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## NEW UPPER CRETACEOUS OSTREIDAE FROM THE GULF REGION

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### ABSTRACT

Four species of Ostreidae from the Upper Cretaceous of the Gulf region are described and figured. Three of the species, *Gryphaea wratheri*, *Ostrea johnsoni*, and *Ostrea travisana*, are new. *Ostrea elegantula* White, originally described from New Mexico, is here first recorded from the Gulf region. All four of the species are narrowly confined in their vertical range and have more or less extended geographic ranges; they are therefore useful as index fossils. The zones that the species characterize lie either in the upper part of the Austin chalk or in beds of upper Austin age (Santonian).

The family Ostreidae is represented in the Upper Cretaceous formations of the Atlantic and Gulf Coastal Plain by the four genera *Ostrea*, *Gryphaea* (in the broad sense), *Gryphaeostrea*, and *Exogyra* and by many species, some of which have not yet been described. Three new species, one of *Gryphaea* and two of *Ostrea*, are placed on record in this paper; they are *Gryphaea wratheri*, *Ostrea travisana*, and *O. johnsoni*. A fourth species, *Ostrea elegantula* White, not previously identified from the Gulf region, is redescribed, and shells from Alabama, more nearly perfect than the type material, are figured; one specimen from New Mexico is figured. These species all occur within a relatively narrow stratigraphic range, which is believed to correspond approximately to the Santonian division of the Senonian of Europe.

In Texas *Gryphaea wratheri* occupies the lowest stratigraphic position of the four species under consideration. It occurs in a zone well above the middle of the typical Austin chalk in Travis County and has been collected in this zone at more or less widely separated localities from Dallas County to Guadalupe County, a distance of 250 miles; the zone has an observed maximum thickness of at least 35 feet. In the Austin chalk, immediately below this zone, is another zone characterized by an abundance of the imprints and shells of *Inoceramus undulato-plicatus* Roemer, and in places this species has been observed to range upward into the *Gryphaea wratheri* zone; the lower zone is also relatively thin (thickness  $50 \pm$  feet) and an even greater known geographic extent than the upper zone, having been recognized at numerous localities from the vicinity of Whitewright, Grayson County, Tex., to Cow Creek, in southern Kinney

County, Tex., a distance of 450 miles. The well-known species *Gryphaea aucella* Roemer occurs in great numbers within a few feet above the *G. wratheri* zone, but Roemer's species has a greater vertical range than *G. wratheri*, having been found in considerable numbers at higher levels to a horizon within 20 or 25 feet of the top of the Austin chalk in the Travis County section; a few shells that appear to be indistinguishable from *G. aucella* have been found in the lower part of the Austin chalk, particularly in Grayson County. Two localities in a sandy facies of the Bonham marl in northeastern Texas have yielded specimens of *Gryphaea wratheri*.

In Alabama shells that seem to be indistinguishable from *Gryphaea wratheri* are present in considerable numbers in the upper part of the Tombigbee sand member of the Eutaw formation, where they are associated in places with *Ostrea johnsoni* and elsewhere with *O. cretacea* Morton. Apparently, however, the Alabama occurrences are not exactly synchronous with the *Gryphaea wratheri* zone in Texas, for other considerations seem to indicate that the Tombigbee sand corresponds in age to a somewhat higher zone in the upper part of the Austin; however, the exact age relation of the *G. wratheri* zone in Texas to the Tombigbee sand has not yet been certainly determined.

The shells of *Ostrea johnsoni* are present in great numbers in the upper 15 feet or less of the Tombigbee sand member of the Eutaw formation between Selma, Dallas County, and Montgomery, Montgomery County, Ala., where they are associated in places with *Gryphaea wratheri*. The species has not been found outside of Alabama. Another much smaller species of oyster, *O. cretacea* Morton, occurs in great numbers farther west, in Perry, Hale, and Greene Counties, in the upper 15 or 20 feet of the Tombigbee sand, and also farther east, in Macon and Russell Counties, in glauconitic sand of the upper Tombigbee, but for some unexplained reason the two species, *O. cretacea* and *O. johnsoni*, have not been seen together at any locality.

*Ostrea travisana* occurs typically in Travis County, Tex., in the upper part of the Austin chalk within 10 or 15 feet of the base of the overlying Taylor marl. Outside of Travis County it has been found near the

top of the Austin at several localities between Bell County and Maverick County, and it occurs in Lamar County, in northeastern Texas, in a phosphatic bed at the base of the Brownstown marl immediately above the Blossom sand; it is worthy of especial note that this phosphatic bed lies some 200 feet or more below the Gober tongue of the Austin chalk, which, though continuous with the main body of the Austin, rises higher in the section than the uppermost part of the typical Austin section in Travis County.

The species *Ostrea elegantula* White was originally described from the breaks of the "Red or Canadian River" in northeastern New Mexico. The species is present in 10 collections in the National Museum from localities of either uppermost Colorado or lowermost Montana age in northeastern New Mexico (pp. 7-8), 6 of which were obtained by W. T. Lee and 4 by N. H. Darton; three of them (colls. 6778, 7172, 7194) are recorded by Lee.<sup>1</sup> The species has also been collected by T. W. Stanton<sup>2</sup> near San Carlos, Presidio County, Tex., from beds believed to be of about the same age as those which yielded the species in New Mexico; at this locality the oyster was associated with *Mortoniceras* cf. *M. delawarensis* (Morton).

Five localities in the upper part of the Blossom sand in Red River County, Tex., distributed along a distance of 19 miles, have yielded *Ostrea elegantula*. The containing bed lies within 10 or 15 feet below the base of the overlying Brownstown marl.

In Alabama the species has been found in an excellent state of preservation in marine glauconitic sand at two localities near Hatcherubbee, in Russell County. This sand, though similar lithologically to the Tombigbee sand member of the Eutaw formation, is estimated to be at least 100 feet stratigraphically higher and is a sandy facies representing the eastward extension of the basal part of the Selma chalk; in the vicinity of Hatcherubbee the sand is closely and conformably overlain by calcareous sandy clay of Selma age.

In the absence of other evidence to the contrary the occurrences of *Ostrea elegantula* recorded in this paper may be interpreted as indicating the approximate age equivalence of the containing beds in Alabama, northeastern Texas, western Texas, and New Mexico.

Each of the four species of Ostreidae treated in this paper is rather narrowly restricted in stratigraphic range and of more or less extended geographic range and is therefore of value as a zonal or index fossil. *Ostrea elegantula*, which has the greatest known geographic range of the four, appears to have come suddenly into the Gulf and New Mexican regions from some as yet undetermined previous habitat and to have survived for only a short time; however,

<sup>1</sup> Lee, W. T., U. S. Geol. Survey Prof. Paper 101, pp. 177, 193, 202, 1917 [1918].

