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WASHINGTON, D. C., *August, 1893.*

Robert T. Jackson

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No. 106

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Robert T. Jackson

UNITED STATES GEOLOGICAL SURVEY

J. W. POWELL, DIRECTOR

THE COLORADO FORMATION AND ITS INVERTEBRATE FAUNA

BY

TIMOTHY W. STANTON

WASHINGTON
GOVERNMENT PRINTING OFFICE
1893

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LETTER OF TRANSMITTAL.

Department of the Interior,
United States Geological Survey,
Division of Mesozoic Invertebrates,
Washington, D. C., July 30, 1892.

Sir: I have the honor to transmit herewith a memoir by Mr. T. W. Stanton on the Colorado Formation and its Invertebrate Fauna, prepared for publication as a bulletin. The work was begun by him at my suggestion, and I have, as chief of the division with which he is connected, been constantly cognizant of its progress.

Very respectfully,

C. A. White,
Geologist in Charge.

Hon. J. W. Powell,
Director of the U. S. Geological Survey.

PREFACE.

The following review of one of the Upper Cretaceous faunas as developed in the interior region of the United States has grown out of the study of a collection of fossils found by me in Huerfano park and adjacent localities in southern Colorado. This collection, the greater part of which was obtained during the summer of 1890, proved to be especially interesting because it afforded data for the closer correlation of certain Cretaceous strata in Utah with those east of the mountains, besides adding a considerable number of new species to the fauna of the Colorado formation. Dr. C. A. White, under whose direction the field work was done, generously assigned these fossils to me for study with a view to publishing the results, and I am greatly indebted to his sympathetic aid in every phase of the work.

The stratigraphic position of the Huerfano park fossils had been fully established in the field to be beneath the Niobrara division of the Colorado formation. In making the preliminary comparisons of species it soon became evident that the fauna of this horizon was much richer than had been supposed. Only about twenty-five or thirty species of invertebrates had been definitely assigned to the strata that are now included in the Colorado formation. Many had been described simply as Cretaceous without assignment to more definite horizons and a considerable number of other species had been erroneously referred to the overlying Montana formation. It therefore became necessary to study as far as practicable the vertical range and the faunal associates of these doubtful species, especially those reported from Utah and New Mexico, making use of the collections of the U. S. National Museum and of the Geological Survey, as well as the published reports and my own observations in the field. This investigation added a large number of species to the fauna of the Colorado formation and showed the desirability of bringing together in one publication the scattered descriptions and illustrations of all the species that can now be assigned to the fauna. While making this compilation the nomenclature and descriptions of the species have been revised in all cases in which better collections or other additional facts seemed to make it necessary. Thirty-nine species are described that are believed to be new to science.

The purely paleontologic portion of the work is supplemented by a geologic introduction in which the Colorado formation is defined, many local sections are described, and faunal lists are given that show the vertical range and areal distribution of the most of the species. Incidentally, some new evidence concerning the position of the Bear River formation is given, and large areas of Cretaceous strata in Utah are correlated with the formations east of the Rocky mountains more accurately than has heretofore been possible.

In addition to the aid received from Dr. C. A. White and the free use of the collections under his curatorship in the U. S. National Museum, I am under many obligations to Dr. W. H. Dall and to Mr. Charles T. Simpson, of the National Museum, for assistance in comparing fossils with recent species, and for valued opinions concerning the generic relations of doubtful forms; also to Prof. Alpheus Hyatt, who has examined several of the species of *Ammonitinæ* at my request, and has given me the benefit of his authoritative opinion as to their relationships.

T. W. S.

THE COLORADO FORMATION AND ITS INVERTEBRATE FAUNA.

By T. W. STANTON.

INTRODUCTION.

HISTORY AND DEFINITION OF THE COLORADO FORMATION.

For many years the well-known upper Missouri section has served as the basis for all studies in the Cretaceous formations of the great interior region of the United States. As first published in 1856, by Hall and Meek,[1] and with a few slight modifications, by Meek and Hayden,[2] it embodied the notes on the Cretaceous strata made by the two authors last named during the earliest of their geological reconnoissances in the upper Missouri river region. It has since been modified and enlarged from time to time by the same authors and by others, and made to include, more or less successfully, all the Upper Cretaceous strata in the region from Kansas to Arizona and from southern New Mexico far northward into British America.

In its original form this upper Missouri section was divided into five parts, which were simply designated by numbers, beginning at the base. The total thickness of the entire Cretaceous series of that region was at first estimated at not more than 650 feet. In 1861 Messrs. Meek and Hayden[3] published a paper in which names were given to the five divisions, with the addition of lists of characteristic fossils and references to typical localities. It should be remembered that this is not a continuous section at any one locality, but it is generalized from all the outcrops seen over a very large area. The thickness assigned to each group is an estimate of its maximum development. The section, as republished in 1876 by Meek,[4] who made no changes excepting in the nomenclature of a few of the fossils, is as follows:

[1] Mem. Am. Acad. Arts. and Sci., 2d ser., vol. v, p. 405.
[2] Proc. Acad. Nat. Sci. Phila., vol. VIII, p. 63.
[3] Proc. Acad. Nat. Sci. Phila., 1861, p. 419.
[4] U. S. Geol. Sur. of the Territories, vol. IX, pp. XXIV and XXV.

General section of the Cretaceous rocks of Nebraska.

