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CHARLES D. WALCOTT, DIRECTOR

THE MOLLUSCA OF THE BUDA LIMESTONE

BY

GEORGE BURBANK SHATTUCK

WITH

AN APPENDIX

ON THE

CORALS OF THE BUDA LIMESTONE

BY

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CONTENTS.

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 3, 1902.

SIR: The accompanying paper by Dr. George B. Shattuck on the Mollusca of the Buda limestone, with an appendix by Mr. T. Wayland Vaughan on the Anthozoa of the same horizon, records all that is known of the fauna of a limited formation constituting the highest member of the Comanche series in Texas. I recommend its publication as a bulletin.

Very respectfully,

T. W. STANTON,
Paleontologist.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

THE MOLLUSCA OF THE BUDA LIMESTONE.

By GEORGE BURBANK SHATTUCK.

PREFATORY NOTE.

During the winter of 1893–94 the Johns Hopkins University came into possession of a valuable collection of fossils which Mr. Robert T. Hill, of the United States Geological Survey, had assembled during many years of geologic study in Texas. Among the various faunas represented in this collection the fauna of the Buda limestone—so called because of its typical development at Buda, Tex.—presented an interesting problem to the author. Through the courtesy of Hon. C. D. Walcott, Director of the United States Geological Survey, and Mr. Hill the author was enabled to accompany the latter during a portion of the field season of 1894, in order to collect from the Buda limestone in the vicinity of Austin, Tex.

The following contribution, which is the result of a study of the Buda limestone fauna, has been prepared under the supervision of Prof. William B. Clark, to whom the author here expresses his deep obligation. He also extends his acknowledgments to Dr. T. W. Stanton, of the United States Geological Survey, for many valuable suggestions and for the use of type specimens, and to Hon. C. D. Walcott and Mr. Robert T. Hill, through whose courtesy the author was enabled to undertake this work. The late Prof. Alpheus Hyatt was consulted regarding the ammonites.

Mr. T. Wayland Vaughan, of the United States Geological Survey, has prepared the concluding section on the corals.

HISTORICAL REVIEW.

The Buda limestone, although possessing considerable thickness (40 to 80 feet) and recording important events which took place at the close of the Lower Cretaceous, is so concealed beneath younger beds that it remained for a long time unrecognized by the various geologists who worked in Texas. It was not until the year 1889 that Mr. Robert T. Hill described it and designated it by the name "Vola limestone," so called on account of a large and beautiful *Vola* which was present in considerable numbers in the formation.[a]

In a second article[b] Mr. Hill gave a section in which he assigned

[a] A portion of the geologic story of the Colorado River of Texas: Am. Geologist, May, 1889, p. 8.

[b] Annot. check list of the Cretaceous invertebrate fossils of Texas: Bull. Geol. Surv. Texas, No. 4, p. xiv.

the Vola limestone—this time referring to it as the "Shoal Creek limestone," because of its typical exposure in the limestone bluffs along Shoal Creek at Austin, Tex.—to a place at the top of the Washita division of the Comanche series; that is to say, the topmost bed of the Lower Cretaceous, and correlated it with the *Ostrea quadriplicata* beds of Denison. In April of the same year Mr. Hill expressed the opinion[a] that the Buda limestone—here speaking of it as the Vola or red chalk limestone, because of the red blotches found in it—belonged to the Washita division, a series of strata deposited by continuous sedimentation during the first profound marine subsidence, that it was underlain by the *Exogyra arietina* clays and overlain by the Denison beds, that its fossils consisted of the characteristic *Vola quinquecostata* Sow. and an undescribed fauna, and that the material was a massive lime bed with oxidizing iron, the total thickness being 50 feet.

Toward the close of the year Mr. Hill published a section[b] of the Lower Cretaceous in which he showed that it belonged to the Lower or Grand Prairie formation (Comanche series), with the Shoal Creek or Vola limestone at the top, possessing a thickness of 75 feet and underlain by the *Exogyra arietina* clays. Nothing further was published regarding the Shoal Creek limestone until 1893, when Profs. W. B. Clark[c] and F. W. Cragin[d] described certain of its fossils.

The following year Mr. Hill again published a description[e] of the Shoal Creek limestone, in which he pointed out the relations of the underlying and overlying beds in more detail, and indicated with a section the gradual thinning of the limestone from Del Rio through Austin to Waco, where it disappeared. The red-colored blotches in the limestone, he concluded, were due to oxidation of the iron in minute glauconite grains. He also announced the discovery of foraminiferal remains and gave a list of fossils.

In 1897 Dr. T. W. Stanton published a comparative study of the Lower Cretaceous formations,[f] in which he discussed at length the features of the Comanche series and pointed out its relations to the other Lower Cretaceous formations. He also mentioned the Shoal Creek limestone and gave a summary of Hill's classification indicating its relative position.

The next publication referring to the Shoal Creek limestone appeared in 1898 as a bulletin of the United States Geological Survey, under

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[a] Events in North American Cretaceous history, etc.: Am. Jour. Sci., April, 1889, 3d series, Vol. XXXVII, p. 290.

[b] Relation of the uppermost Cretaceous beds of the eastern and southern United States: Am. Jour. Sci., Dec. 1889, Vol. XXXVIII, p. 470.

[c] Mesozoic Echinodermata of United States: Bull. U. S. Geol. Surv. No. 97, pp. 90-91, pl. XLIX, figs. 2, a-i.

[d] Cont. to Invert. Pal. of Texas Cret.: Fourth Ann. Rept. Geol. Surv: Texas.

[e] Geol. of parts of Texas, Ind. Ter., and Ark., etc.: Bull. Geol. Soc. America, vol. 5, pp. 317-321.

[f] A comparative study of the Lower Cretaceous formations and faunas of the United States: Jour. Geol., Vol. V, pp. 579-624.

the joint authorship of Messrs. Hill and Vaughan.[a] In this paper the classification of the gryphæas of the Texas region was discussed, species were described, and figures were given. The geographic and stratigraphic distribution was also shown, and the probable relationship and evolution of the various forms of *Gryphæa* occurring in the Texas region were indicated. Before the close of the year the same authors published another paper, discussing the relation of the geology in certain parts of Texas to the flow of underground water.[b] In this paper the Shoal Creek limestone was described and its relation to other strata in the Cretaceous series was pointed out.

The latest publication dealing with the Shoal Creek limestone is by Mr. Hill.[c] In this paper Hill substituted the name "Buda limestone" for "Shoal Creek limestone," and summarized the leading features of the formation.

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[a] The Lower Cretaceous gryphæas of the Texas region: Bull. U. S. Geol. Surv. No. 151.

[b] Geology of the Edwards Plateau and Rio Grande Plain adjacent to Austin and San Antonio, Tex., with reference to the occurrence of underground water: Eighteenth Ann. Rept. U. S. Geol. Surv., Pt. II, pp. 193–316.

[c] Geology and geography of the Black and Grand prairies, Texas, etc.: Twenty-first Ann. Rept. U. S. Geol. Surv. (for 1899–1900), Pt. VII, 1901, pp. 288–290.

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GEOLOGY OF THE BUDA LIMESTONE.

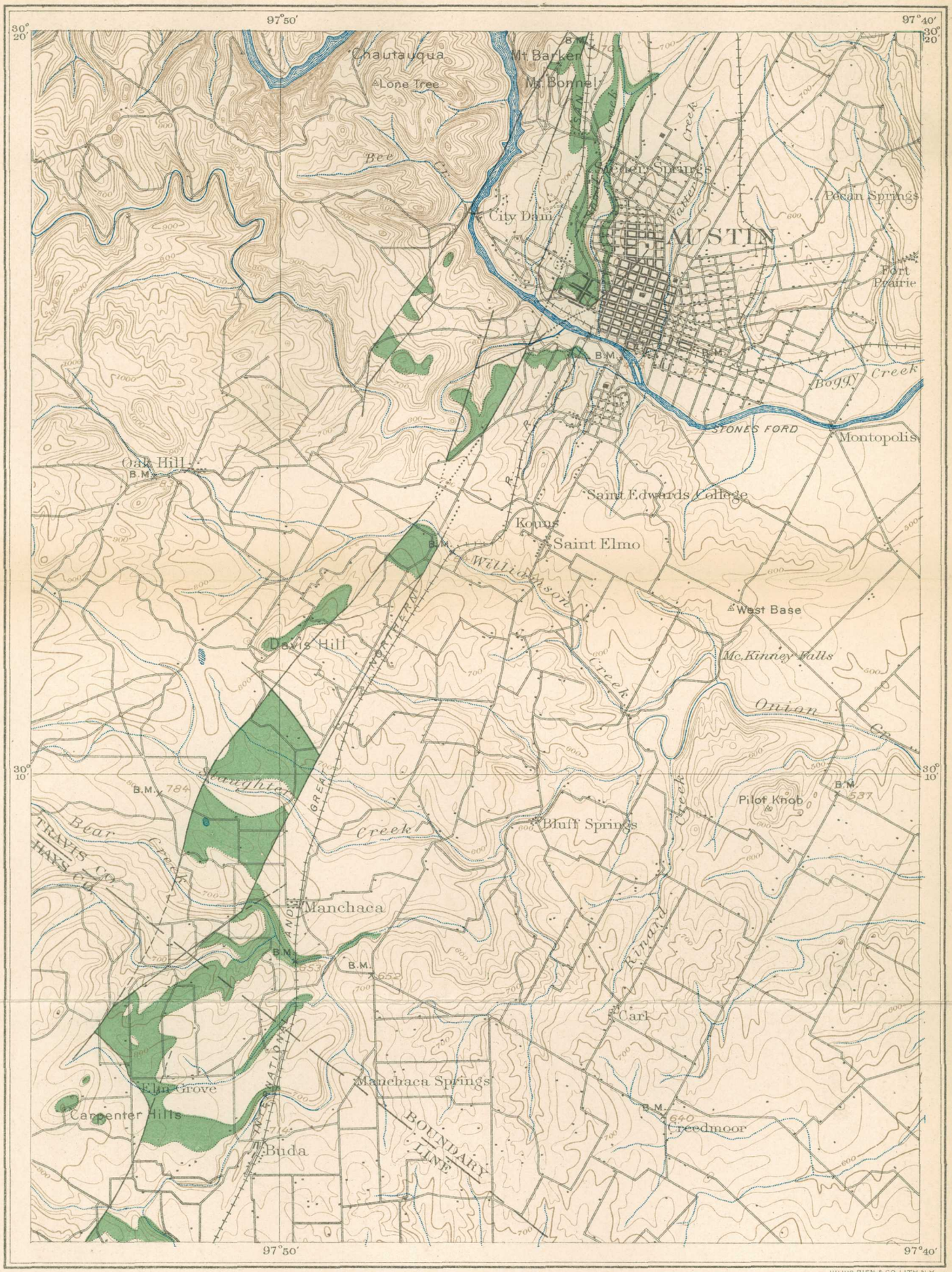
The work of the author while in Texas was confined to collecting from the Buda limestone near Austin, while the task of determining the geologic relations of that formation and mapping its areal extent has been done by Mr. R. T. Hill. The author is, therefore, unable to speak regarding the geology of the Buda limestone, except as that information has been published. The following statement is consequently derived entirely from the description by Mr. Hill, given in the Twenty-first Annual Report of the United States Geological Survey.

The Lower Cretaceous formations of Texas have been placed collectively in one group, called the Comanche series. The Comanche series is again divisible, beginning with the oldest, into the Trinity, Fredericksburg, and Washita divisions. The Washita division is in turn composed of several formations, which vary in number and extent from one locality to another. The city of Austin, Tex., is located in the midst of the region in which the Buda limestone is best developed. There it is found typically exposed in two localities, one along Shoal Creek, on the northeastern border of the city, and the other at Buda, about 14 miles southeast of the city, on the International and Great Northern Railway. In this region the Washita consists of three formations. These are, beginning with the oldest, Georgetown, Del Rio, and Buda. The Georgetown formation is composed principally of limestone; the Del Rio formation consists of an unctuous clay, and the Buda formation is also a limestone.

The Buda limestone first appears south of the Brazos River, where it is apparently the stratigraphic continuation of the Grayson marls, which occur north of the river. As the Buda limestone is traced southward from the Brazos it becomes more clearly defined. This formation was first named the Vola limestone, and later designated the Shoal Creek limestone, but recently it was found that that name was preempted and it is now known as the Buda limestone. It has been defined by Mr. Hill as follows:[a]

The Buda limestone may be defined as the uppermost of the three formations of the Washita division throughout southern Texas, where it is also the final bed of

[a] Twenty-first Ann. Rept. U. S. Geol. Survey, Pt. VII, 1901, p. 283.



JULIUS BIEN & CO. LITH. N.Y.

Geology by R. T. Hill and T. W. Vaughan.
Topography by T. M. Bannon and W. B. Corse

MAP OF THE REGION NEAR AUSTIN, TEXAS.

Showing exposures of Buda Limestone

Scale

1 ½ 0 1 2 3 4 5 miles

the Lower Cretaceous, occupying the same position in the southern section relative to the series as do the Grayson marls of the northern section, the one probably being the seaward extension of the other.

The Buda limestone is best exposed in the steep cliffs of Shoal Creek, in the city of Austin, in the bluffs of Bouldin Creek, and on the outer margins of Barton Creek Valley south of Austin. It is also found well developed at Buda, 14 miles southwest of the city. In this region the limestone is stratified in layers varying in thickness from 2 to 6 feet. As the strata vary somewhat in hardness and power to withstand erosion, they are affected differently by the elements. Certain of them preserve a smooth surface, others exhibit a shattered and rubbly appearance, and still others break down into a fine powder. These last are apt to give place to recesses or caverns which retreat beneath overhanging bluffs of more obdurate material. The limestone when first fractured possesses a light yellowish drab ground color, specked with spots about the size of a coriander seed, but on weathering these little specks oxidize to a yellowish or red color, and cause the surface to appear as if it had been burned. On microscopic examination it has been found that these little spots are fossil foraminifera filled with a mineral substance, possibly glauconite, which on weathering oxidizes to red. The limestone as a whole appears to be made up more largely of foraminifera than any other in the entire Comanche series.

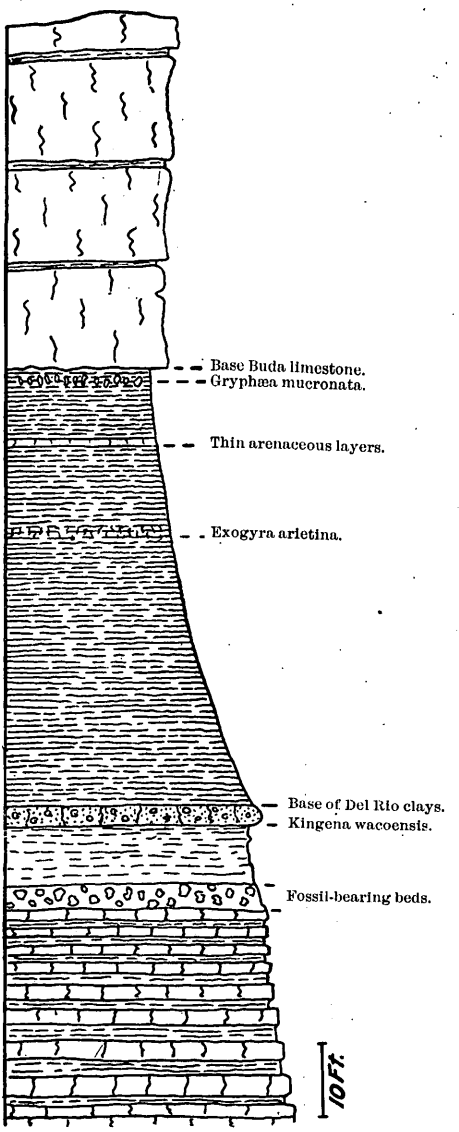


FIG. 1.—Section of Buda limestone, Del Rio clays, and Fort Worth limestone at Austin, Tex.

The outcrop of the Buda limestone is not extensive. It is developed in a narrow band between the Del Rio clay below and the Eagle Ford

formation above, extending from the Brazos to the Colorado and southward to the Rio Grande. Throughout this region it is found exposed in many places. In the region of Austin the formation is nearly 80 feet thick, and it increases in thickness southward, attaining on the Nueces 100 feet. Northward from Austin it decreases in thickness at the rate of about 2 feet a mile, until at Round Rock it is only 20 feet thick, on San Gabriel River 10 feet, at Moody about 5 feet, and at Bosqueville, on the Brazos River, it is represented by a bed of limestone only 1 foot in thickness. North of the Brazos, as stated above, it merges with the Grayson marl and is no longer distinguishable as a limestone stratum.

Although the Buda limestone is rich in fossils the remains are poorly preserved and are often represented only by casts or molds. Many of these forms are also found in earlier members of the Comanche series. The following is a list of the fossils of the Buda limestone which have been identified and described:

LIST OF SPECIES IN BUDA LIMESTONE.

Foraminifera.

Rotalia sp.
Textularia sp.

Echinodermata.

Hemiaster calvini Clark.

Pelecypoda.

Pecten roemeri (Hill).
Pecten quinquecostatus? Sowerby.
Pecten duplicicosta Roemer.
Pecten texanus Roemer.
Lima shumardi sp. nov.
Lima wacoensis Roemer.
Lima sp.
Gervilliopsis invaginata? (White).
Inoceramus sp.
Pinna sp.
Spondylus sp.
Ostrea sp.
Alectryonia sp.
Gryphæa mucronata Gabb.
Exogyra clarki sp. nov.
Modiola? sp.
Cucullæa sp.
Trigonia emoryi Conrad.
Ptychomya ragsdalei (Cragin).
Cardium (Granocardium) budaense sp. nov.
Cardium (Protocardia) texanum (Conrad).
Cardium (Protocardia) vaughani sp. nov.
Pachymya austinensis? Shumard.
Isocardia medialis (Conrad).
Pholadomya roemeri sp. nov.
Homomya austinensis sp. nov.
Homomya vulgaris sp. nov.
Anatina austinensis sp. nov.
Anatina texana sp. nov.