<sup>2</sup> Stanton, T. W., U. S. Geol. Survey Bull. 164, pp. 80, 81, 1900.

its relationship to *Ostrea anomioides* Meek suggests that it may have had its evolutionary development in the early Upper Cretaceous seas of the Western Interior. *Ostrea travisana*, which appeared in the western Gulf region as a fully developed, conspicuously sculptured form and held its place there for only a brief period, may have had its origin in a European Upper Cretaceous sea where several analogous species lived at about the same time. *Ostrea johnsoni*, whose geographic range is the least of the four, came into the eastern Gulf region from an unknown source and, like the others, was able to hold its own for a short time only; however, this species is related to two larger species, *O. subspatulata* Forbes and *O. owenana* Shumard, which are found in later Upper Cretaceous formations.

*Gryphaea wratheri* may have had its evolutionary development within the Gulf region, for it is closely related to and may be a variant of *G. aucella* Roemer. *G. aucella* ranges throughout the full thickness of the Austin chalk but is most numerous in the upper part of the chalk above the *G. wratheri* zone.

Of the collections enumerated 40 were made by the writer, either alone or in company with others. Other persons who participated in making the collections, either alone or with others, include T. W. Stanton, C. A. White, R. T. Hill, T. W. Vaughan, N. H. Darton, W. T. Lee, C. W. Cooke, L. C. Johnson, A. C. McLaughlin, D. H. Walker, Jack Turrentine, J. K. Prather, W. P. Popenoe, and A. C. Munyan.

The oysters were photographed in part by Harry S. Ladd, at the United States National Museum, and in part by N. W. Shupe, of the United States Geological Survey. The prints were retouched by Frances Wieser, of the Geological Survey.

#### *Gryphaea wratheri* Stephenson, n. sp.

Plate 1, figures 1-4

Shell small for the genus, subcircular to broadly subovate in outline, inequilateral, strongly inequivalve. Left valve moderately and broadly convex, steepest on the anterior slope, most gently inclined toward the rear; the left valve of the holotype exhibits a shallow radial depression extending from just back of the beak obliquely downward and backward to the posteroventral margin; this feature is exceedingly variable in strength on different individuals and is entirely wanting on many of them. Beak of left valve weakly to moderately prominent, strongly incurved, direct, situated well in advance of the midlength; scar of attachment generally small but ranging on different individuals up to an observed maximum of 37 millimeters (rare), the larger scars markedly modifying the form of the shell.

Right valve flattish to broadly concave; beak small, flattish, and inconspicuous.

Area small, triangular, much longer than high; resilifer relatively large, more strongly impressed on the left than on the right valve. Adductor scar of medium size, subcircular to subovate in outline, moderately impressed, situated about midway of the height, a little back of the midlength. The band of junction of the two valves on the inner surface ranges in width on average-sized shells from a minimum of 2 millimeters adjacent to the upper anterior margin, to a maximum of about 13 millimeters within the rear margin; roughened areas are present on both the anterior and posterior dorsal ends of this band on each valve. A small slightly impressed pedal scar is present 2 to 4 millimeters below the inner end of the resilifer.

Surface of left valve marked with fine growth lines and with widely spaced nonprominent growth lamellae, which become coarser toward the ventral margin. Surface of right valve ornamented on its lower half by coarse upturned growth lamellae, which converge and pinch out as they pass upward at both the front and the rear; the surface is further marked by a few fine, weak, widely spaced radial lines, such as characterize some other species of this genus in differing degrees of strength.

Dimensions of the holotype: Length 36.2 millimeters, height 36 millimeters, thickness measured from the bottom of the concavity of the right valve through the most convex part of the left valve 12 millimeters. An occasional shell reaches a length of 48 or 50 millimeters.

Among the Upper Cretaceous Gryphaeas, this species is most nearly related to *Gryphaea aucella* Roemer, but it differs in its larger average size, its broader and proportionately more depressed form, and its somewhat rougher surface.

In the vicinity of Austin, Travis County, Tex., the species is present in a restricted zone well above the middle of the Austin chalk as there developed. This zone has been traced northward to the vicinity of White Rock Lake, in Dallas County, a distance of 180 miles. The maximum observed vertical range of the species along this zone (*Gryphaea wratheri* zone) is in a section along U. S. Highway 77, a mile northeast of Sterrett, Ellis County; here the species ranges throughout 35 feet of interbedded hard chalk and softer marly chalk exposed in a gully 23 feet deep just west of the highway and in a cut 12 feet high on the east side of the highway. As seen in an exposure on South Cow Bayou, about 2¼ miles east of Bruceville, McLennan County, the base of this zone lies in the upper part of the zone of *Inoceramus undulato-plicatus*, a narrow zone traceable in the Austin chalk from the Rio Grande in Maverick County to White-

wright, in Grayson County, a distance of 450 miles. A few feet above the top of the *Gryphaea wratheri* zone is a layer of chalk containing the shells of *Gryphaea aucella* Roemer in great numbers; this relation has been observed along Little Walnut Creek in the vicinity of Austin, Travis County; on a branch of Deer Creek, 2 miles southeast of Eddy, in Bell County; and in the drainage basin of White Rock Creek, in the northeastern outskirts of Dallas, Dallas County. The species has been collected at two localities in a glauconitic, sandy layer in the Bonham marl (of upper Austin age) in Fannin County.

Shells of this species are abundant in the upper 15 or 20 feet of the Tombigbee sand member of the Eutaw formation in Alabama. The uppermost layer of the Tombigbee sand, as it has usually been defined, in the area between Eutaw and Montgomery, consists of 4 to 8 feet of strongly calcareous, glauconitic sand containing scattered but rather abundant phosphatic nodules and phosphatic internal molds of mollusks. This layer may mark a time of decrease in the amount of clastic material deposited in a shallow sea, or it may even indicate emergence and erosion along a part of the belt of outcrop; however, farther west, at Plymouth Bluff, on the Tombigbee River, 4 miles west of Columbus, Miss., where the Tombigbee-Selma contact is clearly exposed, phosphatic material is wanting, and there appears to be a gradual transition from sand to chalk; it seems unlikely, therefore, that the phosphatic bed in Alabama indicates more than a diastem or, at the most, an erosion interval of short duration. If a true unconformity is present at the contact the phosphatic bed should more logically be classed as the basal bed of the Selma chalk. Whatever the interpretation, *Gryphaea wratheri*, *Ostrea cretacea* Morton, and perhaps other species are found both in the phosphatic layer and in 10 or 15 feet of the undoubted Tombigbee sand below this layer. *G. wratheri* has been identified from the localities enumerated below.