		Divisions and subdivisions.	Localities.	Estimated thickness.	
Upper Series.	Fox Hills Group. Formation No. 5.	Gray, ferruginous, and yellowish sandstone and arenaceous clays, containing Belemnitella bulbosa, Nautilus Dekayi, Placenticeras placenta, P. lenticularis, Scaphites Conradi, S. Nicolleti, Baculites grandis, Pyropsis Bairdi, Piestochilus Culbertsoni, Pyrifusus Newberryi, Anchura Americana, Pseudobuccinum Nebrascensis, Mactra Warrenana, Cardium subquadratum, and a great number of other molluscan fossils, together with bones of Mosasaurus missouriensis, etc.	Fox Hills, near Moreau river; near Long lake, above Fort Pierre; along the base of the Big Horn mountains, and on North and South Platte rivers.	500 feet.	Equivalents of Upper or White Chalk and Mæstricht beds (Sénonien, d'Orbigny).
	Fort Pierre Group. Formation No. 4.	Dark-gray and bluish plastic clays, containing, near the upper part, Nautilus Dekayi, Placenticeras placenta, Baculites ovatus, B. compressus, Scaphites nodosus, Dentalium gracile, Crassatella Evansi, Cucullæa Nebrascensis, Inoceramus Sagensis, I. Nebrascensis, I. Vanuxemi, bones of Mosasaurus missouriensis, etc.	Sage creek, Cheyenne river, and on White river above the Mauvaises Terres.	700 feet.	
		Middle zone nearly barren of fossils.	Fort Pierre and out to Bad Lands; also down the Missouri on the high country to Great Bend.		
		Lower fossiliferous zone, containing Ammonites complexus, Baculites ovatus, B. compressus, Heteroceras Mortoni, H. tortum, H. umbilicatum, H. cochleatum, Ptychoceras Mortoni, Odontobasis vinculum, Anisomyon borealis, Amauropsis paludiniformis, Inoceramus sublævis, I. tenuilineatus, bones of Mosasaurus missouriensis, etc.	Great Bend of the Missouri below Fort Pierre.		
		Dark bed of very fine unctuous clay, containing much carbonaceous matter, with veins and seams of gypsum, masses of sulphuret of iron, and numerous small scales of fishes. Local; filling depressions in the bed below.	Near Bijou Hill, on the Missouri.		

General section of the Cretaceous rocks of Nebraska—Continued.

		Divisions and subdivisions.	Localities.	Estimated thickness.	
Lower Series.	Niobrara Division. Formation No. 3.	Lead-gray calcareous marl, weathering to a yellowish or whitish chalky appearance above. Containing large scales and other remains of fishes, and many specimens of Ostrea congesta attached to fragments of Inoceramus; also several species of Textularia. Passing down into light, yellowish, and whitish limestone, containing great numbers of Inoceramus problematicus, I. pseudomytiloides, I. aviculoides, and Ostrea congesta, fish-scales, etc.	Bluffs along the Missouri below the Great Bend, to the vicinity of Big Sioux river; also below there on the tops of the hills.	200 feet.	Equivalents of Lower or Gray Chalk and Upper Greensand of British geologists (Turonien and Cenomanien of d'Orbigny.
	Fort Benton Group. Formation No. 2.	Dark-gray laminated clays, sometimes alternating near the upper part with seams and layers of soft gray and light-colored limestone. Inoceramus problematicus, I. tenuirostratus, I. latus ? I. fragilis, Ostrea congesta, Veniella Mortoni, Pholadomya papyracea, Ammonites Mullananus, Prionocyclus Woolgari, Mortoniceras Shoshonense, Scaphites Warrenanus, S. larvæformis, S. ventricosus, S. vermiformis, Nautilus elegans, etc.	Extensively developed near Fort Benton on the Upper Missouri; also along the latter from 10 miles above James river to Big Sioux river; and along the eastern slope of the Rocky mountains, as well as at the Black Hills.	800 feet.	
	Dakota Group. Formation No. 1.	Yellowish, reddish, and occasionally white sandstone, with at places alternations of various colored clays and beds and seams of impure lignite; also silicified wood, and great numbers of leaves of the higher types of dicotyledonous trees, with casts of Pharella ? Dakotensis, Trigonarca Siouxensis, Cyrena arenarea, Margaritana Nebrascensis, etc.	Hills back of the town of Dakota; also extensively developed in the surrounding country in Dakota county below the mouth of Big Sioux river; and thence extending southward into northeastern Kansas and beyond.	400 feet.	

To complete the Upper Cretaceous section of this region there must be added to it at the top the great coal bearing Laramie series of fresh and brackish water beds, which were regarded as Tertiary at the time of the earlier explorations, but are now generally assigned to the Cretaceous; and in western Wyoming the Bear River formation must be interpolated. It is also a brackish-water formation, and was formerly believed to be a part of the Laramie.[1] It has recently been shown to occupy a much lower horizon, probably about that of Dakota.

As explorations were extended throughout the West it was found that, while the divisions of the above sections can be recognized over a large area, there are regions in which they can be applied only with the greatest difficulty, if at all. They had been separated in the first place mainly on account of lithologic differences, though the lines thus drawn happened to coincide with decided faunal breaks in one or perhaps two instances. Naturally, the stratigraphic units thus defined are more or less restricted in their geographic distribution, and are sometimes represented in other regions by deposits of an entirely different character. For example, in large areas west of the Continental Divide the limestone and marls of the Niobrara are not found, they being variously represented at different localities by shales and sandstones. Under such circumstances it is very difficult to discriminate between the dark shales of the Fort Benton and those of the Fort Pierre, unless characteristic fossils are found. This difficulty was encountered by the geologists of the United States Geological Exploration of the Fortieth parallel, and as a solution of it Mr. Clarence King, the chief of that survey, proposed the new term Colorado Group "for the great clay group" of the Cretaceous, making it include the equivalents of the Fort Benton, Niobrara, and Fort Pierre groups of Meek and Hayden.

The name "Colorado Group" was first published in 1875 on one of the atlas sheets of the Fortieth Parallel Survey, and it was more fully defined by Messrs. King, Hague, and Emmons in vols. I and II of the final reports of the same survey. The name has since been used with the same meaning by several other geologists.[2]

But the lithologic classification of the Cretaceous formations adopted by the Fortieth Parallel Survey is often as difficult to apply as the older one which it was intended to replace, even in the region for which it was first proposed; for on approaching the western shore line of the Cretaceous sea along the eastern base of the Wasatch mountains, the Colorado formation ceases to be a "great clay group" bounded by sandstones above and below. On the contrary, there are several alternations of similar heavy beds of sandstone with dark shales throughout the entire series, and no good lithologic or structural reasons can be given for separating them into groups. The section at Coalville, Utah, to be given further on, is a good example of this. Recent paleontologic studies have shown that on the maps of the Fortieth Parallel Survey the upper limit of the Colorado formation at that place is really drawn not higher than the top of the Niobrara. It may be added that in that

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[1] Vide White, C. A.: On the Bear River Formation. Am. Jour. Sci., vol. XLIII, 1892, pp. 91–97; and Stanton, T. W.: Stratigraphic Position of the Bear River Formation. Ibid., pp. 98–115.