Gasteropoda.

Patella sp.
Pleurotomaria stantoni sp. nov.
Trochus sp.
Turritella budaensis sp. nov.
Cerithium? texanum sp. nov.
Harpagodes shumardi (Hill).
Cypræa sp.
Fusus texanus sp. nov.
Fusus sp.

Cephalopoda.

Nautilus texanus Shumard.
Nautilus hilli sp. nov.
Barroisiceras texanum sp. nov.
Barroisiceras hyatti sp. nov.

Anthozoa.

Parasmilia texana, sp. nov.
Trochosmilia (?) sp. indet.
Orbicella (?) texana sp. nov.
Leptophyllia sp. (No. 1).
Leptophyllia sp. (No. 2).

DESCRIPTIONS OF SPECIES.

MOLLUSCA.

PELECYPODA.

PECTINIDÆ.

Genus PECTEN Müller.

PECTEN ROEMERI (Hill).

Pls. II–IV; Pl. V, fig. 1.

Pecten (*Vola?*) *roemeri* Hill, 1889, Pal. of the Cret. Formations of Texas, Pt. 1, Pl. I.

Pecten (*Vola*) *roemeri* Hill, 1889, Annot. Check List Cret. Invert. Fossils of Texas: Bull Geol. Surv. Texas No. 4, p. 8.

Dimensions.—Length, 15 cm.; breadth, 14 cm.

Description.—Shell large, compressed, thick; margin scalloped, concavities of one valve receiving the convexities of the other; suboctahedral; equilateral, unequivalved; right valve subglobose, left valve slightly convex; hinge line straight, two-thirds length of shell, medial, symmetrical, reflected toward left valve; umbos opposite, medial; that of the right valve prominent, that of the left depressed; ears equal, produced, conspicuous, decorated with radiating costæ. Surface decorations consist of six major radiating ribs, including between them groups of two or three minor costæ. In the region of the wings the costæ are of uniform strength. Concentric undulations are also prominent and lines of growth well marked.

This *Vola* is very abundant in the Buda limestone, and suggested the name Vola limestone, by which this formation was originally known. Mr. Hill, in discussing the Buda ("Shoal Creek") limestone in an early paper,[a] referred to this form as *Vola quinquecostata* Sow.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

This form has never been reported from any other formation.

Collections.—Johns Hopkins University;[b] United States National Museum.

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[a] Events in North American Cretaceous history, etc.: Am. Jour. Sci., April, 1889, 3d series, Vol. XXXVII, p. 290.

[b] Concerning the specimens described in this paper, it may here be said that Mr. Hill collected those in possession of the Johns Hopkins University, while those in possession of the United States National Museum were in great measure collected by the writer for the United States Geological Survey.

PECTEN QUINQUECOSTATUS? (Sowerby).

Pl. V, figs. 2–4.

Pecten quinquecostatus Sowerby, 1814, Min. Conch., Vol I, p. 121, tab. 56, figs. 4–8.
Pecten quadricostatus Sowerby, 1814, Min. Conch., Vol. I, p. 121, tab. 56, figs. 1, 2.
Janira quinquecostata d'Orb., 1846, Pal. Franc. Terr. Crét., Vol. III, p. 632, pl. 441, figs. 1–5.
Janira quadricostata d'Orb., 1846, Pal. Franc. Terr. Crét., Vol. III, p. 644, pl. 447, figs. 1–7.

Dimensions.—Length, 35 mm.; breadth, 4 cm.

Description.—Shell medium to small; outline sinuous; right valve ventricose, with prominently elevated umbo; ears absent. The surface decorations consist of five prominent, radiating, trifid ribs, of which the middle individual is more elevated and conspicuous than either of the lateral members. Each of the spaces between the five trifid ribs is occupied by two equal, less prominent ribs, which also extend from the umbo to the margin. All the specimens of left valves in the collection belong to immature individuals. They are slightly concave, bear six major radiating ribs, on the curved surface of which are three or four minor costæ. The depressions between the major ribs are broad and contain two costæ each.

The specific position of this shell has been subject to considerable dispute, and a variety of opinions have been expressed, by those who have described it, in regard to its correct systematic position. This confusion seems to be due to a variation in the number and strength of the minor costæ. In determining this species the author inclines to refer it to *Pecten quinquecostatus* rather than to make it a distinct species. It is a common form in the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

This species has been reported from the Washita limestone, the Edwards limestone, and the Upper Cretaceous beds of New Jersey.

Collections.—Johns Hopkins University; United States National Museum.

PECTEN DUPLICICOSTA (?) Roemer.

Pl. V, fig. 5.

Pecten duplicicosta Roemer, 1849, Texas etc., p. 398.
Pecten duplicicosta Roemer, 1852, Kreid. von Texas, p. 65, Pl. VIII. fig. 2, a, b.

Description.—Shell medium, polygonal; left valve very globose. Decorations consist of six ridges radiating from the umbo to the angles of the margin. These ridges are each traversed by three longitudinal ribs. Each of the spaces between the ridges is occupied by three conspicuous costæ.

Roemer described his type specimen as having all the secondary costæ equally developed, while in the specimen described here the ribs traversing the ridges are not so prominent as the costæ located in the interspaces; moreover, the form here described is not so wide

in proportion to its length as that figured and described by Roemer, but it appears to have suffered compression.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

This species occurs in the Edwards limestone.

Collection.—United States National Museum.

PECTEN TEXANUS Roemer.

Pl. V, figs. 6–8.

Pecten æquicostatus Roemer, 1849, Texas etc., p. 398.
Pecten texanus Roemer, 1852, Kreid. von Texas, p. 65, Pl. VIII, fig. 3, a, b.
Neithea texana Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 151, Pl. V, fig. 2, a, b.
Pecten texanus Gabb, 1861, Notes on Cret. Fossils, etc.: Proc. Acad. Sci., Phil., p. 365.

Dimensions.—Length, 31 mm.; breadth, 35 mm.

Description.—Shell medium, triangular; margin polygonal; left valve globose; umbo curved over hinge area; ears conspicuous; hinge line straight. Decorations consist of minute concentric striæ and six prominent rounded ribs, radiating from the umbo to the angles of the margin; the broad spaces between them are each occupied by two equal, but subordinate, rounded costæ, whose width is greater than that of the grooves separating them.

A young individual has the following appearance: Shell small; margin sinuous; outline triangular; left valve globose; umbo produced. Decorations consist of eighteen radiating costæ, of which every third costa is more elevated than the two intermediate individuals. The right valve is slightly concave and decorated with twenty narrow, radiating ribs, whose disposition is regular.

In the adult specimens figured by both Conrad and Roemer the ribs are described as flattened. This, however, is not the case in these specimens.

This appears to be a rare form in the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.; Fish Pond Point, Texas; Bartons Creek, Travis County, Tex.

This species is common throughout the Washita division.

Collection.—United States National Museum.

LIMIDÆ.

Genus LIMA Bruguiére.

LIMA SHUMARDI sp. nov.

Pl. V, fig. 11.

Dimensions.—Length, 25 mm.; breadth, 26 mm.

Description.—Shell small, thin, oblique, globose; inequilateral, posterior half produced; margins serrated; posterior margin rounded;

anterior margin almost straight; ventral and dorsal margins subparallel; umbo, hinge line, and wings missing. The decorations consist of about 30 low, narrow ribs radiating from the umbo and projecting over the margin, causing the serrated appearance described above. These ribs, which are more pronounced over the posterior than over the anterior region, are separated by broad, flat depressions which carry a varying number of radiating hair-like costæ. Lines of growth, although visible, are not conspicuous as a decorative feature.

This form resembles *L. wacoensis*, but may be distinguished from it by the greater number of large ribs and the presence of the hair-like costæ.

Locality.—Uncertain; probably Austin, Tex.

Collection.—United States National Museum.

LIMA WACOENSIS Roemer.

Pl. V, fig. 10.

Lima wacoensis Roemer, 1849, Texas etc., p. 399.
Lima wacoensis Roemer, 1852, Kreid. von Texas, pp. 63-64, Pl. VIII, figs. 7, a, b.
Lima wacoensis Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 151, Pl. V, fig. 4, a, b.
Lima leonensis Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 151, Pl. V, fig. 3, a, b, c.

Dimensions.—Length, 15 mm.; breadth, 14 mm.

Description.—Shell small, thin, oblique, globose; outline subovate; inequilateral; ventral and dorsal margins subparallel; anterior margin slightly curved; posterior margin elongate and rounded; umbos approximate; hinge line straight and oblique; wings small, undecorated, concave margins. Decorations consist of about 20 small ribs radiating from the umbo. These ribs are of unequal size, being larger over the domed region of the shell and smaller on either side.

This form is not very common.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

This form has also been found in the Comanche Peak chalk, the Washita limestone, and the Del Rio clays.

Collection.—United States National Museum.

LIMA sp.

Pl. V. fig. 9.

Description.—This form is represented by one very imperfect cast of the interior of the right valve. Shell medium; inequilateral; dorsal margin straight, oblique, inflected at an angle of 90 degrees; shell most strongly arched in this region, sloping away in all directions; posterior, ventral, and anterior margins sinuous. About 20 delicate radiating ribs are indicated on this cast.

Locality.—Onion Creek, Buda, Tex.

Collection.—United States National Museum.

PERNIDÆ.

Genus GERVILLIOPSIS Whitfield.

GERVILLIOPSIS INVAGINATA (?) White.

Pl. V, fig. 12.

Dalliconcha invaginata White, 1887, New Generic Forms of Cret. Mol., etc.; Proc. Acad. Sci. Phil., p. 35, Pl. II, figs. 4, 5.

Description.—Shell narrow, depressed, inequilateral; greatly prolonged posteriorly; moderately thick; shaped and curved much like the blade of a scythe; central ridge running down its entire length midway between the margins; hinge line straight, exhibiting in the imperfect specimen about twelve crenulations, which rapidly increase in length until those directly under the beak are about 2 cm. long and of reduced strength; umbos low and terminal; decorations obscure.

The only specimens of this form are casts in such an imperfect state of preservation that they can only questionably be referred to the above-named species.

Locality.—Shoal Creek, Austin, Tex.

This form is also found in the Marietta and Fort Worth beds of northern Texas.

Collection.—United States National Museum.

Genus INOCERAMUS Sowerby.

INOCERAMUS sp.

Dimensions.—Length, 42 mm.; breadth, 57 mm.

Description.—Shell medium; margin not visible; general outline appears to be subovate; inequilateral, anterior portion slightly produced; somewhat ventricose; hinge line straight and situated obliquely to long axis; umbo prominent, produced, curved slightly forward; located at anterior end of hinge line, ears wanting. Decorations consist of plications and striations parallel with lines of growth.

This form appears to be very rare in the Buda limestone. The only specimen of this species is a cast of the interior right valve.

Locality.—Onion Creek, near International and Great Northern Railroad crossing, Travis County, Tex.

Collection.—United States National Museum.

PINNIDÆ.

Genus PINNA Linnæus.

PINNA sp.

Pls. VI, VII.

Description.—Shell elongate, subtriangular; increasing rapidly in breadth from the pointed anterior to the rounded posterior end; breadth not less than 6 cm., length not less than 16 cm. A preserved shell frag-

ment is situated near the posterior end of the right valve and bears on the surface equidistant, longitudinal furrows, while the cast of the inner surface of the left valve shows growth lines converging at the anterior end. These ridges are less conspicuous over the posterior portion of the valve.

In the Buda limestone, *Pinna* is a common form, but preserved almost entirely as casts. Of the eight specimens at hand, only two possess fragments of a shell, and these are too poorly preserved to be of use in specific determination.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Collections.—Johns Hopkins University; United States National Museum.

SPONDYLIDÆ.

Genus SPONDYLUS Linnæus.

SPONDYLUS sp.

Pl. VIII, figs. 1–3.

Dimensions.—Length, 40 mm.; breadth, 5 cm.

Description.—Shell medium, moderately thick, ventricose, inequilateral, produced anteriorly; umbos prominent, bent forward. Decorations consist of wavy, radiating ribs of medium strength, bearing at intervals bosses, which probably are the remnants of former spines.

To this description may be added that of certain smaller forms which are probably the young of this species. The shell is thin, small, globose; margin fluted; outline subovate; inequilateral; inequivalved; lower right valve produced in direction of anterior margin; large scar at point of attachment. The only decorations are fine, irregular, radiating lines, every sixth one of which is strengthened and bears the remnants of spines. The upper valve is also produced anteriorly, and bears decorations analogous to those on the right valve.

All of these forms are badly mutilated and it is therefore impossible to determine the species definitely.

Locality.—Shoal Creek, Austin, Tex.

Collections.—Johns Hopkins University; United States National Museum.

OSTREIDÆ.

Genus OSTREA Linnæus.

OSTREA sp.

Description.—This genus is represented by a fragment of a right valve, of which only the inner surface is visible. The oyster was large, and possessed near the ventral margin a conspicuous concave muscle impression. The margin is scalloped and the surface is smooth.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

Genus ALECTRYONIA Fischer.

ALECTRYONIA sp.

Description.—Shell medium, thick, corrugated; margin with the characteristic alectryonian fluting. The ribs, some of which show the bifid habit, are strong and sharp and radiate from the umbonal portion of the valve.

As only a portion of one valve is present, it is impossible to accurately determine this species.

Locality.—Uncertain, probably Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

Genus GRYPHÆA Lamarck.

GRYPHÆA MUCRONATA Gabb.

Pl. IX.

Gryphæa pitcheri Roemer (not Morton), 1849, Texas, etc., pp. 394–395.

Gryphæa pitcheri Roemer, 1852, Kreid. von Texas, pp. 73–74, Pl. IX, fig. 1a, b, c.

Gryphæa pitcheri var. *navia* (in part) Hall, 1856, Rept. Expl. and Surv. R. R. from Miss. River to Pacific, Vol. III, Pt. IV, p. 100.

Gryphæa pitcheri var. *navia* Conrad (in part), 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 155.

Gryphæa pitcheri Owen (not Morton), 1860, Second Rept. Geol. Surv. Arkansas, pl. 7, fig. 6.

Gryphæa mucronata Gabb, 1869, Geol. Surv. Cal., Palæontology, Vol. II,, pp. 274–275.

Ostrea pitcheri Coquand (in part), 1869, Mon. du Genre Ostrea Terr. Crétacé, p. 40, Pl. IX, figs. 9–12.

Gryphæa navia (Conrad in part) White, 1884, Fourth Ann. Rept. U. S. Geol. Surv., p. 302, Pl. XLIX, figs. 3–6.

Gryphæa mucronata Hill and Vaughan, 1898, Bull. U. S. Geol. Surv. No. 151, pp. 63–65, Pls. XXIV–XXX.

Dimensions.—Length, 35 mm.; breadth, 4 cm.

Description.—Shell laterally subtrihedral; margin straight; inequivalved; inequilateral; lower valve very globose and thick in umbonal region, gradually thinning toward the ventral margin; beak prominent, submedial, slightly bent posteriorly; hinge line straight; ligamental fossa narrow, deep, curved; inside of shell smooth; anterior and posterior margins prominently elevated, the latter more than the former, imparting to the form a compressed aspect in the direction of its length. Surface decorations consist of undulating lines of growth more or less elevated at their margins, and a deep groove extending from beak to ventral edge, a little anterior to the posterior margin. Right valve subcircular, decorated externally with concentric lines of growth.

This is a common form at the base of the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Hill and Vaughan, who have worked out this form with great care, state that—

Gryphæa mucronata occurs in greatest abundance in the upper portion of the Del Rio (*Exogyra arietina*) beds and in the base of the overlying Shoal Creek limestone from the Brazos southward to the Guadalupe. It is well shown in Shoal and Barton creeks, near Austin. North of the Colorado it occurs abundantly in the Grayson beds overlying the Main street limestone, as near Handley, a few miles east of Fort Worth, and northward toward Red River at Denison. It also occurs in the Trans-Pecos region and as far west as Sonora, according to Gabb.[a]

Collection.—United States National Museum.

Genus EXOGYRA Say.

EXOGYRA CLARKI sp. nov.

Pls. X, XI.

Dimensions.—Length, 72 mm.; breadth, 105 mm.

Description.—Shell large, somewhat thicker in umbonal region than at margins; outline elliptical to oval; inequivalved; inequilateral; lower valve very globose, elongated in the direction of its breadth, compressed in the direction of its length; umbo distinctly recurved, adherent, interior of shell smooth, as deeply concave as surface is convex; muscle impression subcentral. Concentric with and a little below the periphery is a broad, shallow groove which is produced by the sudden expansion of the margin. This groove receives the margin of the upper valve. The decorations consist of concentric lines of growth with undulating margins; as the crest of each undulation disappears beneath that of the one just preceding it, irregular ribs are produced which radiate from the umbo and distribute themselves over the surface. The upper valve presents a warped appearance, as if it had suffered compression in the direction of its length; interior surface smooth; muscle impression subcentral; hinge line straight; exterior surface shows concentric and elevated lines of growth, which constitute its only decoration.

This species differs from *Exogyra costata* Say in being less ponderous and broader in proportion to its length, and from *Exogyra sinuata* var. *americana* Marcou in being smaller, more convex, and in rising less abruptly from the margin in the umbonal region. It is easily distinguished from *Exogyra ponderosa* by the fact that it is far less ponderous and possesses growth lines which are more rugged and sinuous at their margins.

A few specimens of this species have been found in the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

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[a] Bull. U. S. Geol. Survey No. 151, 1898, pp. 64–65.

MYTILIDÆ.

Genus MODIOLA Lamarck.

MODIOLA (?) sp.

Pl. VIII, figs. 4, 5.

Description.—Shell medium, slightly inflated; margin absent. Decorations consist of pronounced undulations approximately parallel with the lines of growth, so disposed that series of three or four concentrate themselves into one ridge, which is more prominent and less curved than any one of the separate individuals.

All the specimens are fragmentary casts of the external surface.

Locality.—Onion Creek, Buda, Tex.

Collection.—United States National Museum.