Types: Holotype, U. S. N. M. 75506; 2 figured paratypes, U. S. N. M. 75507, 75507a; 36 unfigured paratypes (22 left and 14 right valves), U. S. N. M. 75508. Named in honor of William E. Wrather, of Dallas, Tex.

*Distribution in Texas.*—Upper middle part of Austin chalk (Santonian): Cut in Gaston Avenue (U. S. Highway 67), just northeast of the intersection of West Shore Drive, 0.7 mile west of the dam of White Rock Reservoir, Dallas County (14075,<sup>2a</sup> type locality); hill south of the Orphans' Home road, 0.45 mile west of White Rock Creek, at eastern edge of Dallas (14148); bottom of deep gully 23 feet below level of U. S. Highway 77, 1 mile northeast of Sterrett, Ellis County (17152); south of Red Oak Creek, southern part of Dallas quadrangle, near Sterrett (3655); "blue rock" at a depth of

<sup>2a</sup> Numbers in parentheses under the heading "Distribution" here and on the following pages are the collection numbers of the United States Geological Survey, unless otherwise indicated.

34 feet, in a dug well near Sterrett (3656); on small branch paralleling the Missouri-Kansas-Texas Railroad at southwest edge of Waco, McLennan County (7561); northward-facing slope of Castleman Creek Valley, in gully north of northeast-southwest road, 20 feet below road level, 2.6 miles south-southeast of Hewitt, McLennan County (17151); Bullhide Creek about 10 miles southwest of Waco, McLennan County (2908); Bullhide Creek 0.6 mile below a northeast-southwest road 2½ miles northeast of Lorena, McLennan County (13808); South Cow Bayou, left bank, about 0.85 mile below the crossing of a northeast-southwest road, about 2¼ miles east of Bruceville, McLennan County (17150); ditch in northeast-southwest road about 1¼ miles northeast of Bruceville, McLennan County (17121); shallow quarry east of Fiskville road 1½ miles south of Fiskville, Travis County (7592); Walnut Creek below the Dessau road crossing, Travis County (7581); Williamson Creek between the upper and lower Lockhart road crossings, Travis County (Hill collection no. 51); left bank of Cibolo Creek about 1 mile above Schertz, Guadalupe County (7653).

Sandy bed in Bonham marl (Austin age): Road to Prospect Church, in bed of branch half a mile south of the church, 3 miles north by west of Dodd City, Fannin County (9695); north of Lone Elm church and school, 3½ miles northeast of Lannius, Fannin County (9699).

*Distribution in Alabama.*—Upper part of Tombigbee sand: 2 miles southeast of Eutaw (595) and in railroad cut a quarter of a mile east of Eutaw station (596), Greene County; Choc-taw Bluff, Warrior River, Greene County (273, 6425); Erie Bluff, Warrior River (6428B); sec. 15, T. 18 N., R. 8 E., near Hamburg, Perry County (321); public road a quarter of a mile south of old Hamburg (6441); Bluegut Creek near Selma, Dallas County (141); SE¼ sec. 18, T. 17 N., R. 12 E., about 7 miles east-northeast of Selma (142); Kenan's mill, about 3 miles northwest of Selma (147, 149, 6829); Batte Smith bluff, Alabama River, 8½ miles (air line) east of Selma (302, 6830, 6831); Cunninghams Bluff, Alabama River, about 10 miles (air line) east of Selma (293); House Bluff, Alabama River, 15 miles west-southwest of Prattville, Autauga County (296, 6442B); Hall's field, sec. 24, T. 17 N., R. 13 E., Autauga County (300); field just east of cut of Louisville & Nashville Railroad 2 miles southwest of Union Station, Montgomery (6832).

*Ostrea travisana* Stephenson, n. sp.

Plate 2, figure 5; plate 3, figures 1-5

1884. *Ostrea diluviana* Linnaeus. White, U. S. Geol. Survey 4th Ann. Rept., p. 295, pl. 40, fig. 1; pl. 41, figs. 1, 2.  
 1893. *Ostrea diluviana* Linnaeus. Cragin, Texas Geol. Survey 4th Ann. Rept. (Invertebrate paleontology, Cretaceous), p. 203.  
 1898. *Ostrea (Alectryonia) diluviana* Linnaeus. Hill and Vaughan, U. S. Geol. Survey 18th Ann. Rept., pt. 2, pl. 62, fig. 1.  
 1901. *Ostrea (Alectryonia) diluviana* Linnaeus. Hill, U. S. Geol. Survey 21st Ann. Rept., pt. 7, pl. 45, fig. 2.  
 1902. *Ostrea (Alectryonia) diluviana* Linnaeus. Hill and Vaughan, U. S. Geol. Survey Geol. Atlas, Austin folio (no. 76), illus. sheet, fig. 42.  
 1924. *Ostrea* sp. aff. *O. diluviana* Linnaeus. Deussen, U. S. Geol. Survey Prof. Paper 126, pl. 10, fig. 1.  
 1928. *Alectryonia* sp. aff. *A. diluviana* Linnaeus. Adkins, Texas Univ. Bull. 2836, p. 104.

All the illustrations given in the papers cited above pertain to the same shell (U. S. N. M. 8300), which is recorded as having come from Bell County, Tex.

The species appears to belong to the subgeneric group to which Fischer von Waldheim<sup>3</sup> gave the name *Alectryonia*, but I have not been able to consult the original description. Presumably the principal distinguishing characteristic of the group is the strongly costate sculpture and the series of geometrically V-shaped projections and notches on the margin of each valve, the one series of which fits reciprocally into that of the other when the two valves are closed (see pl. 3, fig. 5).

Shell large, thick, and exceedingly variable in outline, form, and coarseness of ornamentation; in some of the senile specimens in the collections the shell has grown thick and massive. The holotype, a right valve, is shorter in the length dimension than shells of average outline but is chosen because of its completeness and its known stratigraphic position near the top of the Austin chalk. The paratype shown in plate 2, figure 5, which was found closely associated with the holotype, is a much longer and a more coarsely ornamented right valve. The large, incomplete paratype shown in plate 3, figures 3-5, which was collected by Robert T. Hill and his associates, in 1894, would have served better as a holotype, except that its stratigraphic position is not so exactly known; it was found near an igneous dike cutting the Selma chalk, and its position is believed to be approximately the same as that of the holotype.

Typical shells curve noticeably toward the rear. Both valves exhibit a more or less prominent and sharply developed umbonal ridge, which lies near or in advance of the midlength and which may or may not flatten out toward the postero-ventral margin. The two valves are rather strongly and nearly equally inflated, though the left valve may be a little plumper than the right; the anterior slope is generally much steeper than the posterior one. The scar of attachment on the left valve varies greatly in size and is very large on some shells. On most shells there is a postero-dorsal winglike extension, but this is an exceedingly variable feature on different individuals. The beak is not very prominent on either valve and is generally situated anterior to the midlength of the hinge line.