[2] For the nomenclature and grouping adopted by various authors who have written on the Cretaceous of this region see White, C. A.: A Review of the Cretaceous Formations of North America, Bull. No. 82, U. S. Geol. Sur., from which most of the historical statements here given were obtained.

region the paleontologic lines are not so sharply drawn as they are east of the Front range, though the fauna as a whole in the lower part of the series corresponds with that in the lower portion of the Meek and Hayden section, and is very different from that of the upper.

In the rapid reconnoissance of such large areas as were covered by the earlier surveys in the West there was little time for detailed paleontologic work, and the geologists were therefore often obliged to classify and describe the formations by their most obvious lithologic and structural characteristics. But such classification can be regarded only as tentative, and when, as in the case now under consideration, the lower portion of a "group" or formation is found to contain a fauna that is entirely distinct from that of the upper portion, while the latter is very closely related to the fauna of the overlying formation, it is evident that the plane of separation has not been drawn on the right horizon. A decided change in marine faunas occurring at approximately the same horizon over a large area is evidence of either a considerable time interval or of some great change in external physical conditions, and in either case it should have weight in geological classification, even though the character of the sediments may be so nearly the same both above and below the faunal break that no reason other than the paleontologic one can be seen for their division. Such a difference between adjacent marine fossil faunas certainly represents a more important event than the change from a sandstone to a shale or from a shale to a limestone. These general facts are universally admitted and numerous examples could be cited in which the dividing line between formations as widely separated in age as the Cambrian and the Carboniferous or the Jurassic and the Upper Cretaceous could not be determined until the fossils were studied. But when the faunas both belong to the same geologic period they are more closely related and the importance of such a faunal change is likely to be underestimated by the field geologist.

Meek and Hayden early recognized the fact that the most marked faunal break in their Cretaceous section is at the top of the Niobrara division, and for that reason the line between the "Lower Series" and the "Upper Series" was placed there. In Prof. Meek's last published work[1] he says:

> In passing from the Niobrara group, however, into the succeeding rocks above, in which great numbers of fossils occur, not a single species, so far as known to the writer, has yet been found identical with any form yet known from either of the three divisions below. In addition to this, the upper surface of the Niobrara beds is, at several places on the Missouri river, seen to have been eroded into irregularities or depressions, previous to the deposition of the succeeding Fort Pierre group, thus giving additional evidence that some kind of a physical change (perhaps slight) occurs between the deposition of the latest portion of the Niobrara division and the first of the Fort Pierre beds.

It is now known that a few species do pass from the lower series to

[1] U. S. Geol. Sur. Terr., vol. IX, p. XXXII.

the upper, but this is exceptional. The great majority of the species and all of the abundant ones are distinct, consequently Prof. Meek's argument for making the primary division at the top of the Niobrara is not impaired.

In 1878, when describing the Cretaceous formations of northwestern Colorado, Dr. C. A. White[1] used the nomenclature of King, dividing the section into the Dakota, Colorado, and Fox Hills groups, but for reasons similar to those just enumerated he applied the term Colorado group only to the equivalents of the Fort Benton and the Niobrara, while the Fort Pierre was embodied in the Fox Hills group. These two groups as thus defined are equivalent respectively to the marine portions of the Lower Series and the Upper Series of Meek and Hayden, and are characterized by distinct marine faunas, though there may also be in either of them local intercalations of fresh-water or brackish-water deposits.

This method of grouping the formations was adopted by some of the other geologists of the Survey of the Territories, and it was used on the maps of the Atlas of Colorado.

Mr. George H. Eldridge[2] has recently published an excellent general review and discussion of the classification and nomenclature of the Western Cretaceous, in which he adopted the divisions as defined by Dr. White, but he proposed the new name Montana group for the combined Fort Pierre and Fox Hills. In this manner the confusion caused by using the name Fox Hills in two different senses is avoided, and the original names of the minor subdivisions may still be used in local sections where it is desirable.

After describing each member of the Upper Cretaceous section, especially as developed along the eastern base of the Front range in Colorado, Mr. Eldridge sums up the evidence thus:

> From the foregoing details, the following relations of the several formations to each other may be clearly and legitimately deduced: First, the component strata of the Fort Benton and Niobrara frequently, and the life generally shade into each other; second, this is again even more forcibly paralleled in the sedimentation and life of the Fort Pierre and Fox Hills; third—and on the contrary—between the Niobrara and Fort Pierre, or, which is the same thing, between the Colorado and Montana groups (as was suggested they should be designated early in the paper), there is a differentiation of both sediments and life, greatly in excess of any similarities in these respects that may be noticed from time to time in any particular locality.

Some of the detailed evidence in support of these views will be given in subsequent paragraphs.

Mr. Eldridge has also described[3] a local nonconformity at the top of the Colorado formation at Golden, Colo.

In the present paper the term Colorado formation is accepted in its restricted sense as defined by White and Eldridge. The species de-

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[1] Ann. Rept. U. S. Geol. Sur. Terr. for 1876, pp. 1-60.
[2] Am. Jour. Sci., 3d ser., vol. XXXVIII, 1889, p. 313-321.
[3] Bull. Philos. Soc. of Washington, vol. XI, 1890, p. 264.

scribed by Meek and others from the typical Fort Benton and Niobrara of the Upper Missouri section and from their undoubted equivalents in the Black hills and along the Front range in Colorado have been taken as the nucleus of the fauna. To these have been added others from the same beds and those from other regions that are associated with species believed to be characteristic of this horizon. Some fortunate discoveries of an unusually abundant and varied fauna in the Fort Benton of southern Colorado, and the careful comparison of collections from many localities, thus correlating the beds step by step, have added a considerable number of species to the fauna, some of them new and many more that have either been assigned to a higher horizon or described simply as Cretaceous without reference to any of its divisions. As a necessary result of recently ascertained facts concerning the vertical distribution of some of these species, certain strata that have usually been referred to the Montana formation in Utah and adjoining States are now transferred to the Colorado. This subject will be discussed somewhat in detail when the typical sections are described.