ARCIDÆ.

Genus CUCULLÆA Lamarck.

CUCULLÆA sp.

Dimensions.—Length, 85 mm.; breadth, 63 mm.

Description.—Shell large, inequilateral, posterior end greatly produced; ovate-triangular, ventricose; posterior margin subtruncate; ventral margin extensive, slightly curved; anterior margin short, sharply curved; umbos very strong and conspicuous; situated at anterior end of form, bending forward and inward; both muscle impressions strong; pallial line entire; cast shows faint indications of radial ribbing.

This forms appears to be rare. This collection possesses three internal casts. It bears a striking resemblance to *Cucullæa terminalis* Conrad: Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 148, Pl. IV, figs. 2, a, b.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Collection.—United States National Museum.

TRIGONIIDÆ.

Genus TRIGONIA Bruguiére.

TRIGONIA EMORYI Conrad.

Pl. VIII, fig. 6–8.

Trigonia emoryi Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 148, pl. 3 fig. 2, a, b, c.

Dimensions.—Length, 6 cm.; breadth, 4 cm.

Description.—Shell medium, thick, very much swollen about the anterior region; posterior end greatly produced; anterior margin falling away rapidly with a bold curve; posterior and ventral margins

absent; umbos subterminal, approximate, slightly produced, recurved; muscle impression large, subcentral. The decorations consist of thirty or more strong, curved tubercled ribs becoming indefinite posteriorly. These ribs change direction in passing over the area, so as to form a chevron-like arrangement, and after changing direction again, pass over the escutcheon.

The specimens of this species are almost entirely confined to casts. The above description has been made from a wax impression, supplemented by the anterior fragment of a shell.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.; Bartons Creek, Austin, Tex.

This form has also been reported from the Lower Washita.

Collection.—United States National Museum.

CRASSATELLIDÆ.

Genus PTYCHOMYA Agassiz.

PTYCHOMYA RAGSDALEI (Cragin).

Pl. XII, Pl. XIII, fig. 1.

Pholadomya ragsdalei Cragin, 1895, Des. Invert. Fossils from Comanche series of Texas, Kansas, and Indian Territory: Fifth Ann. Pub., Colorado Coll. Studies, pp. 58–59.

Description.—Shell medium to large, subovate, depressed; inequilateral, somewhat produced posteriorly; hinge line broad and slightly curved; umbos low, directed forward; two cardinal teeth directed backward, one posterior lateral tooth; mantle entire. Decorations consist of three systems of ribs. The one most extensive and conspicuous occupies the broad middle portion of the shell; its ribs, about twenty-five or thirty in number, radiating from beak to margin and carrying numerous tubercles. The second system, situated in front of the first, consists of short curved ribs which take their origin, not from the umbo, but from the anterior margin of the first system, and produce with it the effect of chevrons, with the angle directed toward the umbo. The third system, being very narrow, is less conspicuous than either of the others, is located at the posterior margin, and consists of strong corrugations, originating in the same manner as the second system, but differing from it in being V-shaped, with the apex turned away from the beak.

This appears to be a rather common form, but is poorly preserved, the specimens being represented only as casts. The description was made from wax impressions.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

This form is also found in the Main Street limestone at Denison.

Collections.—Johns Hopkins University; United States National Museum.

CARDIIDÆ.

Genus CARDIUM Linnæus.

Subgenus GRANOCARDIUM Gabb.

CARDIUM (GRANOCARDIUM) BUDAENSE sp. nov.

Pl. XIII, fig. 2-4.

Dimensions.—Length, 45 mm.; breadth, 55 mm.

Description.—Shell medium, thin, cordate, slightly inequilateral; anterior portion somewhat produced; very globose, especially toward the dorsal region, sloping from here abruptly posteriorly and more gently anteriorly and ventrally; hinge line slightly curved; umbos conspicuous, produced, incurved, located a little posteriorly to the center of the hinge line; anterior muscle impression strong, posterior impression larger, but less conspicuous. Surface decorations consist of numerous smooth, radiating ribs, separated by narrow grooves, from which arise alternate rows of coarse, long spines and minute granules.

This form differs from *Cardium* (*Granocardium*) *sabulosum* Gabb by possessing only one row of smaller tubercles between the large, while *sabulosum* possesses two and three rows of smaller tubercles between the large.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, Austin, Tex., contact with Eagle Ford shales; Onion Creek, Buda, Tex.

Collections.—Johns Hopkins University; United States National Museum.

Subgenus PROTOCARDIA Beyrich.

CARDIUM (PROTOCARDIA) TEXANUM Conrad.

Pl. XIII, figs. 5-7.

Cardium (*Protocardia*) *texanum* Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 150, Pl. VI, fig. 6, a, b. c.

Dimensions.—Length, 86 mm.; breadth, 87 mm.

Description.—Shell small to very large, thick, very globose, slightly inequilateral; anterior portion somewhat produced; umbones prominent, produced, curved slightly downward and forward; posterior margin slightly truncated; anterior and ventral margins rounded; toward the posterior, shell slopes more rapidly than toward either the ventral or anterior margins. Decorations consist of about fifteen radiating ribs, roughly parallel with the posterior margin, and the remainder of the shell (about four-fifths) is covered with coarse concentric undulations parallel with the lines of growth and gradually increasing in strength toward the margin. In large specimens these undulations carry on their surfaces faint longitudinal striations.

This species is rather common in the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.; Bartons Creek, Travis County, Tex.; Onion Creek, Buda, Tex. This form has also been found in the Comanche Peak chalk and the Washita limestone.

Collection.—United States National Museum.

CARDIUM (PROTOCARDIA) VAUGHANI sp. nov.

Pl. XIV, fig. 1-3.

Dimensions.—Length, 6 cm.; breadth, 65 mm.

Description.—Shell medium, moderately thick, cordate, slightly inequilateral; very globose; umbos prominent; anterior margin truncated; posterior and ventral margins slightly curving, uniting at an obtuse angle; muscle impressions deep. Decorations consist of thirty or more fine, radiating ribs confined to the posterior region and occupying about one-quarter of the shell surface, the remaining three-quarters being almost smooth.

This form differs from *Cardium hillanum* in being truncated anteriorly, in possessing a larger number of ribs, and in having the remainder of the shell smooth.

Locality.—Not indicated.

Collection.—Johns Hopkins University.

PACHYMYIDÆ.

Genus PACHYMYA Sowerby.

PACHYMYA AUSTINENSIS (?) Shumard.

Pachymya austinensis Shumard, 1859, Trans. Acad. Sci. St. Louis, Vol. I, pp. 604–605.

Pachymya austinensis White, 1879, Cont. to Invert. Palæ. No. 1, Cret. Fossils of West. States and Terr.: Eleventh Ann. Rept. U. S. Geol. and Geog. Surv. Terr., p. 298, pl. 8, figs. 1, a, b, and pl. 5, figs. 7, a, b.

Pachymya? austinensis Hill, 1889, Annot. Check List Cret. Invert. Fossils of Texas: Bull. Geol. Surv. Texas No. 4, p. 15.

Description.—The following is Shumard's original description: "Shell very large, length more than double the width and less than double the thickness; greatest width near the center, where the shell is very gibbous; subangulated diagonally from the posterior side of the beak to the anal extremity and sloping to the margins; posterior slope broad; sides constricted anteriorly by a broad, shallow depression, which commences some distance below the beaks and extends obliquely downward and backward to the base; superior and inferior margins subparallel; buccal end very short, narrowly rounded; anal end obliquely truncated, gaping, angulated at extremity; pallial margin concave in the middle, rounded before and very gently convex posteriorly; beaks nearly terminal, flattened, incurved, approximate; surface marked with irregular, concentric lines of growth.

"Length, 6.30 inches; width, 2.30; thickness, 3.64."

The specimens of this species are too fragmentary to permit of a positive specific determination. They, however, most strongly resemble *Pachymya austinensis* Shumard, and are therefore questionably referred to that species. As it is impossible to describe forms as poorly preserved as those at the disposal of the author, he has taken the liberty to quote the original description made by Shumard. The form described by Shumard came from the Fort Worth beds below the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.

Collections.—Johns Hopkins University; United States National Museum.

CYPRINIDÆ.

Genus ISOCARDIA Lamarck.

ISOCARDIA MEDIALIS (Conrad).

Pl. XIV, figs. 4, 5; Pl. XV, figs. 1, 2.

Cardium mediale Conrad, 1857, Rept. U. S. Mex. Bound. Surv., Vol. I, Pt. II, p. 149, Pl. IV, fig. 4, a, b.

Isocardia (?) *medialis* Hill, 1893, Pal. Cret. Form. Texas: Proc. Biol. Soc. Washington, Vol. VIII, pp. 31–32, Pl. II, figs. 4, 5, and Pl. III, fig. 6.

Dimensions.—Length, 6 cm.; breadth, 6 cm.

Description.—Shell medium to very large, thick, very globose, subcircular; equivalved; inequilateral; anterior and posterior margins subtruncate; ventral margin profoundly and irregularly curved; hinge line curved; teeth, two strongly developed cardinals and one posterior lateral in each valve; ligament external; ligamental grooves deep; umbos prominent, produced, curved downward and forward; anterior muscle impression strong and deep; posterior weak and large, not often visible on poorly preserved specimens. The surface of the shell is decorated with fine concentric striations.

The majority of the specimens of this species are preserved as casts, from two of which impressions of the hinge area have been obtained, thus allaying the doubt expressed by Mr. Hill in his description. Certain of the casts vary slightly from the type in possessing less prominent beaks. One large specimen is less globose than one would expect, considering the size, and has probably suffered compression, as suggested by Mr. Hill in the description of the same species from the Glen Rose beds.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, Austin, Tex., contact with Eagle Ford shales; Onion Creek, Buda, Tex.; north of Waters 1½ miles, Austin and Northwestern Railroad; Williamsons Creek, near Travis County, Tex. This form has also been reported from the Comanche Peak chalk.

Collections.—Johns Hopkins University; United States National Museum.

PHOLADOMYIDÆ.

Genus PHOLADOMYA Sowerby.

PHOLADOMYA ROEMERI sp. nov.

Pl. XV, figs. 3–6.

Dimensions.—Length, 8 cm.; breadth, 7 cm.

Description.—Shell large, very globose, inflated anteriorly, becoming less so ventrally, depressed posteriorly; inequilateral; prolonged posteriorly; margin truncated anteriorly, oblique, describing a wide curve ventrally and dorsally; hinge line straight, slightly inclined backward; umbos inflated, conspicuous, produced, curved downward and forward, and located at anterior end of hinge line. Decorations, as indicated by the cast, consist of radiating ribs which extend from a line a little behind the umbonal ridge to the anterior margin. The remainder of the shell is smooth. The ribs consist of series of tubercles arranged in rows extending from umbo to margin, the space between two contiguous tubercles being about equal to the diameter of the tubercle itself.

This collection possesses two casts of this species, from which the description has been made. The form resembles *Cardium sancti-sabæ* Roemer, but differs from it in having the post-umbonal region more inflated, in being more truncated anteriorly, in the greater acuteness of the anterior-ventral marginal angle, and in the oblique curve of the ventral margin from this point backward.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Collection.—United States National Museum.

Genus HOMOMYA Agassiz.

HOMOMYA AUSTINENSIS sp. nov.

Pl. XVI, figs. 1–3.

Dimensions.—Length, 7 cm.; breadth, 5 cm.

Description.—Shell medium, somewhat globose; equivalved; inequilateral; produced posteriorly; anterior margin short, slightly curved; ventral margin gently curved; posterior margin not whole in specimen, probably gaping; dorsal margin straight, subparallel with ventral margin; umbos conspicuous, elevated, globose, curved downward, inward, and slightly forward, situated near anterior end of shell. The decorations consist of concentric growth lines of about equal strength. This form may be easily distinguished from *H. vulgaris* by the fact that it is much shorter and broader in proportion to its thickness. It is also much more compressed.

Locality.—Shoal Creek, Austin, Tex.

Collection.—Johns Hopkins University.

HOMOMYA VULGARIS sp. nov.

Pl. XVI, figs. 4–5; Pl. XVII.

Dimensions.—Length, 104 mm.; breadth, 48 mm.

Description.—Shell large, thin, elongate-ovate, globose; equivalved; inequilateral; greatly produced posteriorly; margin straight, anterior margin very short, slightly curved; ventral margin prolonged, extending backward with a long, gentle curve; posterior margin oblique downward, joining the ventral margin with a bold curve; dorsal margin straight, subparallel with ventral; umbos very globose, elevated, approximate, in contact, curving inward, downward, and slightly forward; situated at the anterior end of shell; anteriorly closed; posteriorly gaping; posterior portion produced and curved upward. The decorations consist of concentric lines of growth varying in intensity.

This form is longer and thicker than *H. austinensis* in proportion to its breadth.

This form, which is very common in the upper portion of the Buda limestone, is poorly preserved and has usually suffered considerable deformation.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, Austin, Tex., contact with Eagle Ford beds; Onion Creek, Buda, Tex.

Collections.—Johns Hopkins University; United States National Museum.

ANATINIDÆ.

Genus ANATINA Lamarck.

ANATINA AUSTINENSIS sp. nov.

Pl. XVIII, figs. 1, 2.

Dimensions.—Length, 75 mm.; breadth, 38 mm.

Description.—Shell medium, thin, elongate-ovate, somewhat globose; equivalved; inequilateral; anterior end greatly produced; umbos low, curved backward and downward, removed from the posterior end a distance equal to one-third the long diameter of the shell; ventral margins slightly curved and in contact, anterior and posterior margins about equally rounded, gaping; slight concavity in side of form immediately under umbo. The decorations consist of concentric undulations parallel with the lines of growth. This form may be distinguished from *A. texana* on account of its smaller size, lack of the pronounced depression in front of the umbos, as well as by the fact that the umbos are situated nearer the anterior end.

The collection possesses one specimen of this form, which is in a very poor state of preservation.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

ANATINA TEXANA sp. nov.

Pl. XVIII, fig. 3.

Dimensions.—Length, 10 cm.; breadth, 55 mm.

Description.—Shell large, ovate, slightly globose; equivalved; inequilateral; posterior region more contracted and more sharply rounded than anterior; umbos subcentral, produced, bent backward and downward; margins in contact ventrally, gaping at either end; cardinal margin concave at posterior side of beak, sloping away gently anteriorly; ventral margin slightly concave immediately under the umbos, subparallel with dorsal margin. Surface of shell slightly concave below the umbos; deep groove bending downward and backward, located just in front at the base of the umbos; surface shows faint concentric ridges parallel with lines of growth.

This form is larger than *A. austinensis.* It has a pronounced depression in front of the umbos, and the umbos are situated in about the middle of the dorsal side.

The only specimen of this form is an imperfect cast.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

GASTEROPODA.

PATELLIDÆ.

Genus PATELLA Linnæus.

PATELLA sp.

Pl. XIX, fig. 1.

Dimensions.—Height, 5 mm.; breath, 17 mm.

Description.—Shell small, compressed, conical; apex central and erect; aperture circular; diameter, 19 mm. Decorations consist of fine concentric lines crossed by radial ridges bearing much-weathered tubercles, concentrically arranged about the apex.

The collection possesses a single specimen of this form.

Locality.—Shoal Creek, Austin, Tex.

Collection.—Johns Hopkins University.

PLEUROTOMARIIDÆ.

Genus PLEUROTOMARIA de France.

PLEUROTOMARIA STANTONI sp. nov.

Pl. XX.

Dimensions.—Height, 65 mm.; breadth, 80 mm.

Description.—Shell large, elevated, having the form of a broad-based cone; umbilicated; suture distinct; whorls few, increasing rapidly and regularly in size; aperture not present; slitband groove-

like, narrow, traceable along the surface of each whorl, midway between the upper and lower margins; short, transverse ribs converge backward toward the groove; those below are thickly set, comparatively inconspicuous, and bear three tubercles each; those above are pronounced, less thickly placed, and bear likewise tubercles; spaces between these ribs broad, each one offsetting a rib of the underlying series; lower margin of each whorl bound with a revolving cord-like ridge bearing tubercles; under surface of body-whorl decorated with revolving ridges on which are tubercles so arranged as to give the effect of transverse ribs converging toward the center.

The internal cast of this form resembles that of *Pleurotomaria austinensis* Shumard, but the shell may be readily separated from it by the fact that in *P. stantoni* the decoration is very rugged and ornate, and the fine revolving lines present in *P. austinensis* are absent.

Locality.—Shoal Creek, Austin, Tex.; Bartons Creek, Travis County, Tex.; Onion Creek, Buda, Tex.

Collection.—United States National Museum.

TROCHIDÆ.

Genus TROCHUS Linnæus.

TROCHUS sp.

Pl. XIX, figs. 2, 3.

Dimensions.—Height, 15 mm.; breadth, 17 mm.

Description.—Shell small, pyramidal, moderately elevated; whorls four, slightly globose, increasing in size regularly and slowly; aperture and surface decorations wanting.

This species is represented in the collection by one small imperfect cast. The specific determination is therefore impossible.

Locality.—Shoal Creek, Austin, Tex.

Collection.—Johns Hopkins University.

TURRITELLIDÆ.

Genus TURRITELLA Lamarck.

TURRITELLA BUDAENSIS sp. nov.

Pl. XIX, figs. 4–6.

Dimensions.—Breadth, 10 mm.

Description.—Shell medium, elevated, spireform; whorls numerous; sutures conspicuous; imperforate; aperture not fully preserved; outer lip thin. Decorations consist of four revolving ridges bearing tubercles. In the higher regions of the spire these ridges are uniformly developed, but in the adult portion of the shell the two middle ribs are more emphasized than those on either side; the spaces between

are occupied with hair-like lines, of which one or two are slightly larger than the others.

This form differs from both *T. seriatim-granulata* Roemer and *T. planilateris* Conrad, in having four in place of five ribs, and from the latter in having the two middle ridges most conspicuous. The presence of four tubercled ribs, instead of six, provides a ready means of separation from *T. marnochi* White.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, Austin, Tex., contact with Eagle Ford shales; Bartons Creek, Travis County, Tex.; Onion Creek, Buda, Tex.