On the holotype the hinge line at the base of the area is 33 millimeters long. The area is roughly triangular, with its longest dimension on the base, and is 11 millimeters broad at right angles to the hinge line below the beak; the resilifer is triangular, relatively broad, and most deeply impressed on the left valve. Adductor scar large, deeply impressed, elongated in the direction of the height, narrowest above, with upraised margins, situated close to the posterior

<sup>3</sup>Fischer von Waldheim, Gotthelf, Museum-Demidoff (mis en ordre systématique et décrit par G. Fischer), ou Catalogue . . . des curiosités de la nature et de l'art, données à l'Université impériale de Moscou, par. P. de Demidoff, tome 3 (in 1 vol.), illustrated, 1807.

margin and very high in the shell. Pedal scar tiny, situated a few millimeters below the inner, anterior edge of the resilifer. The margins of the shell present a series of deeply indented, geometrically V-shaped notches, those of the two valves fitting reciprocally into each other (pl. 3, fig. 5).

The surface of each valve is strongly and similarly ornamented with prominent, narrow costae that are V-shaped in cross section; away from the beak costae are added by bifurcation and intercalation, mainly, though not exclusively, along the umbonal ridge; the costae tend to become irregularly noded along their crests. The ribbing varies greatly in coarseness on different individuals from the same and from different localities, the number of ribs ranging from 20 to 35. The ornamentation on the right valve of the specimen shown in plate 3, figure 3, indicates a pathologic condition, perhaps due to an injury; apparently the part of the mantle that gives rise to the shell along the line of the umbonal ridge was shoved forward, thus initiating a new stage of growth back of the ridge.

Dimensions of the holotype as oriented with the hinge line in the horizontal position: Length 84 millimeters, height 102 millimeters, convexity 31 millimeters. Dimensions of the incomplete paratype (pl. 2, fig. 5) from the locality of the holotype: Length 110 millimeters, height 105+ millimeters, convexity 26 millimeters. Dimensions of the large incomplete paratype from Onion Creek, Travis County, Tex. (pl. 3, figs. 3-5): Length 90+ millimeters, height 120+ millimeters, thickness 66 millimeters. These measurements emphasize the great variability in outline and form of the individuals of the species.

This species has been found at several widely separated localities in the upper part of the Austin chalk, from Maverick County to Bell County, Tex. The holotype and one paratype were collected on Little Walnut Creek in Travis County within 10 feet of the top of the Austin. In northeastern Texas the species was found, originally by T. W. Stanton, near Paris, Lamar County, in glauconitic sandy marl forming the base of the Brownstown marl of that area, immediately above the Blossom sand; several collections have subsequently been made at this locality. The containing bed is believed to correspond approximately in age to that which yielded the species on Little Walnut Creek, Travis County.

As indicated in the synonymy, several American authors have referred this species to *Ostrea diluviana* Linnaeus,<sup>4</sup> which was originally described from the Upper Chalk of Sweden. Linnaeus' species, as later figured by Nilsson,<sup>5</sup> though similarly ornamented, is

more slender and more strongly curved than *O. travisana*, the umbonal ridge is sharper and more slender, and the two are believed to be distinct. The figures given by Hisinger<sup>6</sup> indicate a broadly ovate shell more like *O. travisana*, but the adductor scar is proportionately larger and more broadly ovate, and is not quite so near the posterior margin.

*Alectryonia deshayesi* Fischer,<sup>7</sup> from the Santonian of the Crimean Peninsula, south Russia, appears to be a close analog of *O. travisana*. As figured by H. Coquand,<sup>8</sup> *Ostrea deshayesi* has a larger and broader adductor scar which is not quite so high on the inner surface, and a more elongated resilifer.

*Ostrea santonensis* D'Orbigny,<sup>9</sup> from the lower Senonian of France, appears also to be closely analogous to *O. travisana*.

It is worthy of note that both *O. deshayesi*, from the Santonian, and *O. santonensis*, from the lower Senonian, occupy about the same stratigraphic position in Europe as does *O. travisana* in America.

Types: Holotype, U. S. N. M. 75509; 1 figured paratype, U. S. N. M. 75510; 1 figured paratype, U. S. N. M. 75511.

*Distribution in Texas.*—Upper part of Austin chalk (upper Santonian): Bell County (U. S. N. M. 8300, figured as indicated in the synonymy); old Sprinkle road (abandoned) on westward-facing slope of Little Walnut Creek Valley near iron bridge, 2 miles southwest of Sprinkle, Travis County (14159, locality of holotype and one paratype); Cameron road, eastward-facing slope of Walnut Creek valley, three-fifths mile west of Sprinkle, Travis County (14068); near Austin, Travis County (Hill collection no. 7); Onion Creek, half a mile below the lower Lockhart road crossing near a big dike, Travis County (Hill collection no. 43, locality of one paratype); Cibolo River 1¼ miles above Galveston, Harrisburg & San Antonio Railway bridge at Schertz, Guadalupe County (7654); Tequesquite Creek a few hundred yards below the crossing of the Eagle Pass-Del Rio road, Maverick County (8229, 10856).

Basal phosphatic sandy bed of Brownstown marl: On a small creek a quarter to half a mile south of the crossing of the Texas & Pacific Railway and the Texas Midland Railroad, at the southwest border of Paris, Lamar County (7508, 13078, 17148).

#### *Ostrea johnsoni* Stephenson, n. sp.

Plate 1, figures 11, 12; plate 2, figures 1-4

Shell of medium size, thick in the umbonal region, becoming thin and frail at the ventral margin, sub-ovate in outline, elongated in the direction of the height, subequilateral, slightly inequivalve. Left valve slightly more convex than the right one. On the right valve a broad ridge or fold originates at or below

<sup>6</sup> Hisinger, W., *Lithaea svecica seu Petrificata svecicae*, p. 49, tab. 14, figs. 5a, b, 1837.

<sup>7</sup> Fischer, G. (de Waldheim), *Bull. nat. Moscou*, tome 8, pl. 2, 1834.

<sup>8</sup> Coquand, H., *Monographie du genre Ostrea, terrain crétacé*, p. 88, pl. 23, fig. 1, 1869.

<sup>9</sup> D'Orbigny, A., *Paléontologie française, Terrain crétacé, Lamelli-branches*, p. 736, pl. 484, figs. 1-3, 1846.