The Colorado formation has been recognized by means of its characteristic fossils in Iowa, Minnesota, the Dakotas, Nebraska, Kansas, Colorado, Wyoming, Montana, Utah, Arizona, and New Mexico. It is also well established that equivalent strata exist in Texas and the adjacent regions and over large areas in British America. In Texas the Eagle Ford shales and the Austin limestone are evidently the equivalent of the Fort Benton and the Niobrara, respectively, but their fauna is in some respects quite different from that of the typical Colorado and for that reason its peculiar species have been excluded, though many of those here described are known to occur in both regions, and it is probable that more thorough collecting will add many to the common list.

The species described from British America have been excluded because the geologists have often found difficulty there in discriminating between the Colorado and Montana formations, and consequently a number of the described upper Cretaceous species have not been assigned to either horizon. While many species evidently belong to the Colorado fauna, there are many others that are doubtful and must remain so until more is known of their associates and their stratigraphic position.[1] For similar reasons a few known species from portions of our area have been omitted, some of which probably belong to this fauna.

From southern Utah and from New Mexico a few species are included whose stratigraphic position is not definitely known, but they are usually associated at the same locality with known Colorado species.

The area to which the Colorado formation is thus arbitrarily re-

[1] Since the above was written Mr. J. F. Whiteaves has published descriptions of four new species of *Ammonites* from the Cretaceous rocks of Athabasca (Trans. Roy. Soc. Canada, sec. IV, 1892, pp. 111-119) and referred them to the horizon of the Colorado formation. They belong to genera that have not yet been found in that formation in the United States and are suggestive of an older horizon.

stricted is sufficiently large to show great variations in the nature and thickness of the sediments and considerable modifications of the faunas. With the 150 species of fossils all from one comparatively limited horizon, now for the first time brought together, it will be much less difficult to extend the correlation of beds belonging to the same horizon in this country, and to make comparisons with Cretaceous faunas as developed elsewhere.

The variations above mentioned can be best shown by describing a few typical sections in different parts of the area. The sections and their faunal lists will be given in greater detail in some cases where important new correlations are made.

GEOLOGIC DESCRIPTION.

THE EASTERN BORDER.

On the eastern border of the area in which the Colorado formation occurs the country is comparatively level; the Cretaceous beds are nearly horizontal and are frequently covered with drift, loess or other recent deposits, so that there are not many good exposures showing the character and the thickness of the different divisions. Consequently, but little detailed work has been done here and very few local sections have been published. It is known that in Iowa and Minnesota, east of the main Cretaceous area, there are many detached remnants that have escaped the general erosion and are evidence of the eastward extension of the Cretaceous sea. Only a few of these isolated localities have yielded characteristic fossils, but since they are in an undisturbed region and not very far distant from the typical Meek and Hayden section, the beds can usually be identified with reasonable certainty by their stratigraphic and lithologic relations.

In the valley of Sauk river, Minnesota, there are exposures of Fort Benton shales that have been described by Mr. J. H. Kloos.[1] He states that in that region the Cretaceous rests on the older crystalline rocks, and only the Fort Benton division seems to be represented. One section obtained from a well showed 73 feet of dark blue clay and shales with two thin seams of lignite. The few fossils that were found were submitted to Prof. F. B. Meek, and proved to be characteristic Benton forms. He identified *Inoceramus problematicus* (=*I. labiatus*) and *Ammonites percarinatus* (=*Prionotropis woolgari*) among them.

Prof. N. H. Winchell[2] states that similar beds extend farther south, along the Minnesota river and the Cottonwood, and at other localities there are exposures of sandstone that are referred to the Dakota, while at New Ulm there is an outcrop of limestone that is believed to represent the Niobrara.

[1] Kloos, J. H. Cretaceous Basin in the Sauk Valley, Am. Jour. Sci., 3d ser., vol. III, 1872, pp. 17–26.

[2] Winchell, N. H. The Cretaceous in Minnesota, Minn. Acad. Nat. Sci. Bull. vol. I, 1878, pp. 349–390.

In western Iowa the Cretaceous beds are somewhat better developed and the exposures are more satisfactory. The following description of the general section from the base upward is condensed from Dr. White's account in the Geology of Iowa.[1]

Iowa Cretaceous section.

	Feet.
1. Nishnabotany sandstone:	
Rather coarse grained, friable, more or less ferruginous sandstone, with occasional thin, irregular layers of clay. Fossils: Fragments of angiospermous leaves. Maximum thickness	100
2. Woodbury sandstones and shales:	
Alternating thin beds of shale and sandstone, the former predominating. The shales vary in character, and at some places a lignitic band is shown. Fossils: *Inoceramus labiatus* and casts of a few other Lamellibranchs are occasionally found, and leaves of *Salix meekii* and *Sassafras cretaceum* also occur. Maximum thickness	150
3. Inoceramus beds:	
Impure chalky limestone and marls with *Inoceramus labiatus*, *Ostrea congesta*, and remains of several genera of fishes. Thickness	50

A detailed section measured by Mr. O. H. St. John[2] along the Big Sioux river above Sioux City, in which the basal sandstone is not represented, shows 45 feet of the Inoceramus beds and 119 feet of the underlying Woodbury sandstones and shales.