Collections.—Johns Hopkins University; United States National Museum.

CERITHIIDÆ.

Genus CERITHIUM Adanson.

CERITHIUM (?) TEXANUM sp. nov.

Pl. XIX, figs. 7, 8.

Dimensions.—Breadth, 10 mm.

Description.—Shell medium; spire elevated; whorls more than six; form narrow, imperforate; whorls small; aperture missing, canal at the anterior extremity. Decorations consist of numerous transverse, slightly curved ribs, each one of which is transformed into a tubercle at the upper part by means of a constriction; these tubercles often are a direct continuation of the ribs, but may at times alternate with them.

This form appears to be rare in the Buda limestone, for the collection contains but two specimens; one is an imperfect shell and the other is a portion of an external cast. The generic determination is therefore doubtful.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, Austin, Tex.

Collections.—Johns Hopkins University; United States National Museum.

STROMBIDÆ.

Genus HARPAGODES Gill.

HARPAGODES SHUMARDI (Hill).

Pl. XXI.

Pterocera shumardi Hill, 1889, Pal. Cret. Form. Texas,, Pl. II.

Dimensions.—Height, 115 mm.; breadth, 107 mm.

Description.—The following is Hill's original description: "Shell cylindrical, subfusiform, smooth, with outer lip expanded and flattened into a conspicuous wing; apex pointed; columella not seen, canal reflected as in dotted lines, but destroyed in chiseling specimen from massive stone in which it was embedded. Whorls eight, the

lower being two-thirds the length of the shell; sutures slight; wings three, ribbed or fingered in the specimen figured, but there are indications that there were formerly two more, making five in all; margin is strongly indented between the termini of the fingers; surface marked by strong parallel lines of growth."

This form is rather common in the Buda limestone.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Collections.—Johns Hopkins University; United States National Museum.

CYPRÆIDÆ.

Genus CYPRÆA Linnæus.

CYPRÆA sp.

Pl. XXII.

Dimensions.—Height, 7 cm.; breadth 65 mm.

Description.—Shell medium, low, spherical, imperforate; whorls four or five; globose; aperture long, narrow slit-like; outer lip broad, expanded, and extending from the aperture at almost a right angle; body-whorl very large, embracing about four-fifths of the preceding whorl; no decorations visible.

This appears to be a rare species in the Buda limestone, as only one specimen is present in the collection. The description has been made from an internal cast.

Locality.—Shoal Creek, Austin, Tex.

Collection.—Johns Hopkins University.

FUSIDÆ.

Genus FUSUS Lamarck.

FUSUS TEXANUS sp. nov.

Pl. XIX, fig. 9.

Dimensions.—Height, 67 mm.; breadth, 14 mm.

Description.—Shell moderately large, elevated, turreted; sutures deep; whorls few, convex, increasing in size regularly and slowly; imperforate; greater part of aperture missing; anterior siphonic-canal long (23 mm.), deep. Decorations consist of well-marked and equal revolving ridges crossed by a few, prominent transverse ribs, which in the body whorl are quite elevated at the suture line, but gradually die out as they pass over the whorl.

This species appears to be rare in the Buda limestone, for only half of an external cast is present in the collection. The description has been made from a wax impression.

Locality.—Shoal Creek, Austin, Tex.; Onion Creek, Buda, Tex.

Collection.—Johns Hopkins University.

Fusus sp.

Pl. XIX, figs. 10, 11.

Dimensions.—Breadth, 13 mm.

Description.—Shell small, elevated, conical; whorls convex, five or six in number; body-whorl large, globose, carrying a central ridge; imperforate; sutures deep; aperture not distinct, probably oval; possesses an anterior canal; internal cast shows distinct, revolving lines on the under side of the outer lip.

This form is represented in the collection by one cast.

Locality.—Shoal Creek, Austin, Tex.; Bouldin Creek, contact with Eagle Ford shales; Onion Creek, Buda, Tex.

Collection.—United States National Museum.

CEPHALOPODA.

NAUTILIDÆ.

Genus NAUTILUS Linnæus.

Nautilus texanus Shumard.

Pl. XXIII, figs. 1, 2; Pl. XXIV, figs. 1, 2.

Nautilus texanus Shumard, 1859, Trans. Acad. Sci. St. Louis, Vol. I, p. 590.

Nautilus texanus Hill, 1889, Annot. Check List Cret. Invert. Fossils of Texas: Bull. Geol. Surv. Texas No. 4, pp. 21, 43, 50.

Nautilus texanus Cragin, 1893, Cont. Invert. Pal. Texas Cret.: Fourth Ann. Rept. Geol. Surv. Texas, p. 236.

Not *Nautilus texanus* Gabb, 1864, Geol. Surv. California, Palæontology, Vol. I, p. 59, Pl. IX, fig. 3, a, b.

Description.—Size varies from small to rather large; laterally compressed; sides slightly convex; dorsal curve abrupt; umbilicus circular, shallow, distinct; volution subovate; anterior portion of aperture absent; posterior portion semielliptical, deeply excavated by preceding volution; longest diameter 10 cm.; width in broadest section 4 cm., broadest portion situated a little below the middle of aperture; septa moderately concave forward; sutures on leaving the umbilicus are directed forward for a short distance, then turn with a sharp curve and run backward for a slightly greater distance, turning again, this time with a broader curve; they run forward once more for a distance about equal to their previous backward course and pass over the dorsum with a wide curve; retrosiphonate; siphuncle continuing backward to preceding septum, situated in dorso-ventral plane, a little to ventral side of middle. Decorations consist of numerous simple, flat ridges which pass from the umbilicus forward, then turn with a wide curve backward for a short distance and pass over the dorsum with a sharp curve.

Locality.—Shoal Creek, Austin, Tex. This form has been reported from the **lime**stone—Fort Worth.

Collection.—Johns Hopkins University.

NAUTILUS HILLI sp. nov.

Pl. XXIII, fig. 3; Pl. XXIV, figs. 3, 4.

Description.—Size varies from small to medium; subovate; compressed; dorsum boldly rounded; umbilicus, medium, circular, small; aperture not complete, increasing gradually in size; posterior portion semielliptical, deeply excavated by preceding volution; longest diameter measures about 105 mm.; greatest width a little below center; septa moderately concave forward; sutures on leaving the umbilicus are directed forward for a short distance, then turn with a sharp curve and run backward for a slightly greater distance, turning again, this time with a broader curve; they run forward once more for a distance about equal to their previous backward course and pass over the dorsum with a wide curve; siphuncle situated in dorso-ventral plane a little below the middle. The shell is without decorations and is smooth except for minute growth lines just distinguishable.

In this form the septa are more widely separated along the dorsum than in *Nautilus texanus*. External decorations are also absent.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

AMMONOIDEA.

Genus BARROISICERAS (?) Grossouvre.

BARROISICERAS TEXANUM sp. nov.

Pl. XXV, figs. 1, 2.

Dimensions.—Longest diameter, 9 cm.; diameter of umbilicus, 12 mm.; convexity, 2 cm.

Description.—Shell medium, subovate, compressed; umbilicus deep, medium, sides gently rounding to surface; body chamber incomplete, poorly preserved, increasing gradually in size, passing at least halfway around whorl; greatest thickness of shell about one-third distance from dorsal to ventral margin. As ribs pass from umbilicus over whorl they become somewhat curved and obscurely tubercled, and on the venter develop a low, oblong tubercle. Ribs 28 or more to the whorl. Sutures as a whole not extremely complex; as far as visible on specimen consist of a ventral superior and inferior lateral and two auxiliary lobes and an external lateral and three auxiliary saddles; of these the ventral lobe is the most complex in outline; the superior lateral less so; inferior lateral and auxiliaries progressively less complicated and rapidly decreasing in size until they disappear as mere notches; of the saddles the external is most sinous in outline, having a conspicuous notch in the center; lateral saddle slightly wavy; auxiliaries decreasing rapidly in size.

This species is represented by a single poorly preserved specimen.

Only fragments of the shell now remain adhering to the internal cast, and nowhere is the surface preserved. The suture lines appear to have suffered somewhat from solution.

Locality.—Little Bear Creek, Hays County, Tex.

Collection.—United States National Museum.

BARROISICERAS HYATTI sp. nov.

Pl. XXV, figs. 3, 4.

Dimensions.—Longest diameter, 4. cm.; diameter of umbilicus, 8 mm.; convexity, 15 mm.

Description.—Shell small, compressed; umbilicus deep, medium; sides sloping gently to surrounding surface; greatest thickness of shell about one-third distance from dorsal to ventral margin. As ribs pass from umbilicus over whorl they develop a slight double curve, carrying obscure tubercles, and on the venter develop a low, oblong tubercle. Suture not very complex; consists of ventral, superior, inferior lateral, and two auxiliary lobes and external, lateral, and three auxiliary saddles, ventral and superior lateral saddles of about equal complexity; inferior lateral and auxiliary lobes of progressively less strength and finally dwindle to mere notches; external and lateral saddles somewhat wavy in outline, but auxiliaries reduced to simple curves.

This species is represented by a fragment of an internal cast about an inch in length. A small portion of the shell still adheres to the cast, showing a smooth and undecorated surface.

Locality.—Shoal Creek, Austin, Tex.

Collection.—United States National Museum.

THE CORALS OF THE BUDA LIMESTONE.

By T. WAYLAND VAUGHAN

ANTHOZOA.

PARASMILIA TEXANA sp. nov.

Pl. XXVII, figs. 1-3.

Corallum short, subcornute; cross section elliptical, somewhat curved in the plane of the shorter transverse axis. Base not preserved intact, but evidently small.

Greater diameter of calice, 14 mm; lesser diameter of calice, 10 mm; height of corallum, 15.5 mm.

The costæ correspond to all cycles of septa, and are regularly alternately larger and smaller in size, the larger rather prominent. The edges are usually acute, both edges and sides granulate. No recognizable epitheca on the outside of the corallum. Septa in four complete cycles, reckoning six as the fundamental cycle. The margins are somewhat exsert. They are so-called entire; show no dentations, but some obscure crenations. The septal faces show striations, with granulations along their courses; the striæ are fine and alternate in position, i. e., the striæ on opposite sides of a septum do not stand opposite each other, but alternate with each other. The septal constitution, as interpreted from the striæ, is of ascending trabeculæ, with an area of divergence about corresponding in position with the wall. No pali could be discovered on any septum, the larger septa being directly continuous to the columella. The members of the first and second cycles and some of the third reach the columella. There is some dissepimental endotheca, and apparently occasional dissepiments exist between the costæ. The calicular fossa is moderately deep, not very narrow. The columella is very well developed, vesicular.

Locality.—Shoal Creek, Texas.

Type.—In the United States National Museum.

Remarks.—The only other species of *Parasmilia* from the Cretaceous of Texas is *P. austinensis* Roemer,[a] from the Edwards limestone,

[a] Ueber eine durch die Häufigkeit Hippuriten-artiger Chamiden ausgezeichnete Fauna der oberturonen Kreide von Texas. Mit 3 Tafeln. Palæontologische Abhandlungen, Vol. IV, pt. 4, Berlin, 1888, p. 284, Pl. XXI, Figs. 1a, 1b.

near Austin. A most striking difference between the two species is, the costæ in Roemer's species are equal in size, while in *P. texana* they alternate most pronouncedly.

TROCHOSMILIA (?) sp. indet.

Pl. XXVII, figs. 4, 5.

This species is represented by a single broken specimen, from which one can not make out sufficient detail to determine the genus. The specimen is 19 mm. high; the broken base has a greater diameter of 8 mm.; the greater diameter of the calice is about 15.5 mm., and the lesser 10 mm. or slightly more. The corallum is very nearly straight; the calice is apparently inclined to the vertical axis, the shorter transverse axis not lying in a horizontal plane. Wall, solid; costæ well developed, corresponding to all septa, regularly alternating in size. The larger costæ are tall, narrow, and thin, with sharp edges. Over the costæ are many granulations. This is the extent of the detail that can be described.

Locality.—Shoal Creek, Texas.

Type.—United States National Museum.

CORAL sp.

Pl. XXVI, figs. 2, 3.

A fine, large, simple coral, whose size and form are shown by the figures. The whole of the interior of the corallum has decayed, therefore the genus can not be determined.

Locality.—Shoal Creek, Texas.

Specimen figured.—Johns Hopkins University.

ORBICELLA (?) TEXANA sp. nov.

Pl. XXVI, fig. 1; Pl. XXVII, fig. 6.

Corallum forming rather large masses, as much as 140 mm. high and more than that much across. The corallites are small, the usual diameter being between 1 and 2 mm.; they are crowded or not, the distance between adjacent corallites being in some cases as great as the diameter of the corallites. The costæ are prominent and join the corallites one to another. The usual number of septa is 20, 10 small and 10 large; they are much thicker at the wall than in the costal or inner portion. The lateral faces bear rather tall, erect spines. Exotheca present; endotheca rare. Columella poorly developed, composed of a few processes from the inner ends of the septa.

Locality.—Shoal Creek, Texas.

Type.—Johns Hopkins University.

Remarks.—The specimens referred to this species are embedded in a hard yellow limestone, the condition of preservation being such

that it is impossible to describe them in detail. There is a possibility that the species may be a *Stephanocœnia*. This species might be confused with *Astrocœnia guadalupæ* Roemer.[a] The latter species, according to Roemer's generic reference, would have a styliform columella, but his description of this part of the skeleton is not explicit. *A. guadalupæ* is an Edwards limestone fossil, as Roemer states, and the specimens have been changed into black flint. Flints are found only in the Edwards limestone in Texas.

LEPTOPHYLLIA sp. (No. 1.)

Pl. XXVII, figs. 9–11.

This specimen is fragmentary, being broken across the top. The transverse outline is not exactly but is approximately circular; the diameter of the upper broken end is about 20 mm.; the height of the specimen is about 14 mm. The outside of the corallum is not preserved in its original condition. No scar of detachment was seen. There appears to be no well-developed wall; the outer ends of the septa have a discontinuous coating over them that in part is probably epithecal in character. The septa are very numerous, thin, crowded, and extremely perforate. Nine septa were counted in the space of 5 mm. Synapticula are numerous, and apparently there are also some dissepiments. There is no columella. A considerable number of the larger septa reach the axial space.

Locality.—Shoal Creek, Texas.

Specimen.—In the United States National Museum.

LEPTOPHYLLIA sp. (No. 2.)

Pl. XXVII, figs. 7, 8.

The single specimen of this species is good, but not perfect. The chief difficulty in treating the species is that one specimen is not sufficient to give an adequate idea of all the essential specific characters.

The corallum is simple, irregular in shape, low, with an elliptical cross section. The base is not well preserved, but the corallum is apparently attached and the base is probably moderately large.

Greater transverse diameter, 20 mm.; greater diameter of calice, 16.5 mm.; lesser diameter of calice, 13.5 mm.; height of corallum, 11 mm.

Through an apparent deformity, the calice became constricted at a certain height above the base, so that the transverse diameters of the calice are not so great as the greatest diameters of the corallum. The figures show these features.

Neither true theca nor pseudotheca is present. There appears to be some epitheca. Synapticula are abundant between the peripheral

[a] Kreidebildungen von Texas und ihre organischen Einschlüsse, Bonn, 1852, p. 87, Pl. X, fig. 8, a, b.

ends of the septa. The septa are crowded, not very thick; as nearly as could be made out, in five cycles, six systems; the fifth cycle may not always be complete. Only a portion of the calice is well preserved. The septal faces are granulate; septal perforations fairly abundant, especially on the inner portions of the larger septa. Synapticula are rather abundant, and there may be, though I am not certain, an occasional dissepiment. There is no developed columella; the septa of the first, second, and third cycles, and some of the fourth, meet in the axial space.

Locality.—Shoal Creek, Texas.

Specimen described and figured.—United States National Museum.

This species differs from *Leptophyllia* sp. (No. 1) by being elliptical in cross section and having less perforate septa. The number of septa to 5 mm. is the same for both species. They may in reality belong to the same species, but such can not be proved from the material at my disposal.

PLATE II.

PLATE II.

Page.