<sup>4</sup> Linné, Caroli a, *Systema naturae*, ed. 12, tome 1, pars 2, p. 1148, 1766.

<sup>5</sup> Nilsson, S., *Petrificata suecana, pars prior*, p. 32, pl. 6, figs. 1A-B, fig. 2, 1827.

the midheight and extends with increasing breadth to the ventral margin; opposed to this ridge on the left valve is a broad depression. Beak of left valve of medium prominence, dull-pointed, weakly incurved, roughened on the tip by a small scar of attachment, situated centrally; beak of right valve small, non-prominent, overtopped by the beak of the left valve. Dorsal margin of left valve broadly arched; that of right valve nearly straight. The anterior and posterior margins of the shell diverge somewhat from the ends of the hinge and pass below into the rather sharply rounded ventral margin, the trend of which in some adults is sinuous as a result of the broad reciprocal fluting of the two valves. In larger, typical adult shells the margins of the two valves are reciprocally and broadly sinuous all the way around below the ends of the hinge, the sinuosities including nine bends, five convex to the right and four to the left as the shell is held with the beaks upward and the front edge away from the observer; in most shells of less than three-fourths adult size the sinuosities of the margins are seen only in their incipient stages; however, an occasional half-grown shell has these curves conspicuously developed; on the other hand, the margins of many adults are straight or only weakly sinuous.

Hinge line of holotype about 25 millimeters long; area of left valve 10 millimeters high above hinge line, that of right valve 8 millimeters high. Resilifer broad, deep on the left valve, shallow on the right. Area finely striated with growth lines. Adductor scar large, elongate-ovate, the elongation directed obliquely upward toward the rear, situated posteriorly below the midheight. The pedal scar appears as a small pit on the inner surface, 2 to 5 millimeters below the inner edge of the resilifer.

In addition to the sharply developed growth lines the surface of each valve presents a series of gentle, concentric undulations, the crests of which are 5 to 10 millimeters apart in the vicinity of the midheight; these tend to smooth out toward the margins; an occasional specimen exhibits fine radial lining in the umbonal region.

Dimensions of the holotype: Length 54 millimeters; height 75 millimeters; thickness 31.5 millimeters; the largest specimen measured is 83 millimeters high.

In outline, in surface features, and in the shape and low position of the adductor scar this species resembles *Ostrea subspatulata* Forbes, which occurs in the Peedee formation of North Carolina and in the upper part of the Ripley formation in eastern Alabama and adjacent parts of Georgia; however, *O. johnsoni* averages scarcely half as large as *O. subspatulata*; lacks a strong bend to the left in the ventral portion, has a sinuous margin in the typical adult, and is more finely sculptured.

The shells of this species are abundant in the upper 15 feet or less of the Tombigbee sand member of the Eutaw formation and have been collected at 9 localities in this zone from the vicinity of Selma, Dallas County, to the vicinity of Montgomery, Montgomery County, Ala., an air-line distance of 40 miles. Fossils associated with the species include the echinoid genus *Hardwinia?* and the mollusks *Gryphaea wratheri* Stephenson, *Exogyra wpatoiensis* Stephenson, *Baculites asper* Morton, and *Placenticerus* aff. *P. guadalupeae* (Roemer).

Types: Holotype, U. S. N. M. 75512; 1 figured paratype, U. S. N. M. 75513; 2 figured paratypes, U. S. N. M. 75514, 75514a; 15 unfigured paratypes, U. S. N. M. 75515. Named in honor of the late L. C. Johnson, a pioneer student of Cretaceous and Tertiary geology in Alabama.

*Distribution in Alabama.*—Upper part of Tombigbee sand member of Eutaw sand in Alabama: Ravine half a mile west of Kenan's mill, 3 or 3½ miles northwest of Selma, Dallas County (6828); bluff on Valley Creek 100 yards above the crossing of U. S. Highway 80, northwest of Selma (16997); SE¼ sec. 18, T. 17 N., R. 12 E., about 7 miles east-northeast of Selma (142); Bluegut Creek near Selma (141); Batte Smith Bluff, Alabama River, Dallas County (302; 6830, locality of holotype, 1 figured paratype, and 15 unfigured paratypes; 17044); at and in fields near House Bluff, Alabama River, Autauga County (296, 6442B; 17011, locality of 2 figured paratypes); Woods Bluff, Alabama River (304); Cunninghams Bluff, Alabama River (293); Coatoma Creek, 0.9 mile northeast of Mount Moriah Church, in NW¼ sec. 32, T. 16 N., R. 17 E., Montgomery County (17010, lower 5 feet of section; 17009, upper 3 feet of section).

### *Ostrea elegantula* White

Plate 1, figures 5-10

1876. *Ostrea elegantula* Newberry, Geological report, in Macomb, J. N., Report of the exploring expedition from Santa Fe, N. Mex., to the junction of the Grand and Green Rivers, p. 33. (Named without description or illustration, and therefore at this stage a nomen nudum.)
1884. *Ostrea elegantula* Newberry. White, U. S. Geol. Survey 4th Ann. Rept., p. 295, pl. 36, figs. 5-7. (Authorship ascribed to Newberry, who, however, has neither a published nor a manuscript claim to authorship.)
1903. *Ostrea anomioides* var. *nanus* Johnson, School of Mines Quart., vol. 24, p. 185, pl. 1, figs. 10a-d, 1903.
1908. *Ostrea anomioides* var. *nanus* Johnson. Shimer and Blodgett, Am. Jour. Sci., 4th ser., vol. 25, p. 61, 1908.

The following description is based mainly on shells from Alabama which are well preserved, in contrast to the poor state of preservation of the types and also of most of the other material from the type region in New Mexico.

Shell small, thin, often translucent in transmitted light, broadly subovate to subquadrate in outline, squarish above, inequilateral, strongly inequivalve. Left valve of medium convexity, greatest inflation below the beak, above the midheight; anterior slope

steep above, becoming slightly less steep toward the margin; upper posterior slope more gentle, flattening and broadening toward the margin to form a slight winglike extension. Right valve nearly flat. Beak of left valve slightly prominent, incurved, direct, situated about two-fifths the length of the shell from the anterior extremity; beak of right valve small, flat, non-prominent.

Area very small, triangular, longest on its inner margin; resilifer relatively broad, shallow, most strongly impressed on left valve. Adductor scar small, ovate, situated back of the midlength at about the midheight. The pedal scar appears on each valve as a small pit high on the inner surface about 2 millimeters below the inner end of the resilifer. Both the inner antero- and postero-dorsal margins are faintly crenulated for short distances away from the ends of the hinge line.

