral nodes. Specimens from the western rim of the Black Hills in Wyoming (USGS 12649), obtained from a dark limestone concretion in beds correlated by Cobban and Reeside (1952 cor. chart) with the lower part of the Greenhorn limestone, (pl. 6, fig. 5), are very similar in form and suture pattern to *B. orbiculatum*, but most of the individuals have a less conspicuous development of the ventral nodes; however, weak nodes are present and on some the nodes are stronger than on others. This difference, though slight, appears to be fairly consistent in a dozen or more individuals and with the limited available material it seems advisable to regard the Black Hills specimens as belonging to a separate undescribed species. There is also an undescribed species of *Borissiakoceras* from a Cretaceous locality 1 mile northeast of Wilcox, Wyo.; it has a thin disklike form, an excavated venter, a narrower umbilicus, and a more elaborate suture pattern, than has *B. orbiculatum*.

***Borissiakoceras orbiculatum* Stephenson, n. sp.**

Plate 6, figures 1–4

This species is represented in the basal beds of the Eagle Ford shale by three specimens from Walnut Creek, Tarrant County, Tex. (USGS 11740). Shell small, strongly compressed, rounded on the venter, each volution enveloping about three-fifths of the preceding one. Flanks flat, diverging slightly outward; ribs represented by obscure, widely spaced, gently sigmoidal undulations, each with a short node, oblique forward, at each ventral angle. No other nodes present. Venter nearly semicircular in cross section at early stages, obtusely subangular at each edge in later stages. On a juvenile stage of one of the three specimens evidence of a small, threadlike ventral keel was noted on the exterior of the shell, but this keel was accidentally destroyed in preparation; it was not reflected on the underlying internal mold. Two specimens of the closely

related, undescribed species from the western rim of Black Hills, Wyo., previously mentioned, each bears an imprint of a small, threadlike, evenly beaded ventral keel at an early stage of growth; among the 16 specimens from this locality these 2 are the only ones that reveal the presence of a keel. Growth lines gently sigmoidal on each flank indicate a weak lateral crest; the growth lines also indicate a rather pronounced ventral crest. Umbilicus small, about one-fourth the diameter, with steep, rounded sides.

The sutures are not clearly revealed on the holotype, which is chosen for its size and perfection of form, but are uncovered on one small paratype. The ventral lobe is broad, simple, and of moderate depth; the ventral saddle is simple, broadly rounded, and about one-third as high as the lobe is deep. The lateral suture pattern is simple; the first lateral saddle is rendered bifid by a shallow notch; the first lateral lobe is much smaller than the ventral lobe and may be simple or weakly bifid; the second lateral saddle is about as broad as the first and is similarly bifid; the second lateral lobe is about as deep as the first, but is narrower and is simple; between this lobe and the line of involution are two smaller simple saddles separated by a shallow simple lobe. One specimen of the closely related species from the locality on the western rim of the Black Hills, shows the sutures at a later stage of growth perfectly preserved (pl. 6, fig. 5); they are like the suture in *B. orbiculatum* except that two or three additional small notches appear in the lateral saddles.

Dimensions of the holotype, an individual that probably includes most of the living chamber: Diameter 22.5 mm, maximum radius center to venter 14 mm, dorsoventral diameter of volution near the aperture about 9 mm, corresponding transverse diameter about 4.5 mm, width of volution from line of involution to venter near aperture 11 mm, maximum diameter of umbilicus about 5 mm.

Types.—Holotype, USNM 108832; 2 figured paratypes, USNM 108833. *Borissiakoceras* sp., from western rim of Black Hills, Wyoming, figured for comparison of sutures, USGS 12649, USNM 108834.

Occurrence.—Found only at the type locality on Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County (USGS 11740). Adkins (1933, p. 433) lists the genus *Borissiakoceras*, n. sp., from Walnut Creek, but does not state the exact locality.

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PLATES 4-7

PLATE 4

[Figures natural size except as indicated]

FIGURES 1-3. *Inoceramus arvanus* Stephenson (p. 55).

1. Internal mold from concretion in field 2.5 miles north-northeast of Alvarado, Johnson County. USGS 14583, USNM 108840.
2. Internal mold from Walnut Creek, about 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108849.
3. Internal mold from Bird Creek, 4 miles east-northeast of Belton, Bell County. USGS 11845, USNM 108864.