Pecten roemeri (Hill) 15

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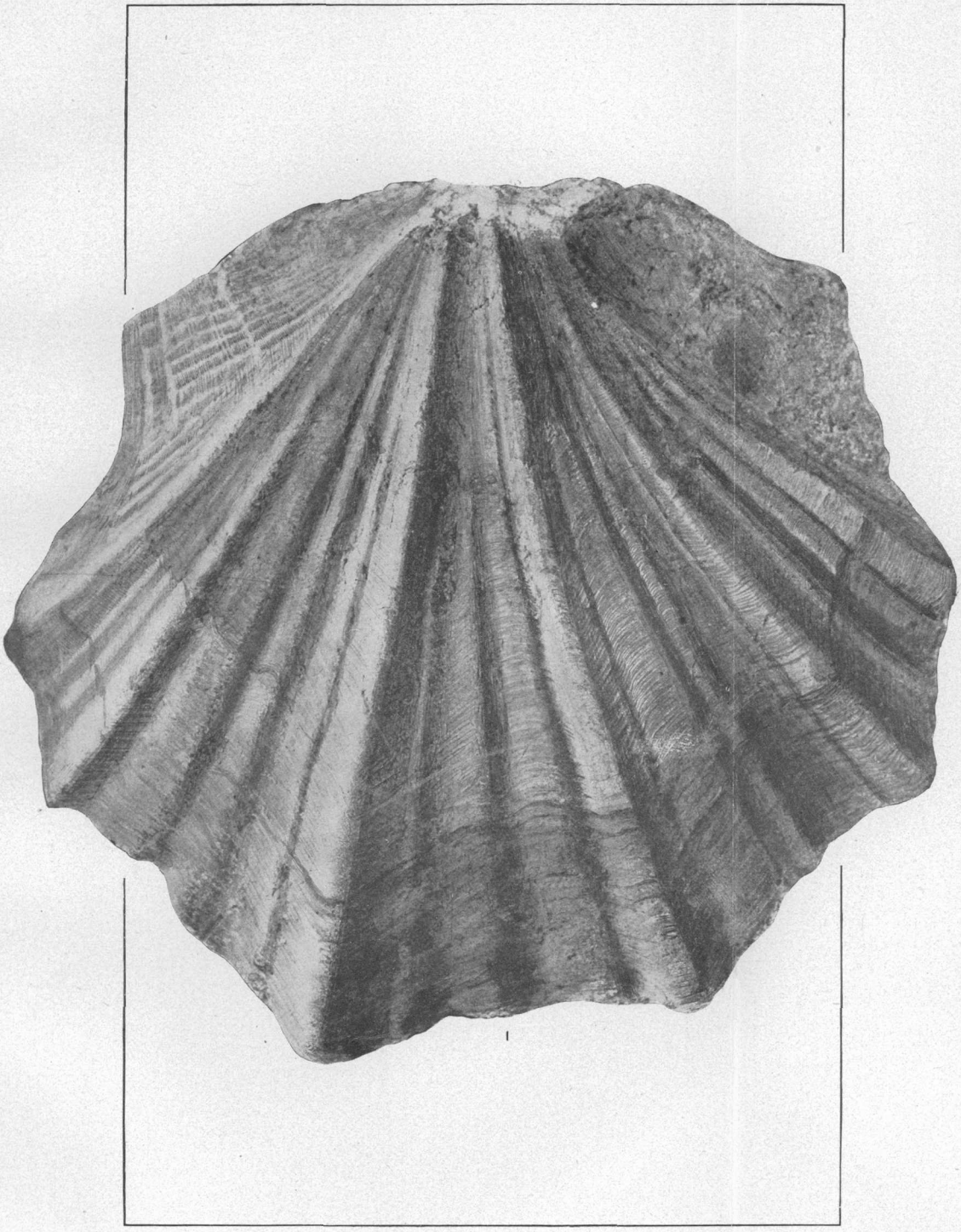

PECTEN ROEMERI (HILL).

PLATE III.

PLATE III.

Page.

Pecten roemeri (Hill) 15

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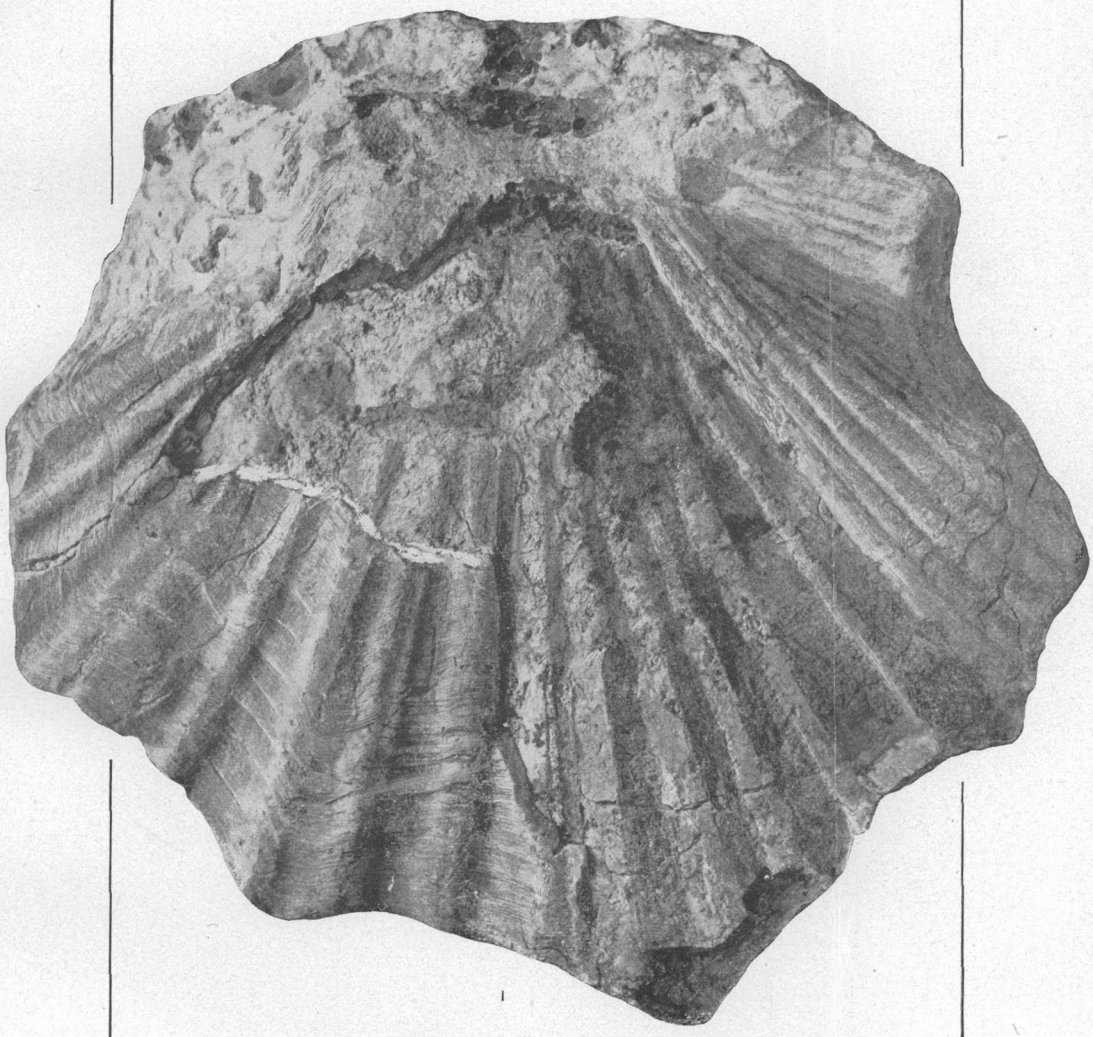

PECTEN ROEMERI (HILL).

PLATE IV.

PLATE IV.

Page.

Pecten roemeri (Hill) 15

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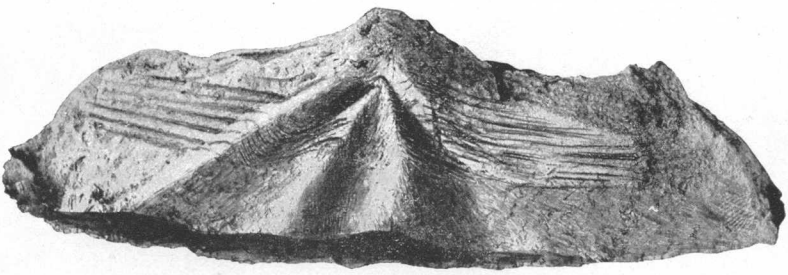

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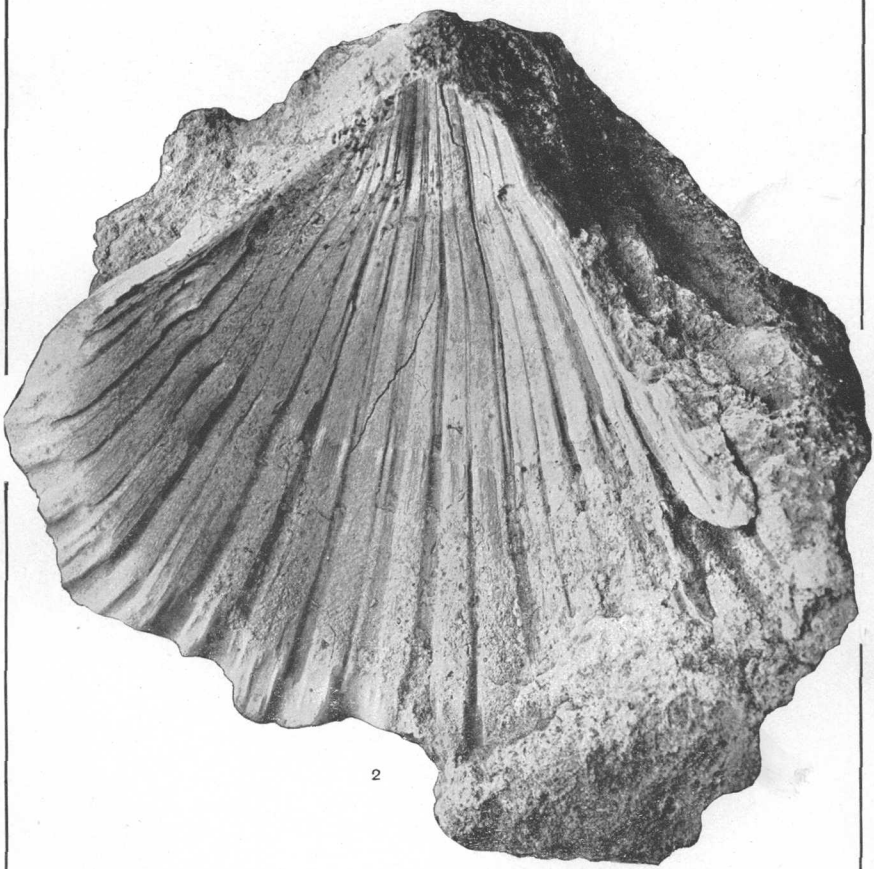

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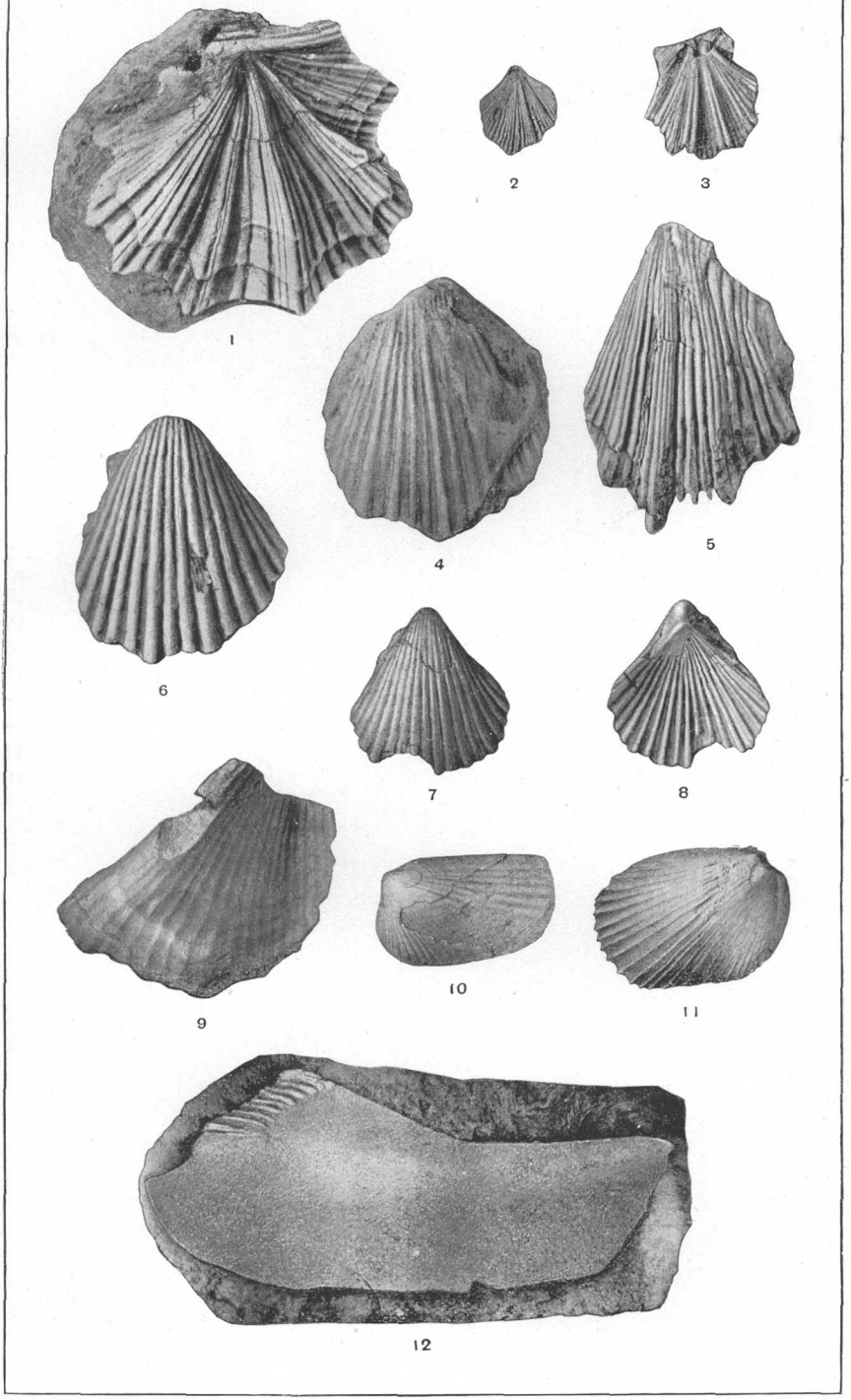
PECTEN ROEMERI (HILL).

PLATE V.

PLATE V.



PECTEN, LIMA, GERVILLIOPSIS.

PLATE VI.

PLATE VI.

Page.

Pinna sp. 19

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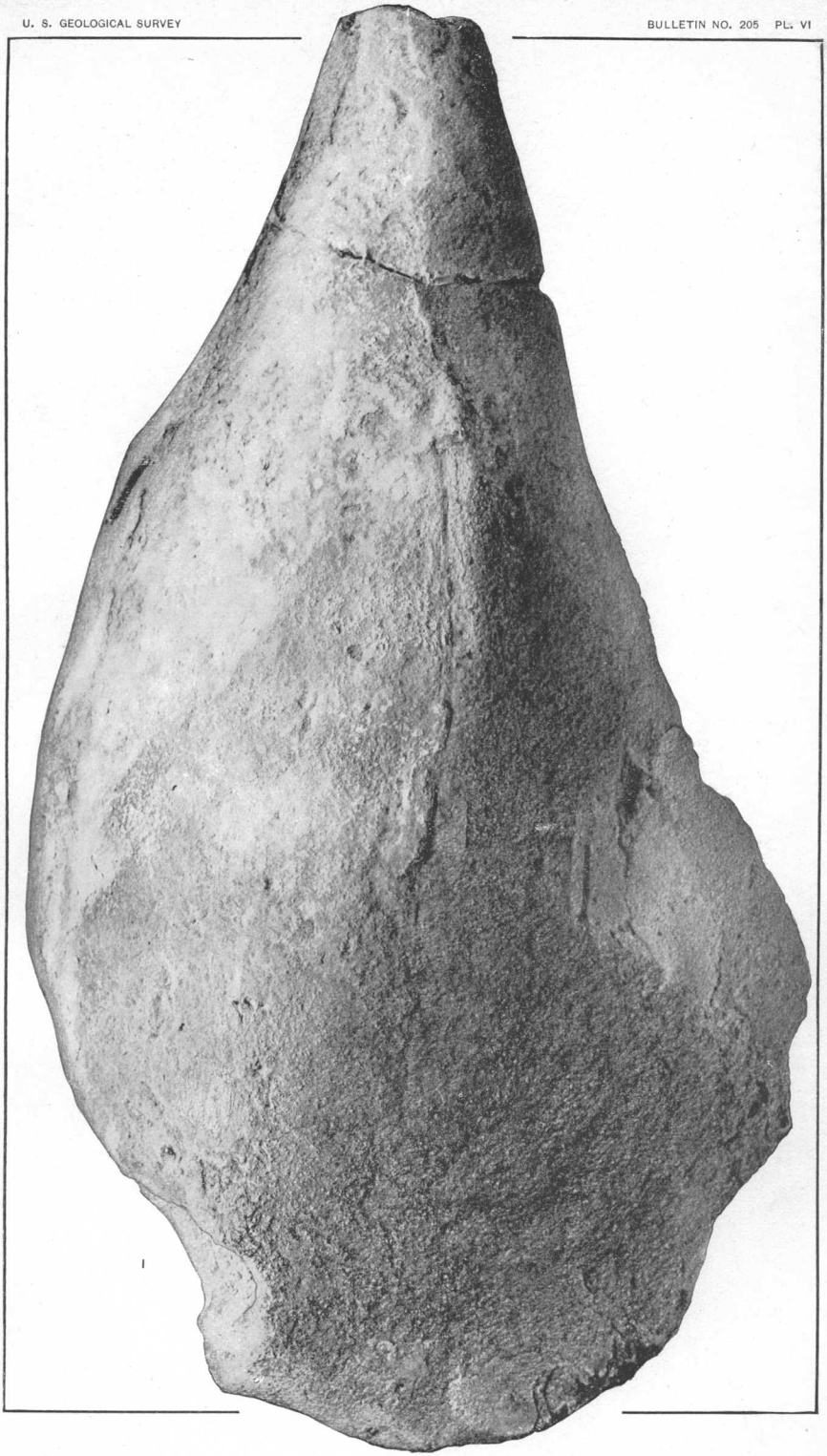


PINNA SP.