Surface of left valve ornamented with a series of delicate, slightly upraised, elegantly crinkled concentric lamellae, spaced 1 to 2 millimeters apart; the crinkles on different lamellae are aligned radially and represent weak radial costae. Surface of right valve covered with gentle, narrow, concentric undulations on which very faint crinkling may be detected.

Dimensions of the left valve shown in plate 1, figures 5-7: Length 17.5 millimeters, height 21 millimeters, convexity 5 millimeters. This specimen is about maximum size for the Alabama shells, but some of the Texas shells are as much as 25 millimeters high, and the two cotypes, right and left valves, are respectively 31.2 and 26 millimeters high; among the New Mexico collections an occasional shell may reach as much as 40 millimeters in height.

In the well-preserved Alabama material the individual shells exhibit considerable variation in form, outline, and strength and coarseness of ornamentation. When these differences are taken into consideration it does not seem practicable to separate the Alabama and Texas shells from White's species from New Mexico.

The two cotypes are recorded as having come from a section on the "Red or Canadian River" in northeastern New Mexico. One is a left valve with the outer shell layers partly scaled off but retaining faint impressions of the characteristic fine, crinkled ornamentation like that so well preserved on the Alabama shells; the other is a right valve which, except for its larger size, is like the right valves from Alabama. The concentric growth lines on the left valve seem to indicate that the posterior wing is weakly developed on this cotype, but this wing is present in typical form on other shells from the type region in northeastern New Mexico; these specimens were identified by T. W. Stanton. Although Newberry recorded this species as associated with other species of mollusks of upper

Benton age, T. W. Stanton and J. B. Reeside<sup>10</sup> state that all the later collections came from beds that lie stratigraphically near the boundary between the Colorado and Montana groups; they believe that the original record is in error.

*Ostrea elegantula* is present in 10 collections in the National Museum from localities in northeastern New Mexico, 6 of which were obtained by W. T. Lee and 4 by N. H. Darton; 3 of them (collections 6778, 7172, 7194) are recorded by Lee.<sup>11</sup> The species has also been collected by T. W. Stanton<sup>12</sup> near San Carlos, Presidio County, Tex., from beds believed to be of about the same age as those which yielded the species in New Mexico.

*Ostrea anomioides* Meek,<sup>13</sup> which was originally described from the Missouri River below Gallatin, Mont., is obviously closely related to *O. elegantula*, but the type material in the National Museum indicates a stronger development of narrow, concentric ribs, or folds, and a very weak development of the fine crinkling of the concentric lamellae. Inasmuch as present available evidence suggests that Meek's species came from beds of lower Colorado age,<sup>14</sup> and in view of the differences in ornamentation just noted, it seems reasonable to regard *O. anomioides* as distinct from *O. elegantula*.

In Texas the species has been collected from 5 localities in the upper part of the Blossom sand in Red River County along a distance of 19 miles.

Types: Two cotypes, U. S. N. M. 18611; from the breaks of the Canadian River, in northeastern New Mexico. On the back of one of the labels accompanying the types T. W. Stanton has written: "It is questionable whether this really came from the Colorado group. Many specimens apparently referable to *Ostrea elegantula* were collected by Lee in the Hagan coal field, near Una del Gato, New Mexico." The beds that yielded the oyster in the Hagan coal field are included by Lee in the Mesaverde formation and are interpreted to be of lower Montana age. One plesiotype from the base of the Mesaverde formation in the Hagan coal field is figured, U. S. N. M. 75517. Two plesiotypes from marine sand of lower Selma age near Hatchechubbee, Russell County, Ala., are figured, U. S. N. M. 75516 and 75516a.

*Distribution in New Mexico.*—Upper part of Mancos shale (transition beds): 2 miles southwest of Madrid (7164); about a mile southwest of Waldo (7165); road from Cabezon to Raton Springs (7194); east flank of Ortiz Mountain, near Omara mine (7180).

<sup>10</sup> Oral communications.

<sup>11</sup> Lee, W. T., U. S. Geol. Survey Prof. Paper 101, pp. 177, 193, 202, 1917 [1918].

<sup>12</sup> Stanton, T. W., U. S. Geol. Survey Bull. 164, pp. 80-81, 1900.

<sup>13</sup> Meek, F. B., U. S. Geol. Survey Terr. 6th Ann. Rept., for 1872, p. 488, 1873. White, C. A., U. S. Geol. Survey Terr. 12th Ann. Rept., for 1878, p. 10, pl. 11, figs. 4a, 4b, 1883.

<sup>14</sup> Stanton, T. W., U. S. Geol. Survey Mon. 32, pt. 2, p. 633, 1899.

Basal part of Mesaverde formation: Garcia & Goebel mine, 30 feet above coal seam, northwest of Socorro (9606); same locality 40 feet above coal seam (9607); Herring mine, 50 feet above coal seam, 20 miles northeast of Socorro (9608); 40 feet above coal seam,  $1\frac{1}{4}$  miles south of Perry Cox place, 15 miles north of Carthage (9764); Hagan coal field, from sandstone below the coal (6778, 1 specimen figured); Hagan coal field, 500 feet south of mine opening (7172).

*Occurrence in Presidio County, Tex.*—Overturned beds near shaft of San Carlos coal mine,  $2\frac{1}{2}$  miles southeast of store at San Carlos (1468).

*Distribution in Red River County, Tex.*—Upper part of Blossom sand: Cut in Reed's store road just south of Pecan

Bayou, about 2 miles north of White Rock (13561, 16675); field west of road 0.4 mile south of Vandalia (13079, 17149); small earth tank east of Dimple road near foot of northward-facing slope of branch of Tanyard Bayou, 4.2 miles north by west of public square at Clarksville (17126); old Clarksville road 2.2 miles east-southeast of Detroit (17153); head of ravine east of old Clarksville road 1.4 miles southeast of Detroit (17125).

*Distribution in Alabama.*—Marine sand of lower Selma age: Cut of Central of Georgia Railway half a mile east of Hatchchubbee, Russell County (6825, locality of two figured specimens; 17005); east end of cut in State Highway 26, 5.1 miles west of Hatchchubbee (17003).