4-5. *Pseudomelania? basicostata* Stephenson, n. sp. (p. 57).

- Views of the holotype, $\times 3$, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108847.

6-11. *Lispodesthes lirata* Stephenson, n. sp. (p. 57).

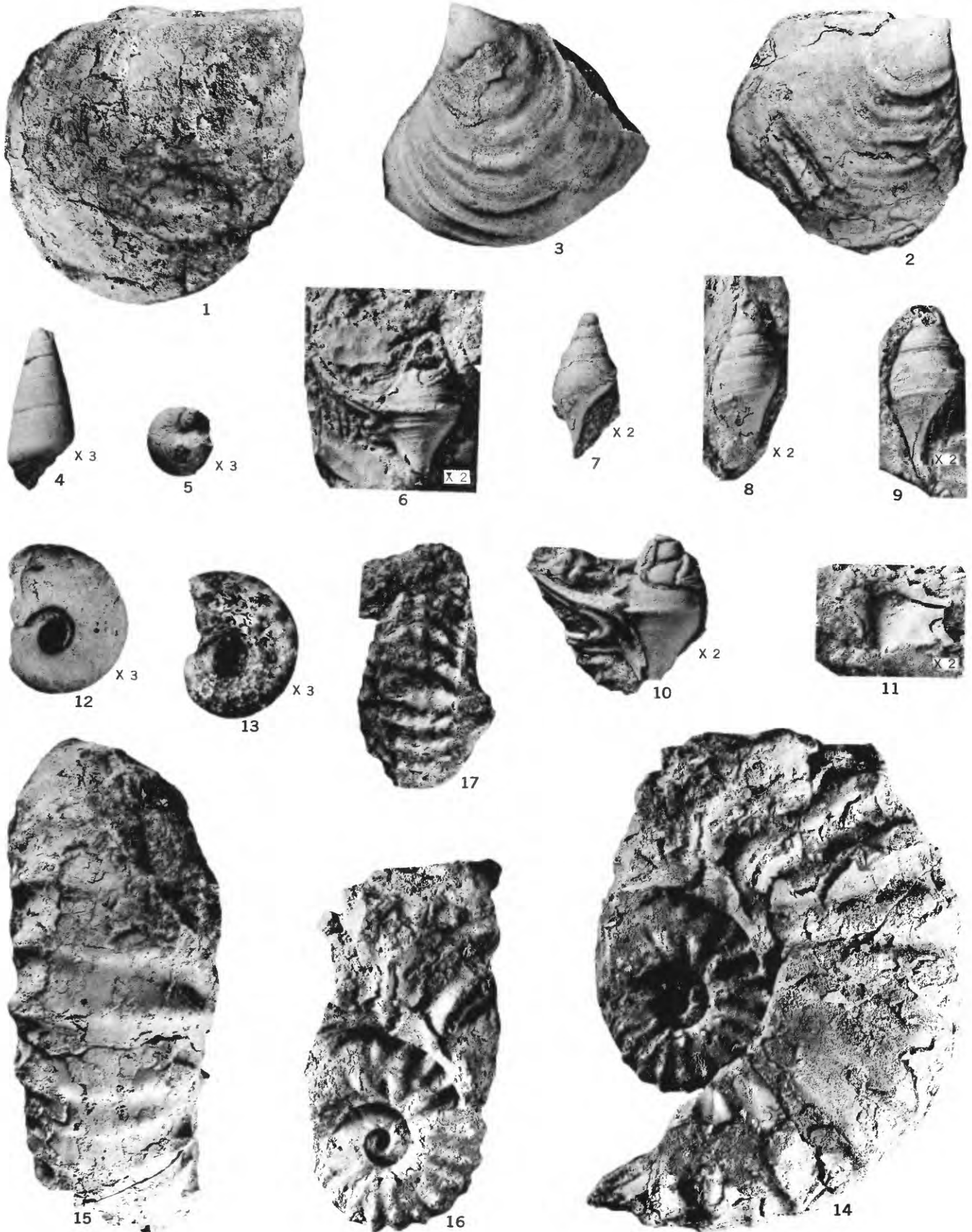
6. Holotype, $\times 2$, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108856.
- 7-9. Views of 3 paratypes (each $\times 2$) from the same source. USNM 108862.
10. A paratype, $\times 2$, from a locality on Walnut Creek near the preceding locality. USGS 14580, USNM 108857.
11. Inner view of a paratype, $\times 2$, from the same source, showing groove under upper prong of expanded lip. USNM 108857.