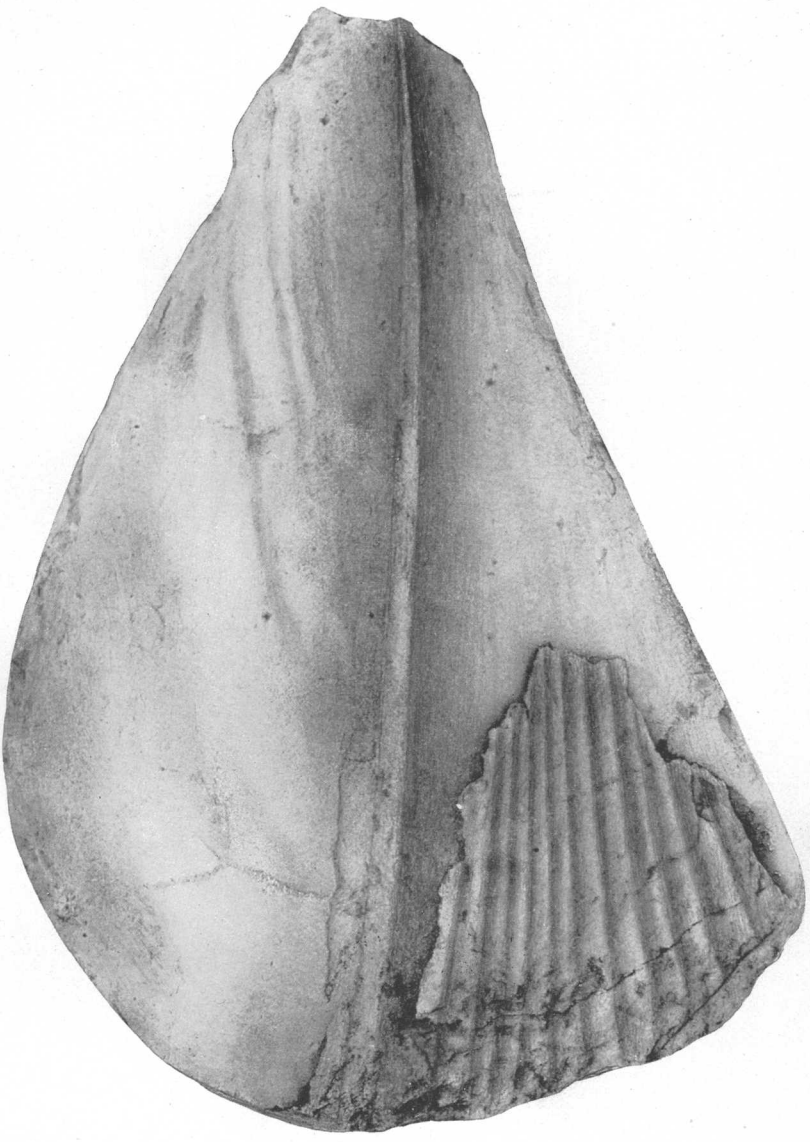
PLATE VII.

PLATE VII.

Page.

Pinna sp 19

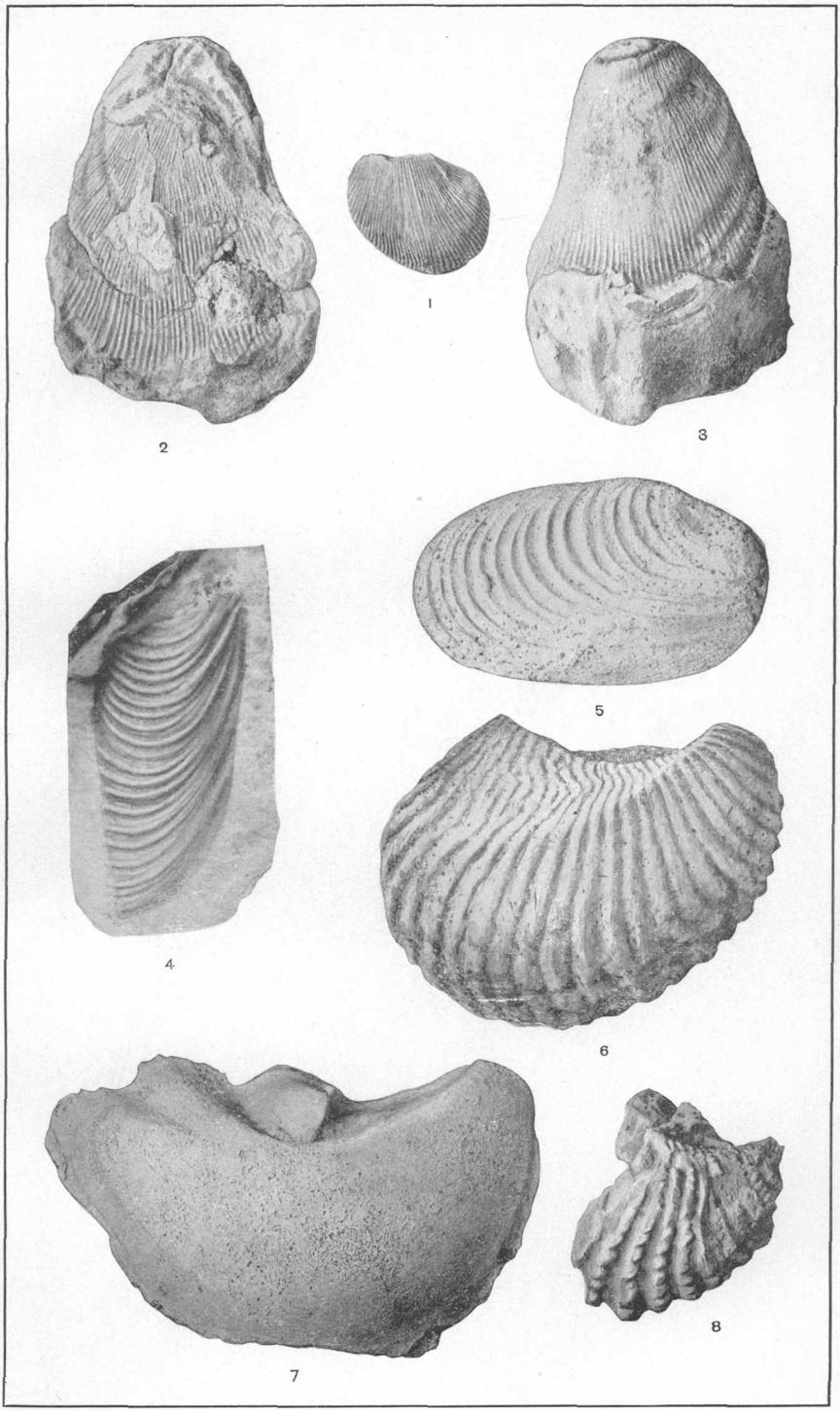
52



PINNA SP.

PLATE VIII.

PLATE VIII.



SPONDYLUS, MODIOLA, TRIGONIA.

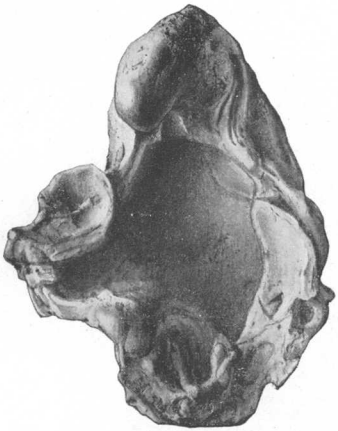
PLATE IX.

PLATE IX.

Page.

Gryphæa mucronata Gabb 21

56



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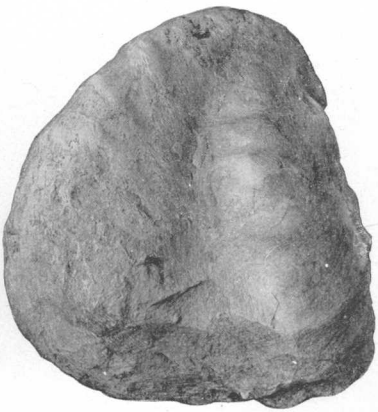

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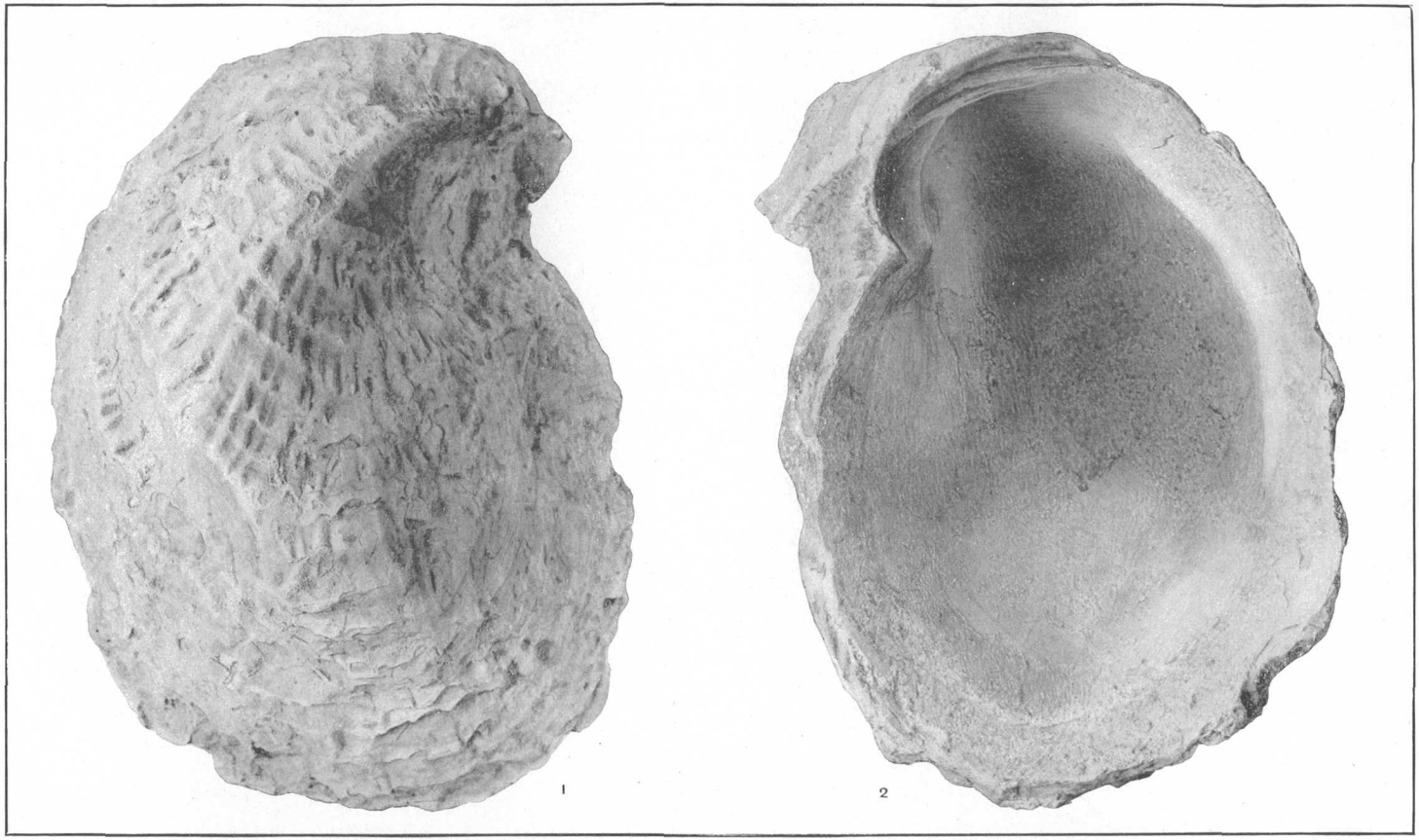
GRYPHÆA MUCRONATA GABB.

PLATE X.

PLATE X.



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EXOGYRA CLARKI SP. NOV.

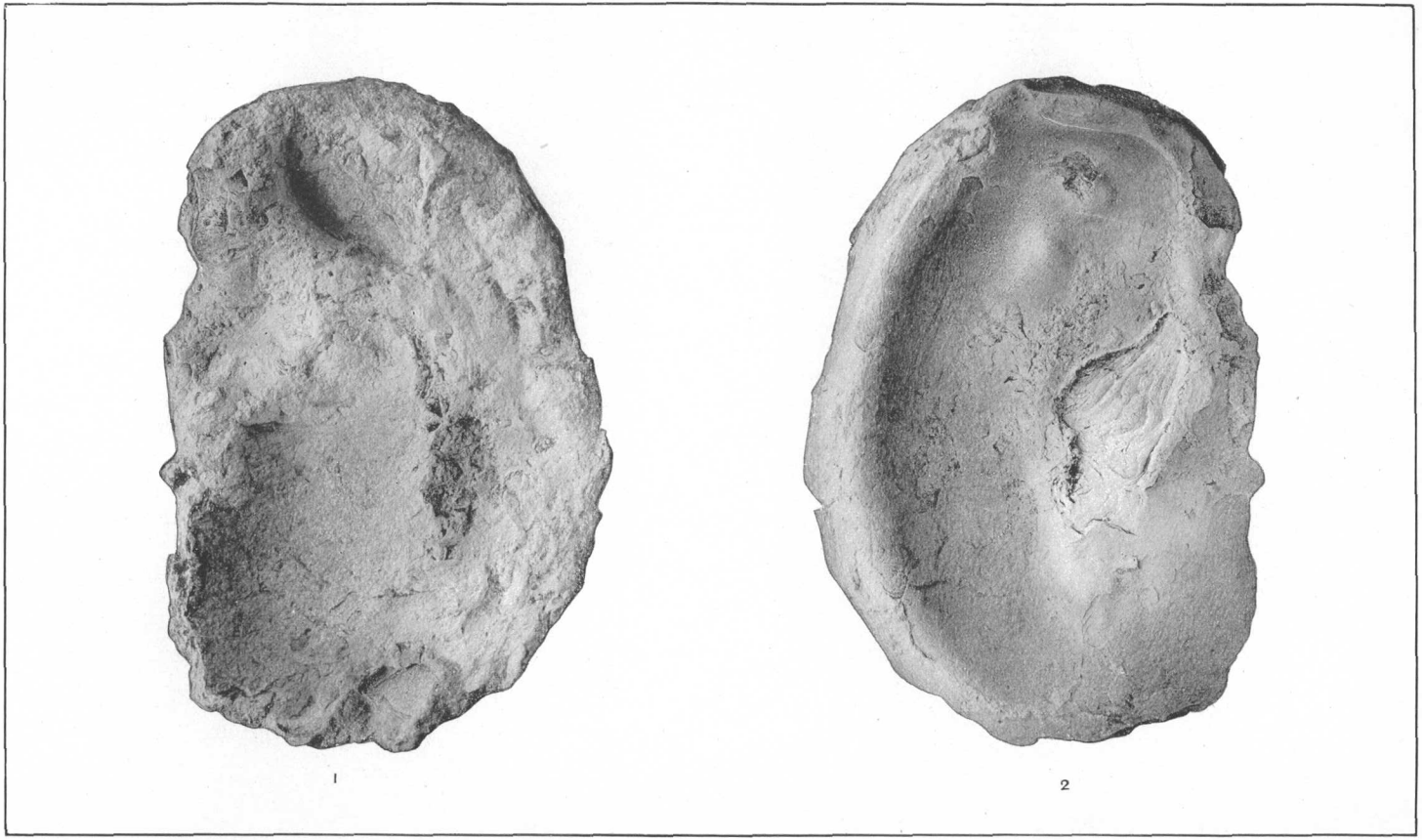
PLATE XI.

PLATE XI.

Page.

Exogyra clarki sp. nov..... 22

60



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EXOGYRA CLARKI SP. NOV.

PLATE XII.

PLATE XII.

Page.

Ptychomya ragsdalei (Cragin) 24

62

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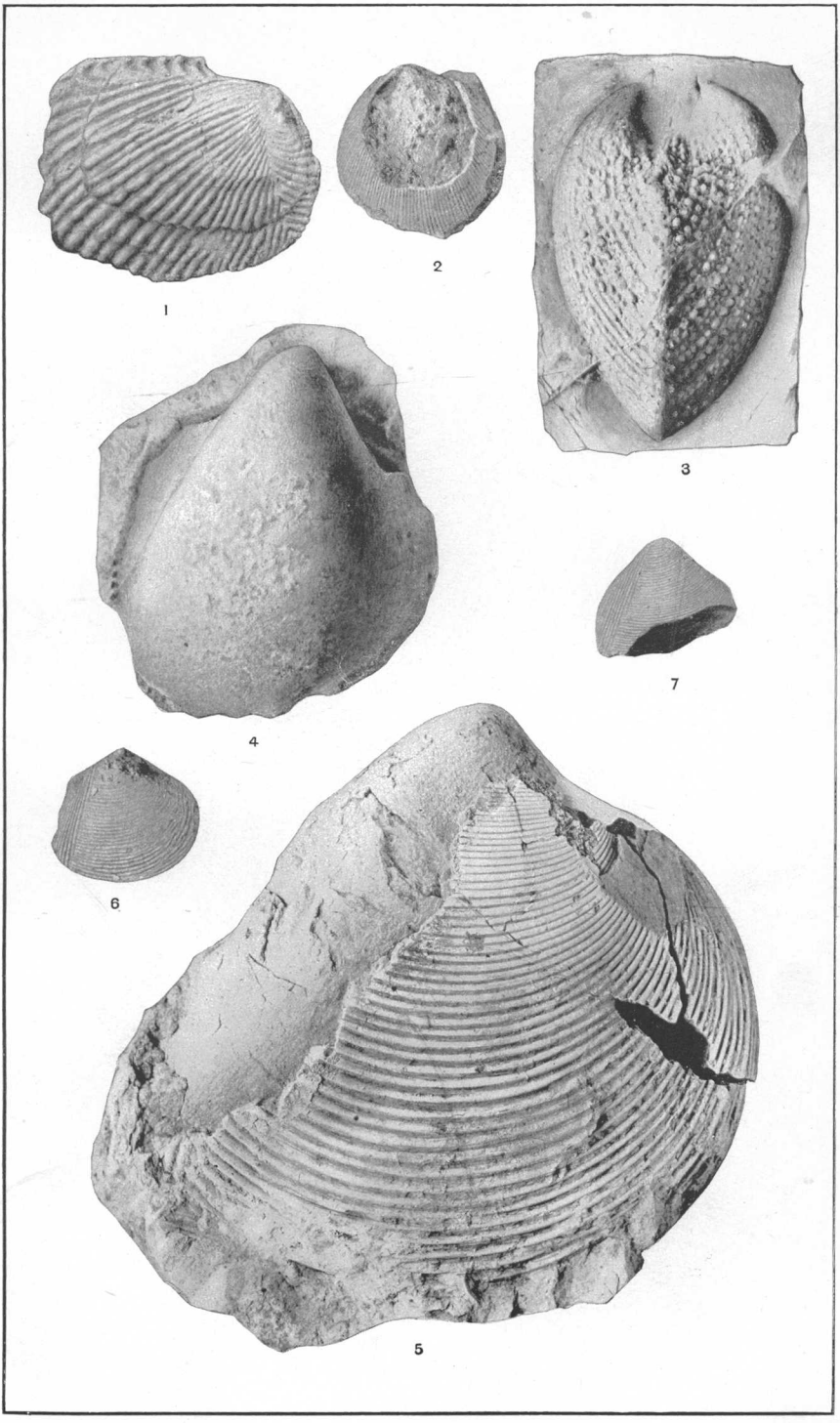
PTYCHOMYA RAGSDALEI (CRAGIN).