The original section of Meek and Hayden was described from this same neighborhood, and the divisions above given correspond in a general way to the Dakota, Fort Benton, and Niobrara groups, though it seems possible that a part of the Dakota is included in the Woodbury sandstones and shales. Evidently there is a gradual transition from the one formation to the other at this point, and if marine fossils were found to the bottom of the series we should expect them to belong to the same fauna as those in the upper beds. Four species of invertebrates have been described by Meek and Hayden from the "Dakota group at the mouth of Big Sioux river." Future studies may prove that they belong to the Colorado fauna, but as I have not been able to identify them satisfactorily with species that occur in the beds above the Dakota elsewhere, it has seemed best to omit the description of them. They are:

Cyrena dakotensis.
Trigonarca siouxensis.
Mactra siouxensis.
Arcopagella? macrodonta.

Southwestward from this locality the Cretaceous occupies a broad irregular belt through Nebraska and Kansas, lying unconformably on the Carboniferous, and farther south on the red beds that are usually referred to the Jura-Trias. The strata dip gently to the northwest, and in the western part of these states the Cretaceous is overlain by fresh-water deposits of late Tertiary age. Since the beds are nearly horizon-

[1] Rept. Geol. Sur. of Iowa, vol. I, Des Moines, 1870, pp. 285-291.
[2] Rept. Geol. Sur. of Iowa, vol. II, pp. 196-199.

tal and the Tertiary deposits are not very thick, the streams have cut through into the Cretaceous for some distance within the Tertiary area, thus making its boundary very irregular. Only a part of it has been accurately mapped.

Until recently all of the Cretaceous strata of Kansas have been referred to the Dakota and the Colorado formations, and there is no doubt that these two formations do cover a large area within the state, but it has been shown[1] that a part of the Lower Cretaceous Comanche series, with some of its characteristic species of fossils, occurs in several of the southern counties, and the probable existence of the Montana formation in the northwestern part of the state has been reported.

Prof. B. F. Mudge, who spent several seasons in collecting vertebrate fossils from the Niobrara division in Kansas and visited the most of the Cretaceous outcrops in the state, estimated[2] the total thickness of the Cretaceous at 960 feet, of which 500 feet was assigned to the Dakota and the remainder to the Niobrara.

The fact that the beds above the Dakota contain a greater proportion of calcareous material than usual led Prof. Mudge to conclude that they all belong to the Niobrara and that the Fort Benton shales are absent, but it is evident from the description that his Niobrara represents the whole of the Colorado formation. The data for the following section of the Upper Cretaceous strata of Kansas[3] are taken from the paper last cited:

Kansas Upper Cretaceous section.

	Feet.
1. Dakota formation.	
Brown and variegated sandstone of varying degrees of hardness, frequently with ferruginous concretions, and usually interstratified with thin beds of clay shales, and one or more seams of lignite. Fossil plants abundant; animal[3] remains rare. Estimated thickness	500
2. Colorado formation.	
a. Interstratified shales and thin layers of limestone containing *Inoceramus labiatus* and a few other mollusks, with occasional fish remains	140
b. Bluish black or slate colored shale with many concretions containing *Prionotropis woolgari, Scaphites, Inoceramus,* etc	60
c. Massive chalky limestone with *Inoceramus deformis, Ostrea congesta,* and occasional remains of fish and saurians	60
d. Buff and white chalk or chalky limestone with calcareous shales. Fossils: *Uintacrinus socialis, Inoceramus labiatus, I. deformis?, Ostrea congesta, Radiolites?, Baculites anceps?* and great numbers of vertebrates, including birds, reptiles, and fishes. Thickness	200
Estimated total thickness of the Colorado	460

[1] Cragin, F. W. The Cheyenne Sandstone and the Neocomian Shales of Kansas. Washburn College Lab. of Nat. Hist. Bull., vol. II, No. 11, and Am. Geologist, vol. VI, p. 233, and vol. VII, p. 23.

[2] Mudge, B. F. Notes on the Tertiary and Cretaceous Periods of Kansas, U. S. Geol. Sur. Terr. Ann. Rept. for 1875, pp. 277-294.

[3] 15 species of invertebrates, none of which have been found in the overlying strata, have been described by Meek (U. S. Geol. Sur. Terr., vol. IX) and White (Proc. U. S. National Museum, vol. II) from this horizon in Saline county, Kansas.

THE UPPER MISSOURI REGION.

The immense area of Cretaceous in Nebraska, North Dakota, South Dakota, and Montana has had little careful study excepting along the course of the Missouri river and around the base of the Black hills. The section quoted at the beginning of this paper gives a general description of the beds as developed in this region, but they are subject to considerable local variation and it is especially worthy of note that the calcareous Niobrara division disappears entirely in Montana, as it does along the eastern base of the Wasatch mountains and elsewhere in Utah, and in southwestern Colorado.

In the Black hills the strata have been most fully described by Prof. Henry Newton.[1] He was able to recognize there all five of the divisions of the Upper Missouri section. The principal differences as compared with that section are the presence of several thin beds of sandstone interstratified with the upper portion of the Fort Benton shales, and the fact that nearly all of the divisions are much thinner. The estimated thicknesses are:

Black hills Cretaceous section.

	Feet.
1. Dakota.	
Coarse yellow or red sandstones with discontinuous variegated clays. In some places a part of the sandstone is soft and white, and at other localities it is changed to a dense quartzite	250–400
2. Fort Benton.	
Dark plastic clays which usually contain large quantities of alkaline salts and selenite. Thin bedded calcareous sandstones, containing numerous fossils, are frequently found in the upper part	200–300
3. Niobrara.	
Gray calcareous shales and marls with some limestone; *Inoceramus labiatus* and *Ostrea congesta* very numerous. Thickness, roughly estimated	100–200
4. Fort Pierre.	
Dark gray and bluish plastic clays with many fossiliferous calcareous concretions in the upper part. Thickness, estimated	150–250
5. Fox Hills.	
Ferruginous sandstone, with *Veniella humilis, Sphæriola transversa, Ideonarca shumardi*, etc. Thickness, roughly estimated	100

According to these estimates the total thickness of the Colorado formation in the Black hills region is only 300 to 500 feet, and the entire marine Cretaceous section is less than 1,000 feet. It should be remembered that no accurate measurements of local sections were made. The following species of fossils have been reported from the Colorado beds of this region:

Ostrea congesta.
Inoceramus labiatus.
Inoceramus fragilis.
Inoceramus perplexus.
Inoceramus altus.
Fusus shumardi.
Prionotropis woolgari.
Prionocyclus wyomingensis.
Scaphites warreni.
Scaphites wyomingensis.
Scaphites larvæformis.