12-13. *Desmoceras?* sp. (p. 58).

12. Internal mold, $\times 3$, coated for photographing, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108830.
13. The same specimen, uncoated, to show sutures.

14-17. *Acanthoceras johnsonianum* Stephenson, n. sp. (p. 58).

- 14, 15. Views of holotype, from concretions in a field, 2.5 miles north-northeast of Alvarado, Johnson County. USGS 14583, USNM 108846.
16. View of partly uncovered inner volution of holotype.
17. Back view of inner volution of holotype.



INOCERAMUS, PSEUDOMELANIA?, *LISPODESTHES*, *TARRANTOCERAS*, *DESMOCERAS*, AND *ACANTHOCERAS*

PLATE 5

[Figures natural size except as indicated]

FIGURES 1-10. *Tarrantoceras rotatile* Stephenson, n. sp. (p. 59).

1-3. Views of the holotype, coated, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108835.

4. Side view of holotype, uncoated, to show sutures.

5. View of part of venter of holotype, uncoated, to show sutures.

6, 7. Views of an incomplete paratype, from the same source, USNM 108854.

8-10. Views of a small paratype, from the same source, USNM 108854.

11-21. *Tarrantoceras stantoni* Stephenson, n. sp. (p. 60).

11-13. Three views of the holotype, from gully in field 1 mile north of Lillian, Johnson County. USGS 24510, UNSM 108866.

14, 15. Views of a small paratype, $\times 3$, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108861.

16, 17. Views of a small paratype from the same source. USNM 108861.

18. A small paratype, $\times 3$, coated, from the same source, USNM 108861.

19, 20. Views of the same paratype, $\times 3$, uncoated to show sutures.

21. An incomplete specimen, from concretions in a field, 2.5 miles north-northeast of Alvarado, Johnson County, to show gerontic features near aperture. USGS 14583, USNM 108845.

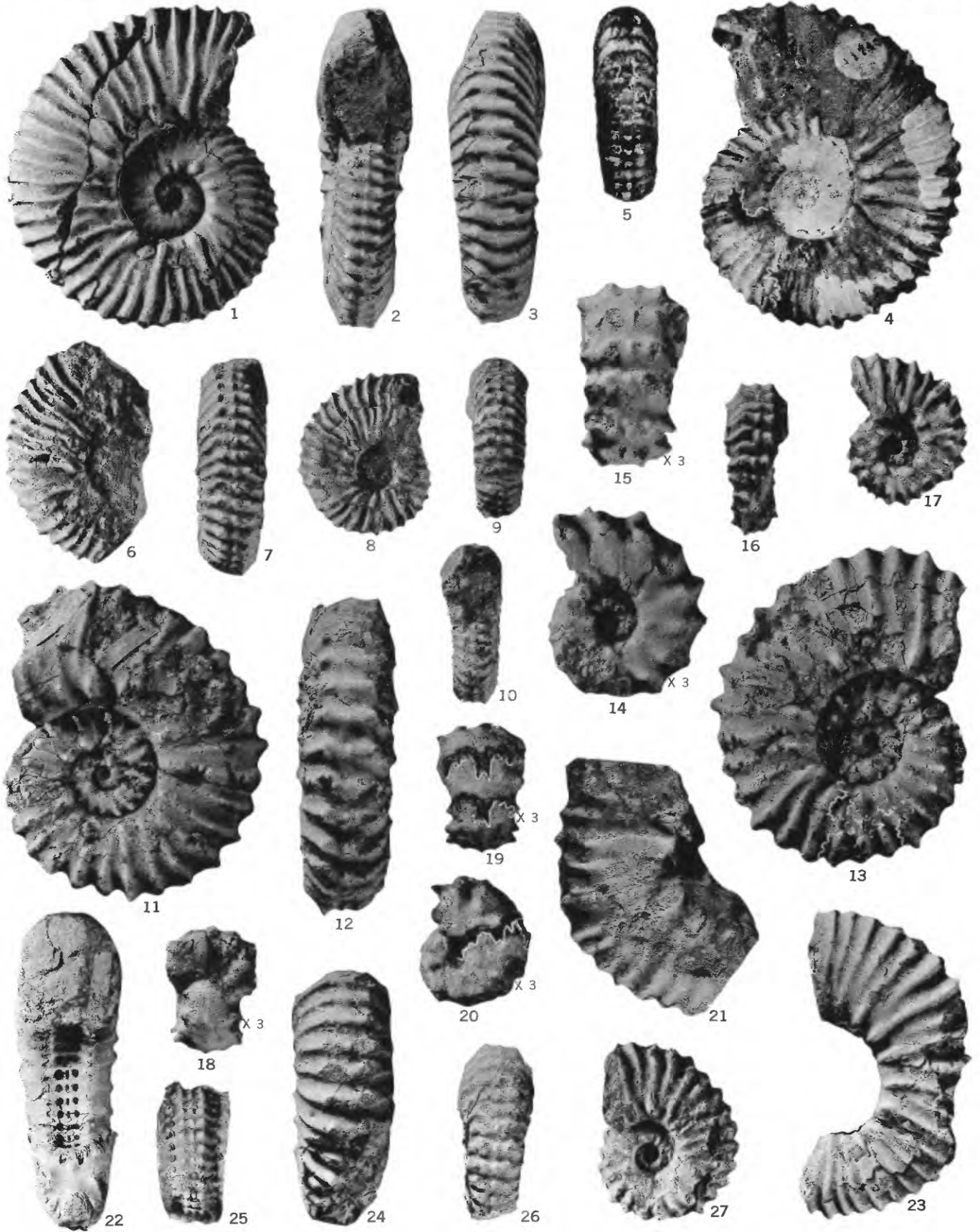
22-27. *Tarrantoceras lillianense* Stephenson, n. sp. (p. 60).