PLATE XIII.

PLATE XIII.



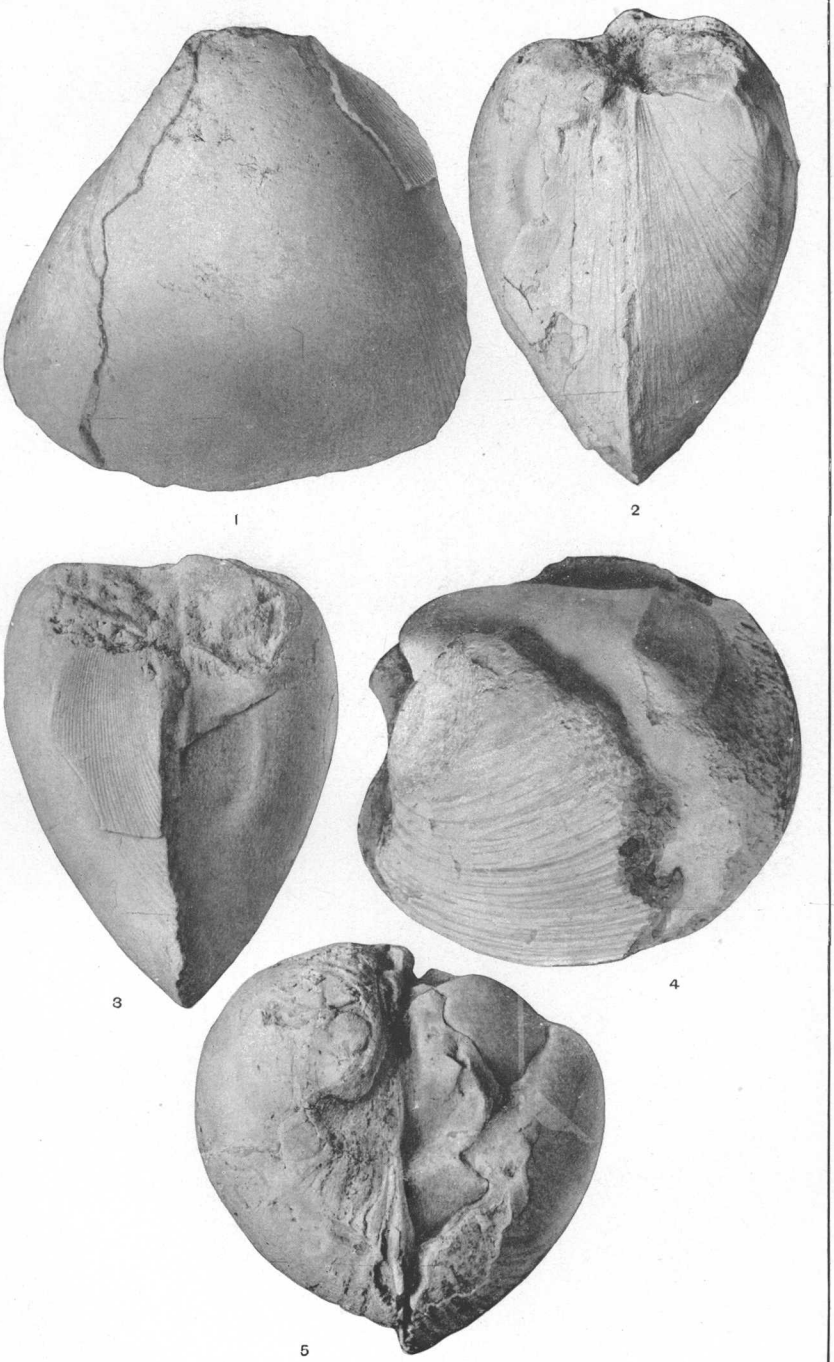
PTYCHOMYA, CARDIUM.

PLATE XIV.

PLATE XIV.

Page.

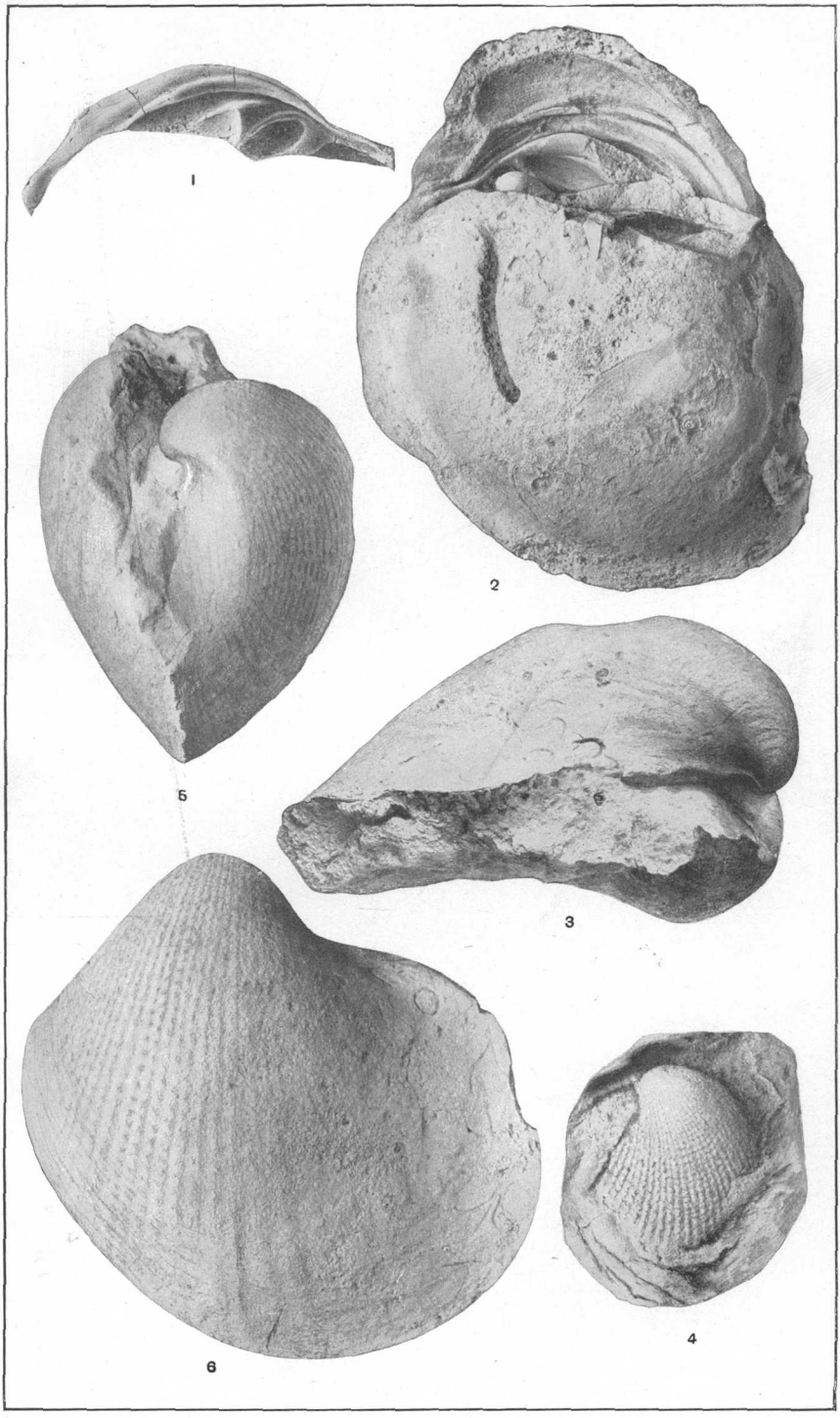
Figs. 1–3. Cardium (Protocardia) vaughani sp. nov 26
Figs. 4, 5. Isocardia medialis (Conrad) 27



CARDIUM, ISOCARDIA.

PLATE XV.

PLATE XV.



ISOCARDIA, PHOLADOMYA.

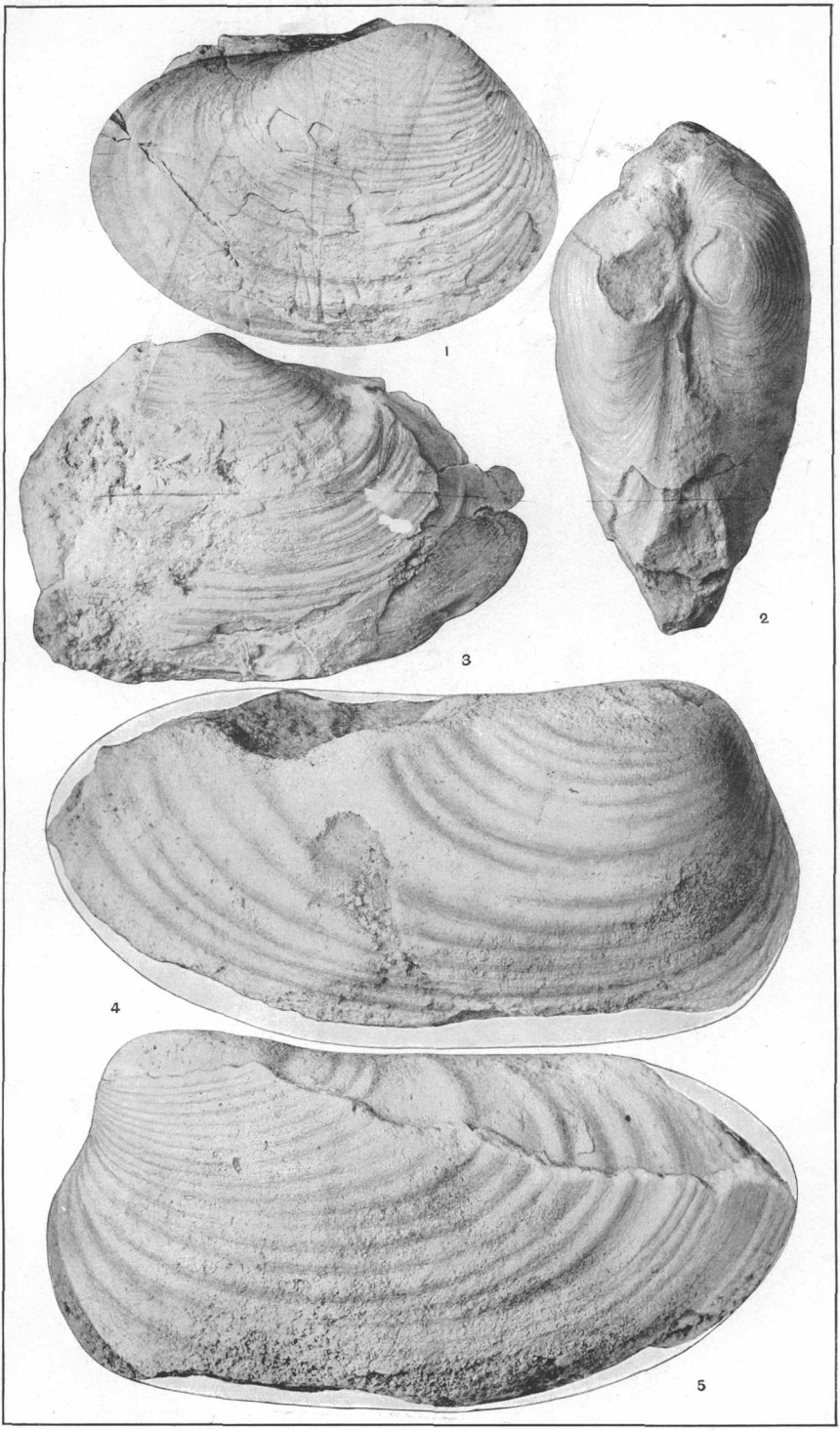
PLATE XVI.

PLATE XVI.

Page.

Figs. 1–3. Homomya austinensis sp. nov 28

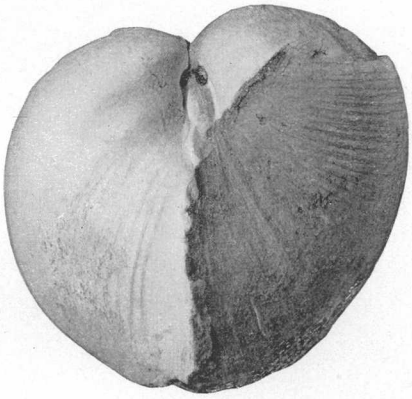
Figs. 4, 5. Homomya vulgaris sp. nov 29



HOMOMYA.

PLATE XVII.

PLATE XVII.



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HOMOMYA VULGARIS SP. NOV.

PLATE XVIII.

PLATE XVIII.

Page.

Figs. 1, 2. Anatina austinensis sp. nov 29
Fig. 3. Anatina texana sp. nov 30

1

2

3

ANATINA.

PLATE XIX.

PLATE XIX.

1

2

3

7

4

8

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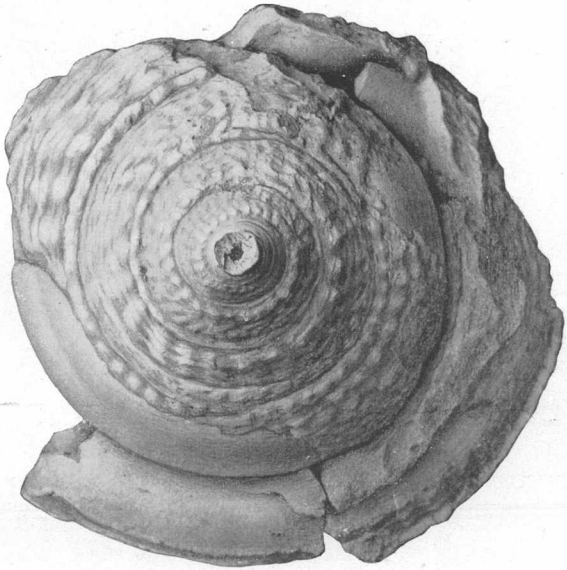
11

PATELLA, TROCHUS, TURRITELLA, CERITHIUM, FUSUS.

PLATE XX.

PLATE XX.

78



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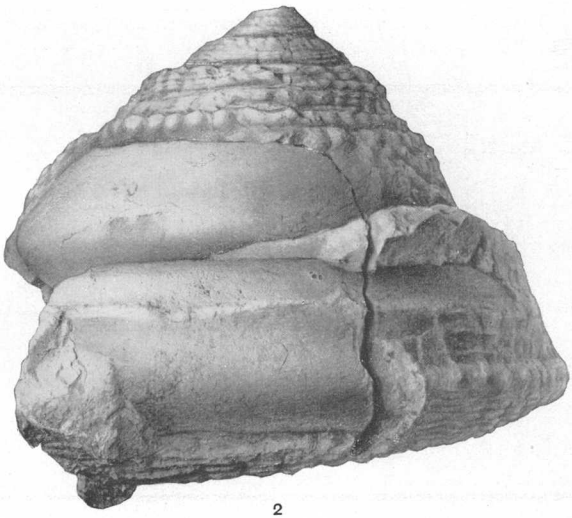

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PLEUROTOMARIA STANTONI SP. NOV.

PLATE XXI.

PLATE XXI.

Page

Harpagodes shumardi (Hill) 32

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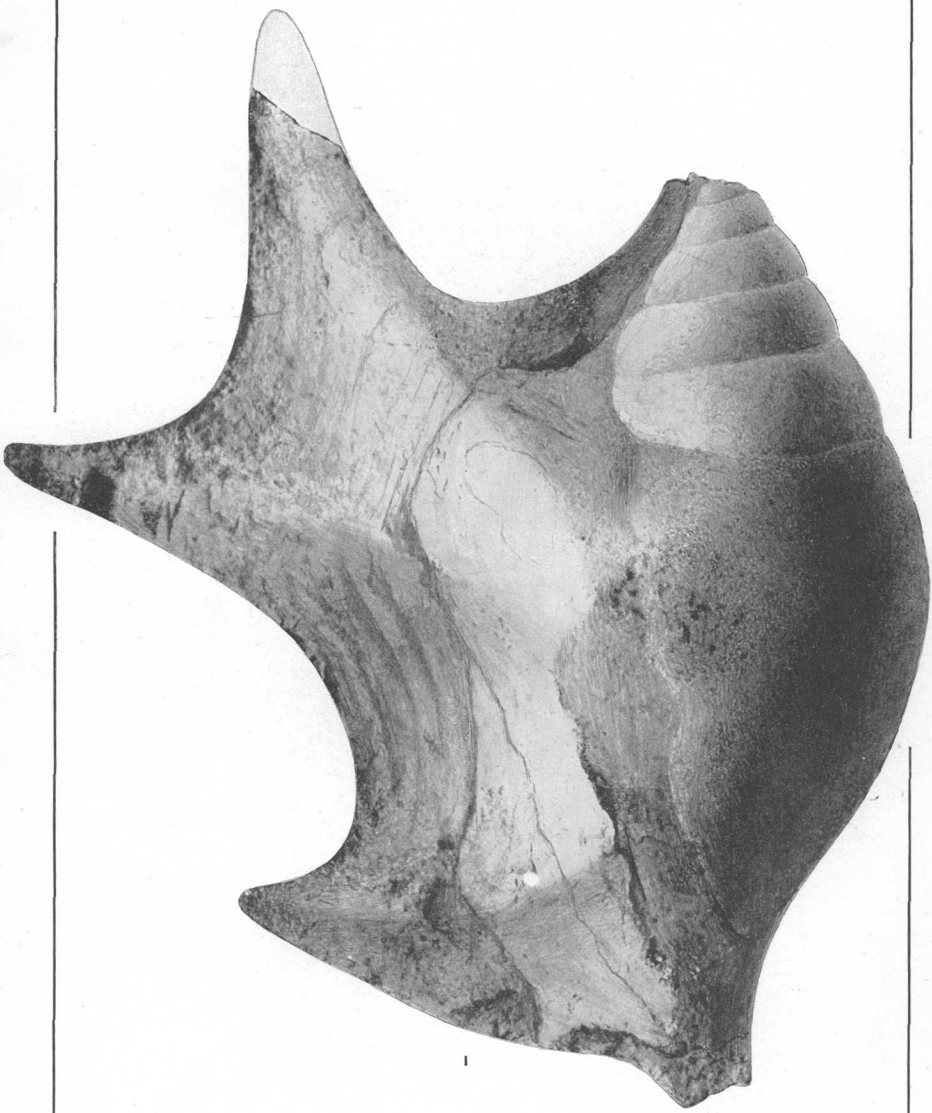

HARPAGODES SHUMARDI (HILL).