[1] Newton, Henry, and Walter P. Jenney, Geol. of the Black Hills of Dakota, Washington, 1880. The Cretaceous is described on pp. 169-185.

In Montana the Fort Benton division of the Colorado formation is well represented, and the types of many of its characteristic species were collected in that state. According to Meek and Hayden[1] this division attains a thickness of about 800 feet in the neighborhood of Fort Benton. The following species of invertebrates have been obtained within a few miles of that locality, but their exact vertical range in the local section has not been published:

Inoceramus fragilis.
Inoceramus umbonatus.
Inoceramus exogyroides.
Inoceramus tenuirostratus.
Inoceramus undabundus.
Pholadomya papyracea.
Scaphites vermiformis.
Scaphites ventricosus.
Scaphites mullananus.
Nautilus elegans.

Nearly all of these have been found in the Colorado formation or its equivalents at other localities and none of them is known to occur at a higher horizon.

The geologists who have recently studied the Cretaceous coal fields of Montana have been unable to divide the marine portion of the Upper Cretaceous into distinct formations, and the collections of fossils have not been sufficient to indicate the paleontologic break if there is one. The following section, adapted from Mr. W. H. Weed's paper[2] on "The Cinnabar and Bozeman Coal Fields of Montana," shows the character of the strata up to and including the lower portion of the Laramie.

Cretaceous section of Cinnabar mountain, Montana.

	Feet.
Laramie:	
Sandstones, containing coal	800
Coal seam	5
Sandstones, white, massive, cross-bedded	125
	935
Colorado and Montana:	
Fissile, argillaceous sandstones and shales	240
Shales, generally crumbly, with layers of black bituminous shale, and harder sandy ledges	450
Shaly sandstones and limestones	225
Sandstone	40
Sandy, splintering, gray shales and limestones	165
Black bituminous shales	500
Limestone	40
Black shales, sometimes arenaceous	400
Sandstone	10
Black and dark-blue shales	250
Sandstone	15
Sandy shales	75
Sandstone	10

[1] Proc. Acad. Nat. Sci., Phila., 1861, p. 421; U. S. Geol. Sur. Terr., vol. IX, p. XXIX.
[2] Bull. Geol. Soc. Am., vol. II, 1891, p. 352.

Colorado and Montana—Continued.	Feet.
Thinly laminated arenaceous shales with *Ostrea anomioides*	340
Sandstones	15
Shales	75
	2,850
Dakota:	
Quartzite	30
Limestone with great numbers of a small fresh-water gasteropod	10
Sandy shales	150
Red earthy limestones, magnesian	50
Conglomerate	40
Sandstone and shales	95
Sandstone	151
	526
Total Cretaceous	4,311

Sections at other localities give a much greater total thickness, but the marine portion, or combined Colorado and Montana, seems not to vary greatly. It is evident that both of these formations are represented in the section, but there seems to be no lithologic or structural reason for making a division and all of the fossils yet reported from the locality belong to the Colorado fauna and probably all came from near the horizon of *Ostrea anomioides*. The following species were collected there by members of the U. S. Geological Survey of the Territories.

Ostrea anomioides.
Trigonia, related to T. evansana.
Inoceramus sp.?
Baculites asper?
Scaphites ventricosus.

At a locality near the Missouri river below Gallatin, Montana, where the same beds are exposed, the first three of the above-named species occur, and associated with them are *Corbicula inflexa*, *Pharella? pealei*, and a number of others[1] represented by casts that can not be specifically determined.

COLORADO AND NEW MEXICO.

Along the eastern base of the Front range in Colorado the Upper Cretaceous formations are well developed and easily distinguishable both by lithologic features and by an abundance of characteristic fossils. From the northern boundary of the state to the Arkansas river and beyond, the first prominent "hogback," or foothill of the mountains is composed of the sandstones and conglomerate of the Dakota. It is so constant lithologically that it can be readily recognized without the aid of the plants which are the only fossils that are commonly found in it in this region. On the plain immediately east of the Dakota ridge the shales and limestones of the Colorado, the softer clay shales and

[1] See Prof. Meek's lists in Ann. Rept. U. S. Geol. Sur. Terr., for 1872, pp. 474, 475.

the sandstones of the Montana, and the coal-bearing sandstones and shales of the Laramie are exposed in the order in which they are named. There are numerous fossiliferous zones throughout the marine portion of the strata, and it is usually not difficult to trace the characteristic species of the Colorado and Montana formations, respectively, almost to the dividing line between the two formations.

The section given below is based on descriptions of the Cretaceous strata in the Denver region by Mr. Geo. H. Eldridge.[1] Although originally intended only for a limited area surrounding Denver, Mr. Eldridge's description with very slight modifications will apply equally well to any part of the Cretaceous belt between Wyoming on the north and Pike's peak on the south. Perhaps the Laramie portion of the section should be excepted in this statement, as it is not so well developed in the northern and southern portions of this area as in the Denver basin.

Cretaceous section in central Colorado.