22, 23. Views of the holotype, from gully in field 1 mile north of Lillian, Johnson County. USGS 24510, USNM 108841.

24. Back ventral view of the holotype.

25. View of rubber cast made from imprint on inner curve of holotype.

26, 27. Views of a paratype, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108848.

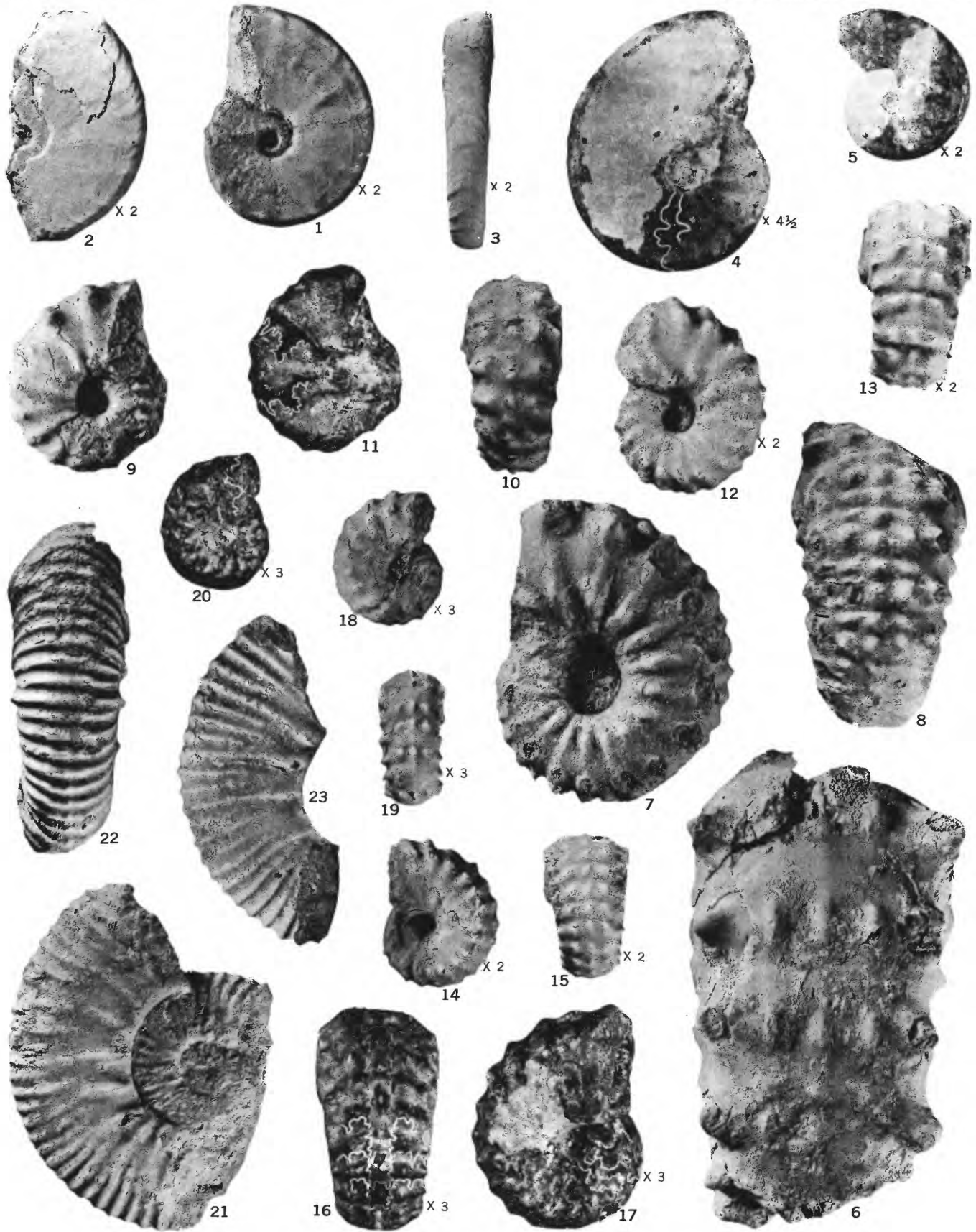


TARRANTOCERAS

PLATE 6

[Figures natural size except as indicated]

- FIGURES 1-4. *Borissiakoceras orbiculatum* Stephenson, n. sp. (p. 64).
1. Holotype, $\times 2$, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740, USNM 108832.
 - 2, 3. Side and back ventral views of a paratype, $\times 2$, from the same source, USNM 108833.
 4. Side view of a paratype, $\times 4\frac{1}{2}$, showing sutures, from the same source, USNM 108833.
5. *Borissiakoceras* sp. (p. 64).
View, $\times 2$, of specimen from western rim of Black Hills, Wyo., USGS 12649, USNM 108834. Inserted for comparison with *B. orbiculatum*.
- 6-20. *Euomphaloceras lonsdalei* (Adkins), (p. 62).
Six specimens shown in the order of size from largest to smallest.
6. Ventral view of fragment from septate portion of a large topotype, from Bird Creek, 4 miles east-northeast of Belton, Bell County. USGS 11845, USNM 108831.
 - 7, 8. Views of another smaller topotype, USNM 108831.
 - 9-11. Views of a plesiotype from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County, USGS 11740, USNM 108824.
 - 12, 13. Views, $\times 2$, of a small plesiotype, from the same source, USNM 108824.