PLATE XXII.

PLATE XXII.

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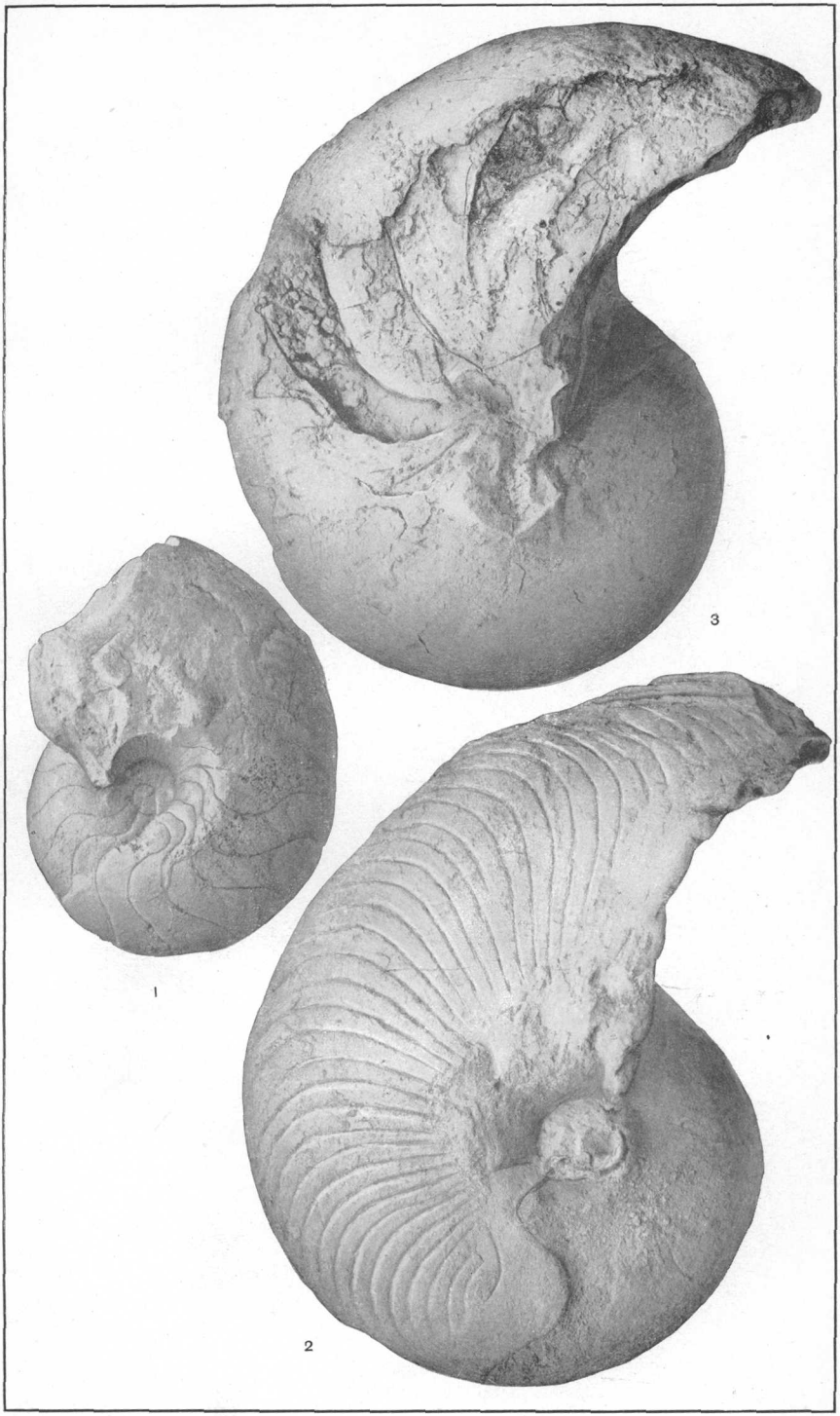
CYPRÆA SP.

PLATE XXIII.

PLATE XXIII.



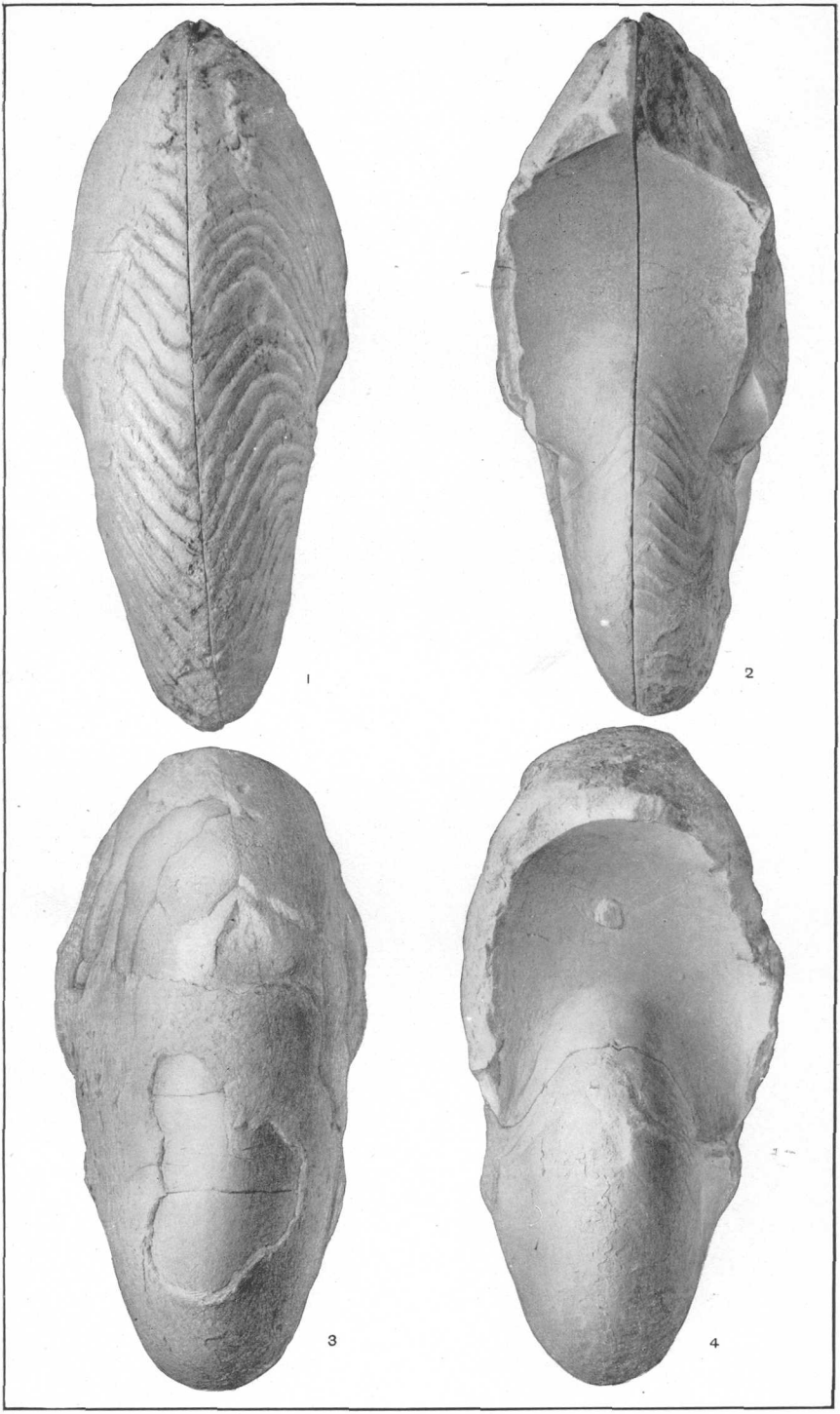
NAUTILUS.

PLATE XXIV.

PLATE XXIV.

Page.

Figs. 1, 2. Nautilus texanus Shumard 34
Figs. 3, 4. Nautilus hilli sp. nov 35



NAUTILUS.

PLATE XXV.

PLATE XXV.

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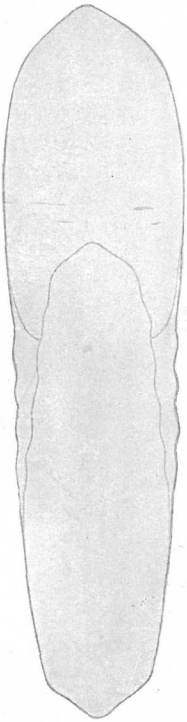

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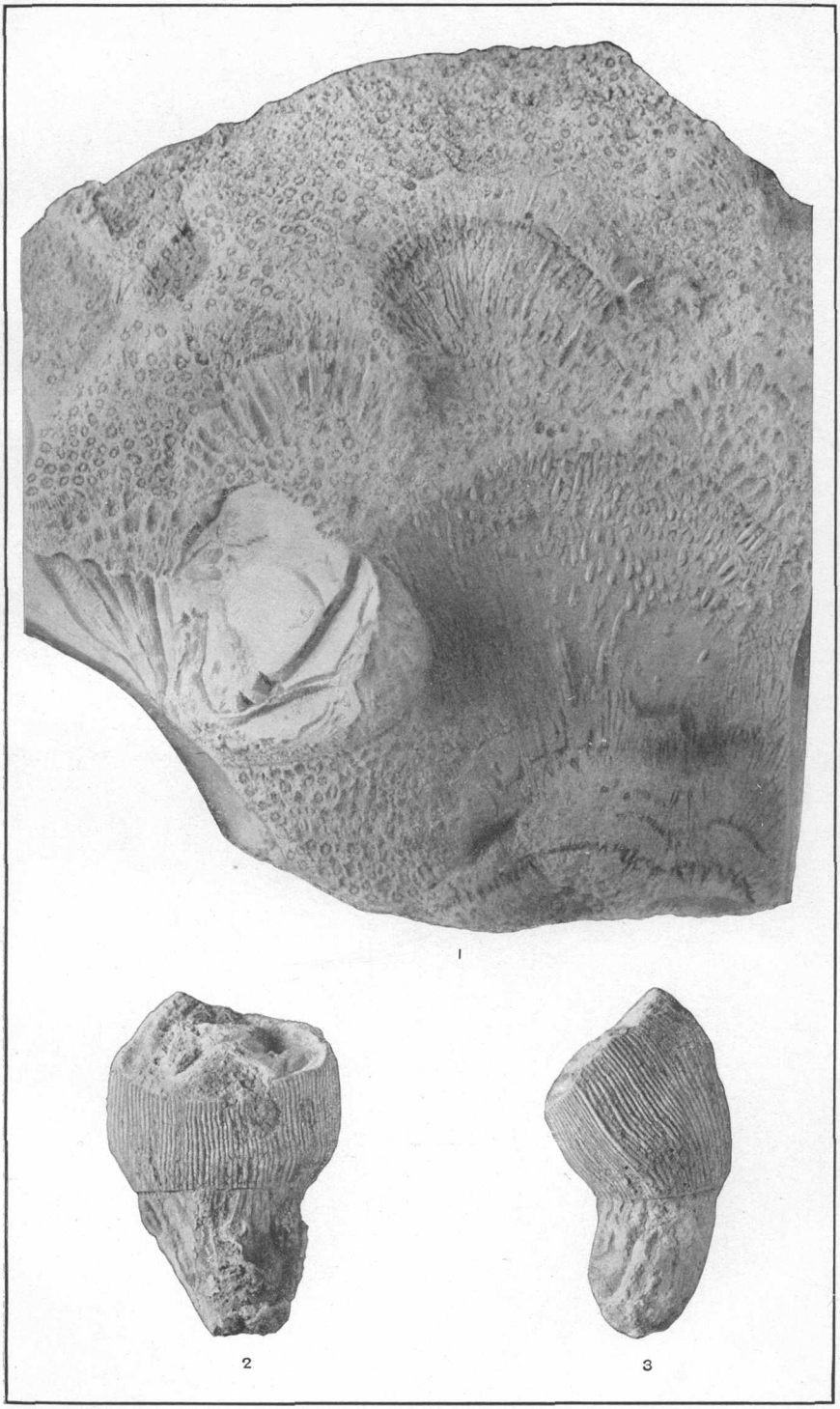
BARROISICERAS.

PLATE XXVI.

PLATE XXVI.

CORALS OF THE BUDA LIMESTONE.

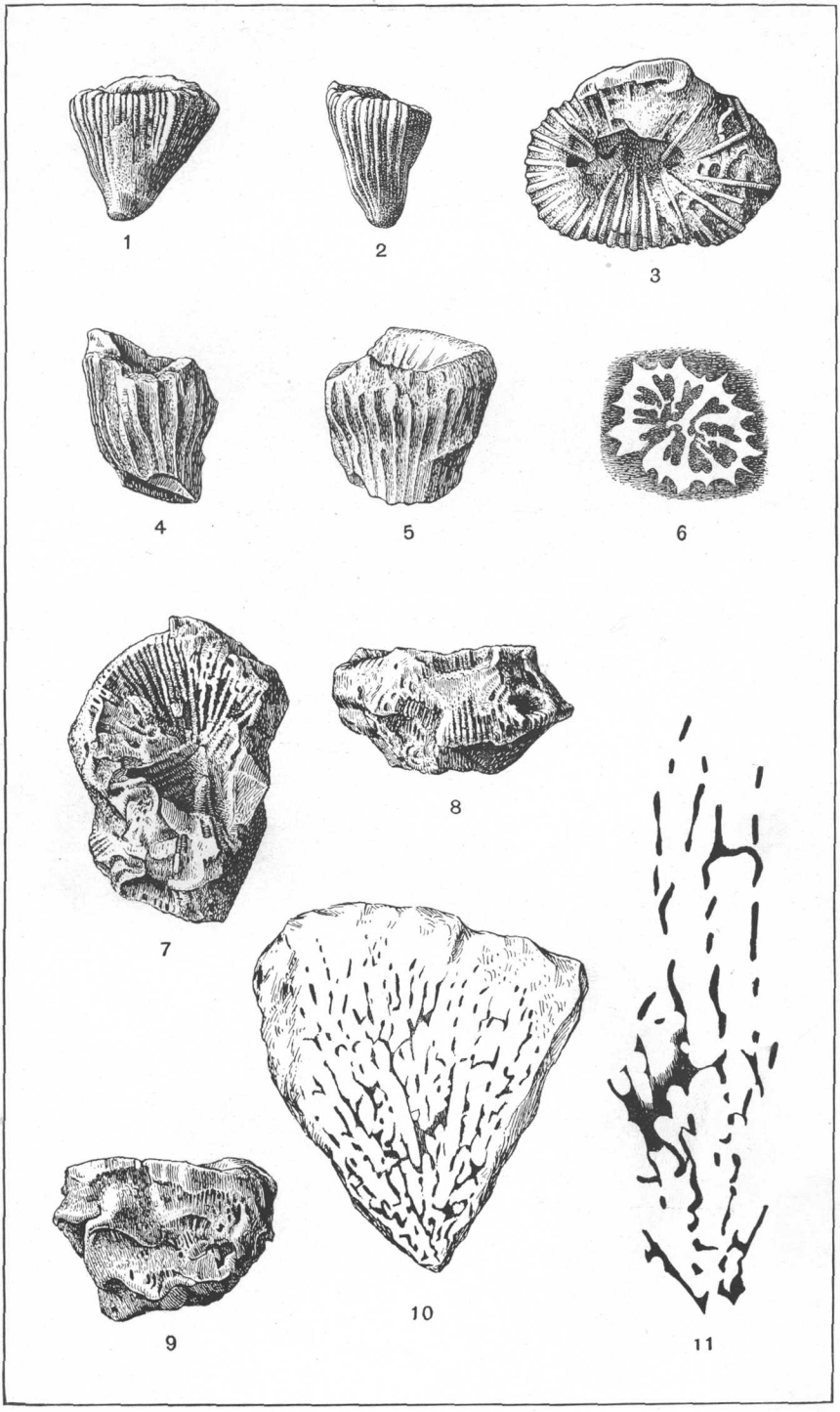


CORALS OF THE BUDA LIMESTONE.

PLATE XXVII.

PLATE XXVII.

CORALS OF THE BUDA LIMESTONE.



CORALS OF THE BUDA LIMESTONE.

INDEX.

[Names in italic are synonyms; figures in black-face type are numbers of page on which detailed descriptions appear; figures in italic denote illustrations.]

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

[Bulletin No. 205.]

The serial publications of the United States Geological Survey consist of (1) Annual Reports, (2) Monographs, (3) Professional Papers, (4) Bulletins, (5) Mineral Resources, (6) Water-Supply and Irrigation Papers, (7) Topographic Atlas of United States—folios and separate sheets thereof, (8) Geologic Atlas of United States—folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

The Bulletins, Professional Papers, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, Methods of hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports. This bulletin is the fifty-ninth number in Series C, the complete list of which follows (all are bulletins thus far):

SERIES C, SYSTEMATIC GEOLOGY AND PALEONTOLOGY.

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