	Feet.
Dakota:	
A thin bed of conglomerate composed of well-rounded quartzose pebbles united by strong siliceous cement. Hard, usually gray, sandstone in two prominent benches separated by a band of fire clay. Fossil plants are abundant at some localities. Total thickness of the formation about	300
Colorado:	
Fort Benton—	
Dark shales with frequent intercalations of fossiliferous drab limestone in the upper third. *Inoceramus labiatus* is the most abundant and characteristic species and *Prionotropis woolgari* is occasionally found	400–500
Niobrara—	
Drab-white limestone containing *Inoceramus deformis*, *I. labiatus*, *Ostrea congesta*, etc.	40
Gray clays and buff siliceo-calcareous shales with *Ostrea congesta* and numerous scales of fishes	260
Total thickness of Colorado formation	700–800
Montana:	
Fort Pierre—	
Drab shaly clays with numerous highly fossiliferous concretions of drab limestone and occasional unimportant bands of sandstone. Characteristic fossils:[2] *Inoceramus cripsii*, *I. proximus*, *Avicula linguiformis*, *A. nebrascana*, *Lucina occidentalis*, *Anisomyon* (several species), *Ptychoceras mortoni*, *P. crassum* *Heteroceras* (several species), *Baculites ovatus*, *B. compressus*, *Placenticeras placenta*, *Sphenodiscus lenticulare*, *Scaphites nodosus*, *Nautilus dekayi*, etc. Thickness	7,700

[1] On some Stratigraphical and Structural Features of the Country about Denver, Colorado. Proc. Colo. Sci. Soc., vol. III, pp. 93–97. On certain peculiar Structural Features in the Foot hill Region of the Rocky mountains near Denver, Colorado. Bull. Philos. Soc. of Washington, vol. XI, p. 249.

[2] The fauna contains a large number of species the most of which are figured by Meek, U. S. Geol. Sur. Terr., vol. IX, pls. 11–27.

	Feet.
Montana—Continued.	
Fox Hills—	
Arenaceous clays capped by a bed of yellow fossiliferous sandstone. Fossils:[1] *Cardium speciosum, Mactra alta, Tancredia americana. Veniella humilis, Callista deweyi, C. owenana, Sphaeriola cordata, Liopistha undata, Anchura americana, Scaphites conradi*, etc. Thickness	800–1, 000
Total thickness of Montana formation	8, 700
Laramie:	
Sandstones and coal beds, about	400
Clays, ironstones, and rarely coal beds	800
Fossils: plants and fresh and brackish-water mollusks	
Total thickness	1, 200

The Fort Pierre shales here have a much greater development than in any other part of the Rocky mountain region. With this exception the section is almost identical with Meek and Hayden's Upper Missouri section.

Southward from the neighborhood of Denver the Montana formation becomes much thinner, until, on the Arkansas river between Canyon city and Pueblo, its thickness is approximately 3,000 feet. It is also less fossiliferous and more uniform in lithologic character, so that the Fox Hills is not usually recognizable as a distinct division, though the fossiliferous zone, with its characteristic species at the top of the Fox Hills, has been observed at Colorado Springs, and the underlying shales at that place and in the Arkansas valley yield some Fort Pierre forms, such as *Inoceramus cripsii, I. proximus, Lucina occidentalis, Baculites ovatus, Scaphites nodosus, Heteroceras*, etc., but throughout the formation as a whole fossils are not so numerous either in species or individuals as they are in the section last described.

In the area now under consideration the Colorado formation becomes a more important feature of the geology on account of the greater area that it covers and of the better development of its fauna. The chief cause of its increased area is a low anticlinal fold extending out into the plain as a prolongation of the axis of the Front range. The erosion that has planed off this fold until it is scarcely noticeable as a topographic feature has removed the Laramie and Montana strata from an area at least 25 miles wide, and at a few places along the crest of the fold has just reached the Dakota sandstone.[2] Consequently the nearly horizontal shales and limestones of the Colorado form the surface over a large area,[3] and are well exposed in long bluffs on the Arkansas, the Cucharas, and other streams, and also in the usual narrow belt along the foothills.

The characteristic Fort Benton shales resting on Dakota sandstone vary considerably in thickness. Near the mountains at Canyon city

[1] Some of these also occur in the Fort Pierre division.

[2] The Dakota is exposed on the bank of Arkansas river 8 miles above Pueblo and on the plains 10 miles east of Cucharas.

[3] On the geological sheets of Hayden's Atlas of Colorado the area assigned to the Colorado formation along the Front range and in the southern central part of the state is too large on account of the fact that the Fort Pierre shales are all mapped as Colorado, although the legend states that they are included in the Fox Hills.

the thickness is 400 to 500 feet, but out on the plain it decreases until it is less than 300 feet.

About the middle of the dark shales there is always a calcareous zone, sometimes 40 or 50 feet thick, consisting of alternating layers of shale and drab limestone, the latter full of *Inoceramus labiatus.* The upper 150 feet of dark shale frequently contains brown or drab calcareous concretions, some of which are fossiliferous. Near Carlile Springs, on the Arkansas river, 18 miles west of Pueblo, the upper part of this zone yielded the following species:

Exogyra suborbiculata.	Liopistha concentrica.
Ostrea lugubris.	Turritella whitei.
Ostrea malachitensis.	Amauropsis bulbiformis.
Inoceramus fragilis.	Xenophora simpsoni.
Cardium pauperculum.	Pugnellus fusiformis.
Veniella mortoni.	Rostellites dalli.
Anatina lineata.	Prionotropis hyatti.

Above the Fort Benton shales there is a bed of rather coarse massive gray sandstone which at Carlile Springs is almost 15 feet thick. It is here capped by 1 to 2 feet of brown calcareous sandstone containing *Ostrea lugubris*, impressions of *Prionocyclus wyomingensis*, and numerous shark's teeth. Above this is about 40 feet of light-colored, compact limestone with *Inoceramus deformis*, *I. labiatus*, and *Ostrea congesta*, passing up into light gray and buff calcareous shales with *Ostrea congesta.*

The section is essentially the same as the one in the Denver region, with the addition of the sandstone at the top of the Fort Benton shales. This new feature is not distributed over a very large area, nor is it constant even in the region under consideration, but it is rendered important by the fact that at some localities it is very fossiliferous and contains a varied littoral fauna, part of which had previously been known only in a limited area in northern Utah where its stratigraphic relations were not clear. East of the mountains this sandstone was not seen farther north than Colorado Springs, where it is 10 feet thick. On the Arkansas river above Pueblo it is from 15 to 20 feet thick. Along the foothills in the neighborhood of Canyon city its thickness varies from 4 to 10 feet. At some localities in Huerfano park, where it is very fossiliferous, it is 40 feet thick, and for convenience in accurately referring the species to their horizon I have there called it the Pugnellus sandstone on account of the abundance of the characteristic fossil, *Pugnellus fusiformis.* Usually it is a compact, massive, or heavy bedded sandstone of uniform texture throughout, but at the localities where it is very fossiliferous the fossils occur in thin bands and lenticular masses of hard calcareous sandstone, while the larger part of the rock is more friable and sometimes contains partings of shale.