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PLATES 1-3

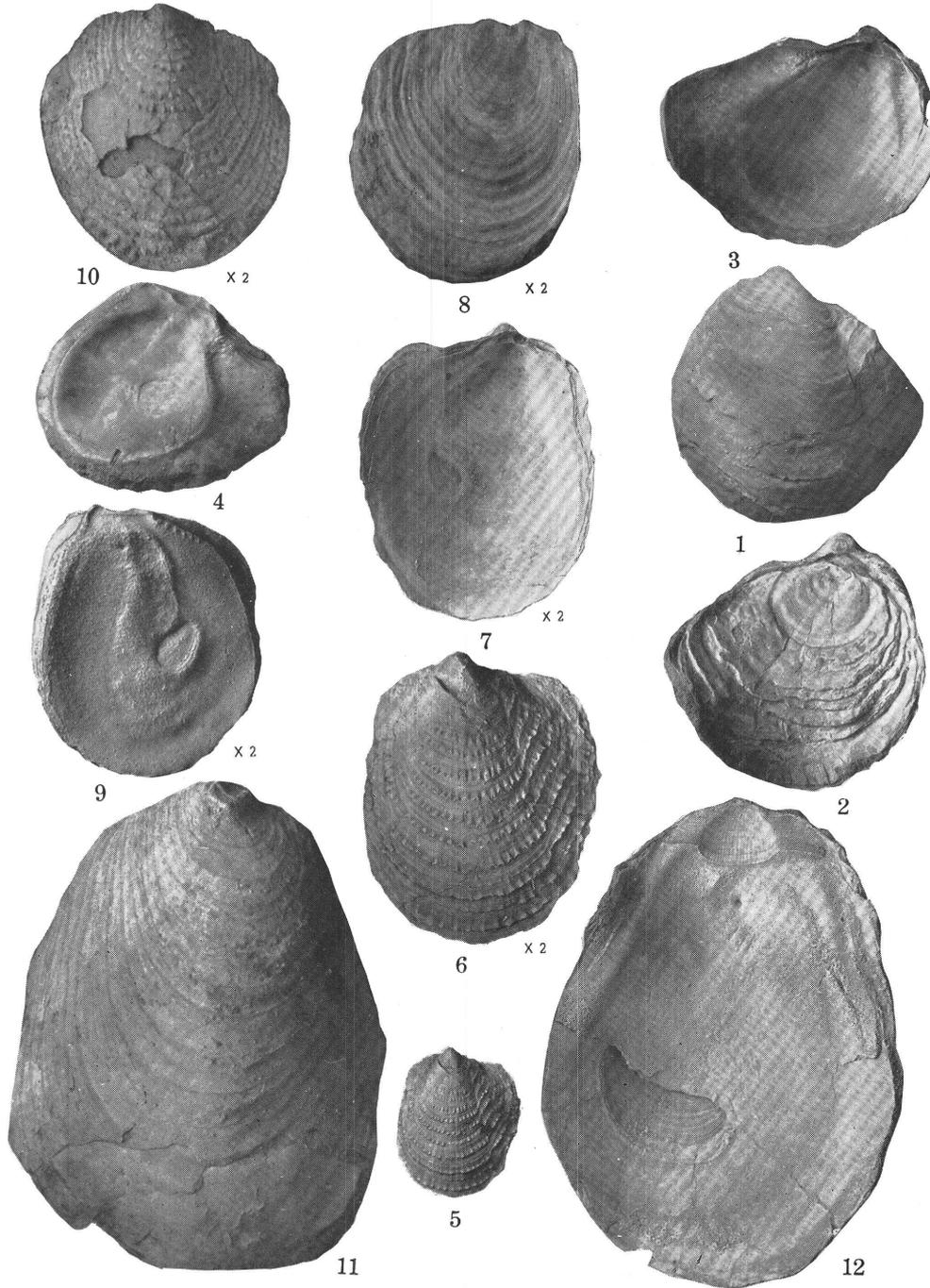
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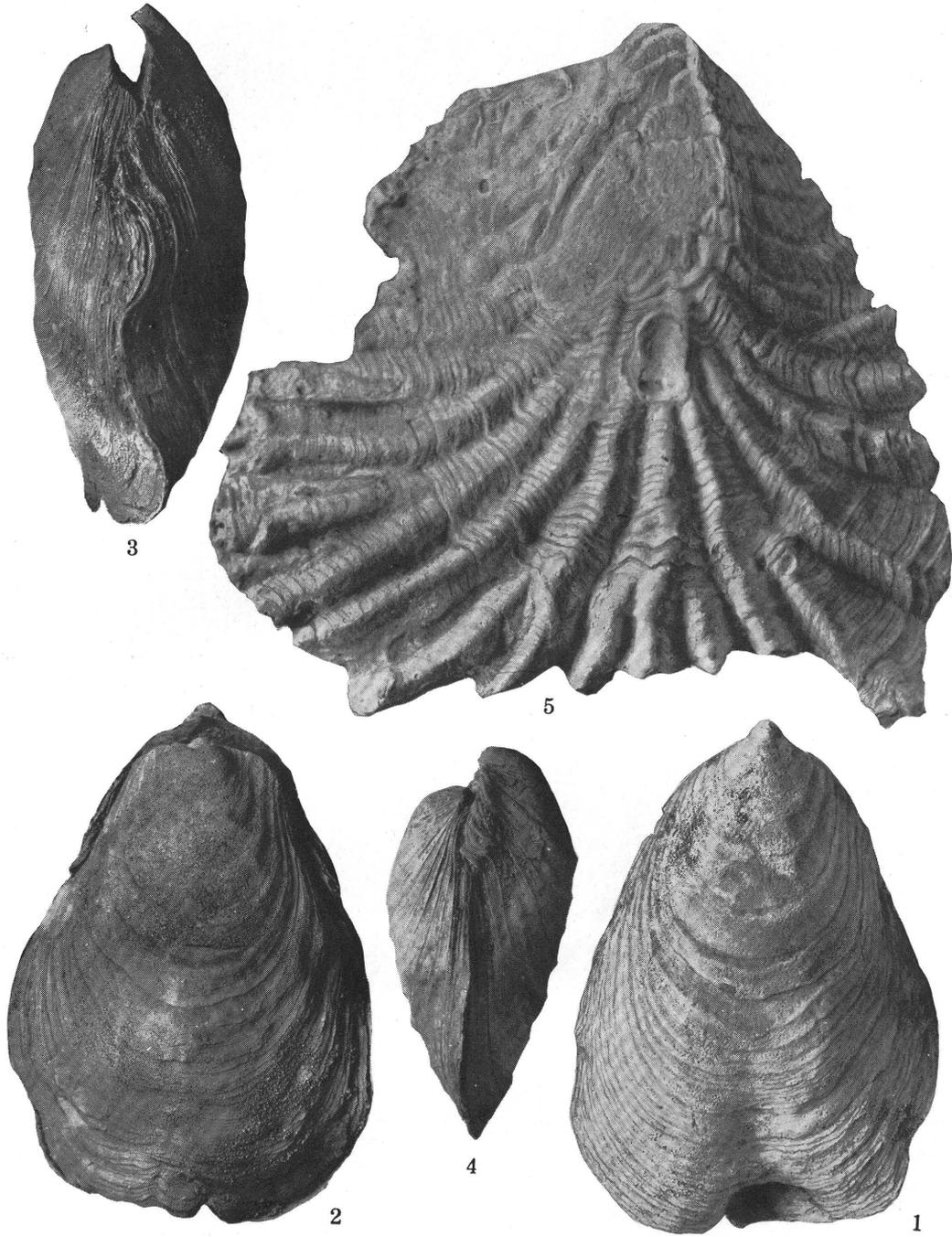
## PLATE 1