 - 14-17. Views of a small plesiotype, from the same source; 14, 15 side and back ventral views, $\times 2$, coated; 16, 17 back ventral and side views, $\times 3$, uncoated, to show sutures. USNM 108824.
 - 18-20. Views, $\times 3$, of the smallest plesiotype from the same source; figures 18, 19 coated; figure 20 uncoated, to show sutures. USNM 108824.
- 21-23. *Tarrantoceras multicoelatum* Stephenson, n. sp. (p. 61).
21. Holotype from concretion in field, 2.5 miles north-northeast of Mansfield, Tarrant County. USGS 14583, USNM 108844.
 - 22, 23. Views of a paratype, from the same source, USNM 108842.



BORISSIAKOCERAS, EUOMPHALOCERAS, AND TARRANTOCERAS

PLATE 7

[Figures natural size]

FIGURES 1-9. *Euomphaloceras alvaradoense* (Moreman) (p. 63).

1. Ventral view representing part of living chamber of a large plesiotype, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 14582, USNM 108828.
- 2, 9. Views of a plesiotype, from concretion in a field, 2.5 miles north-northeast of Alvarado, Johnson County. USGS 14583, USNM 108825.
- 3-5. Side and ventral views (figs. 3, 4), coated, plesiotype, from Walnut Creek, 4.75 miles east-northeast of Mansfield, Tarrant County. USGS 11740, USNM 108822; partial view of opposite flank of same specimen (fig. 5), uncoated, to show sutures.
- 6-8. Side and ventral views (figs. 6, 7), coated, of a plesiotype from the same source, USNM 108822; back ventral view of same specimen (fig. 8), uncoated, to show sutures.



EUOMPHALOCERAS