[Figured material is deposited in the United States National Museum]

- FIGURES 1-4. *Gryphaea wratheri* Stephenson, n. sp. 1, Exterior of left valve of holotype (U. S. N. M. 75506); 2, exterior of right valve of holotype; 3, interior of a paratype, a left valve (U. S. N. M. 75507); 4, interior of a paratype, a right valve (U. S. N. M. 75507a).
- 5-10. *Ostrea elegantula* White. 5, Exterior of a left valve from cut of Central of Georgia Railway half a mile east of Hatchechubbee, Ala. (U. S. N. M. 75516); 6, enlargement of the same shell; 7, interior of the same shell; 8, exterior of a right valve from the same locality (U. S. N. M. 75516a); 9, interior of the same right valve; 10, exterior of an imperfect left valve from sandstone below the coal, in Hagan coal field, N. Mex. (U. S. N. M. 75517).
- 11-12. *Ostrea johnsoni* Stephenson, n. sp. 11, Exterior of a paratype, a left valve (U. S. N. M. 75514); 12, interior of a paratype, a left valve (U. S. N. M. 75513).



NEW UPPER CRETACEOUS OSTREIDAE FROM THE GULF REGION



NEW UPPER CRETACEOUS OSTREIDAE FROM THE GULF REGION.

## PLATE 2

[Figured material is deposited in the United States National Museum]

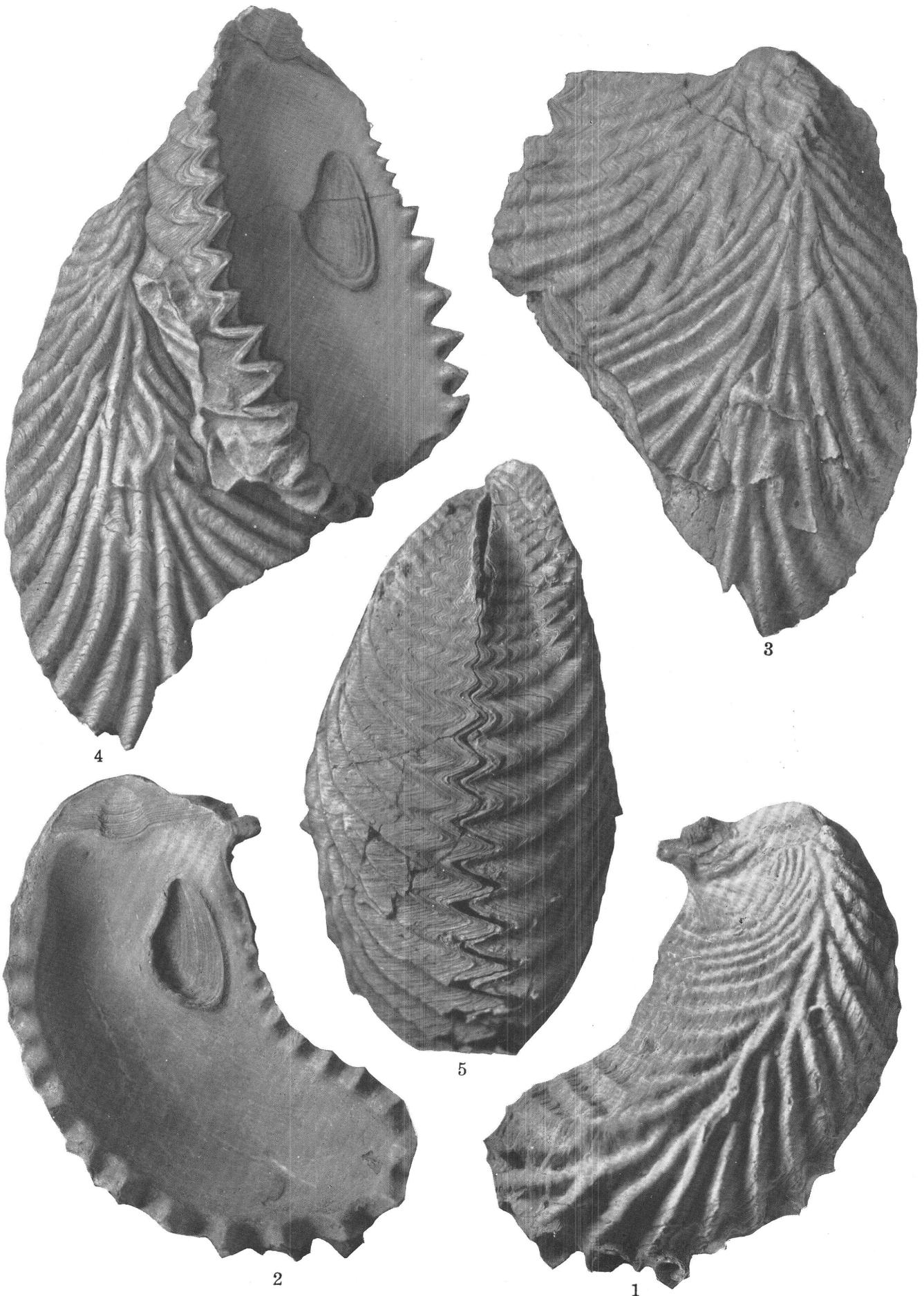
- FIGURES 1-4. *Ostrea johnsoni* Stephenson, n. sp. 1, Exterior of left valve of holotype (U. S. N. M. 75512); 2, exterior of right valve of holotype; 3, front edge view of holotype; 4, front edge view of a small paratype (U. S. N. M. 75514a).
5. *Ostrea travisana* Stephenson, n. sp. Exterior of paratype, a right valve of more than average length (U. S. N. M. 75510).

PLATE 3

[Figured material is deposited in the United States National Museum. All figures slightly reduced]

FIGURES 1-5. *Ostrea triviana* Stephenson, n. sp. 1, Exterior of holotype, a right valve (U. S. N. M. 75509); 2, interior of holotype; 3, exterior of right valve of a paratype from Onion Creek, Travis County, Tex. (U. S. N. M. 75511); 4, exterior of left valve of the same paratype and right valve of another individual to which the paratype is attached; 5, front edge view of the same paratype.





NEW UPPER CRETACEOUS OSTREIDAE FROM THE GULF REGION.