This thin bed of sandstone shows that over a considerable area there was a brief cessation and probably a reversal of the downward movement of the Fort Benton sea bottom just prior to the deposition of the Niobrara limestone. Both the character of the sediments and the contained fossils indicate that the bed was deposited in shallow waters not far from land.

The band of brown calcareous sandstone above the Pugnellus sandstone is rather more persistent, and it always contains sharks' teeth and impressions of *Prionocyclus wyomingensis*, and usually *Ostrea lugubris*. Its thickness varies from 1 to 4 feet.

The Cretaceous section of Huerfano park, Huerfano county, Colorado, is entirely similar to that of the Arkansas valley just described, but as it has furnished so large a proportion of the species here described it deserves a separate notice in order that the evidence on which these species are referred to the Colorado formation may be given.

The "park" is a synclinal basin almost surrounded by the uplifts of the Wet mountains on the east and north and of the Sangre De Cristo range on the west and southwest. The central and larger portion of this basin is filled by a thick series of sediments of Eocene and later Tertiary age.[1] The Cretaceous strata are exposed at many places around the margin, especially on the east, north, and west sides. The entire series from the Dakota to the Laramie, inclusive, is represented, but the Montana and Laramie are not often well exposed.

The fossils were nearly all collected from a single bed, the Pugnellus sandstone, which is easily recognized in all its outcrops both by its position and by its fossils. The most prolific localities examined are near Quillian's ranch on Williams creek, on Muddy creek about 10 miles above Gardner post-office, in Poison canyon, and near Malachite post-office on the north side of Huerfano river. The Pugnellus sandstone at these four localities has yielded the following list of species, the majority of which were found at all the localities:

Ostrea lugubris.
Ostrea malachitensis.
Exogyra suborbiculata.
Anomia subquadrata.
Gervillia propleura.
Avicula gastrodes.
Inoceramus labiatus.
Inoceramus fragilis.
Solemya? obscura.
Pinna petrina.
Yoldia subelliptica.
Trigonarca obliqua.
Lucina juvenis.
Cardium pauperculum.
Tapes cyprimeriformis.
Legumen? ———.
Tellina (Palæomœra) whitei.
Siliqua huerfanensis.
Pholadomya coloradoensis.
Anatina lineata.
Liopistha (Psilomya) concentrica.
Mactra emmonsi.
Mactra huerfanensis.
Turritella whitei.
Xenophora simpsoni.
Gyrodes depressa.
Gyrodes conradi.
Amauropsis bulbiformis.
Mesostoma occidentalis.
Pugnellus fusiformis.
Fusus (Neptunea?) venenatus.
Tritonidea? huerfanensis.
Fasciolaria? (Cryptorhytis) utahensis.
Pyropsis coloradoensis.
Rostellites dalli.
Rostellites ambigua.
Rostellites gracilis.
Cancellaria malachitensis.
Actaeon propinquus.
Haminea truncata.
Placenticeras ———.
Prionotropis hyatti.
Cassidulus stantoni.

[1] Hills, R. C.: Tertiary beds of the Huerfano river basin. Proc. Colo. Sci. Soc., vol. III, 1890, pp. 148–164, 217–223.

It should be noted that this list contains 13 of the 14 species collected from the upper part of the undisturbed Fort Benton shales in the Arkansas valley.

The stratigraphic evidence that the Pugnellus sandstone is near the top of the lower division of the Colorado formation is equally conclusive. A section measured on Muddy creek gives the following succession of strata in ascending order:

Dakota: Hard brown and gray sandstone with plant remains, not fully exposed.

	Feet.
Colorado:	
Dark clay shales	100
Gray limestone in thin bands alternating with shale. *Inoceramus labiatus* abundant	30
Dark shale	300
Rather coarse gray and yellowish sandstone, becoming shaly above, with occasional very fossiliferous bands and lenticular masses containing the species listed above	40 to 50
Brown calcareous sandstone with *Ostrea congesta, Prionocyclus wyomingensis,* and shark's teeth	4
Light drab limestone with *Inoceramus deformis, I. labiatus,* and *Ostrea congesta* passing up into calcareous shales	75
Total thickness of Colorado exposed	559

Other localities in the park show that the upper bed of limestone is overlain by 300 to 400 feet of light gray or buff calcareous shales, succeeded by the drab clays of the Montana formation, with a probable thickness of 3,000 feet. The latter have yielded specimens of *Inoceramus proximus, Lucina occidentalis, Baculites ovatus, Ptychoceras,* and a few other characteristic forms.

The southern continuation of the Arkansas valley Cretaceous area in Colorado and northeastern New Mexico has been described by Dr. J. S. Newberry,[1] Prof. J. J. Stevenson,[2] and others.[3] From these descriptions it is evident that the Colorado formation there retains about the same lithologic and paleontologic features as in the region above described, excepting that the Pugnellus sandstone with its shallow-water fauna has not been noticed, and there seems to be a greater proportion of limestone throughout the formation.

Dr. Newberry states that on the banks of the Canadian river[4] the "Middle Cretaceous" exposures are from 800 to 1,000 feet thick, consisting mostly of blue limestone interstratified with dark blue and

[1] Macomb's exploring expedition from Santa Fé, N. Mex., to junction of Grand and Green rivers. Geol. Rept., Washington, 1876, pp. 32–35.

[2] U. S. Geog. and Geol. Surveys west of the One hundredth meridian, vol. III. Supplement, pp. 88–158. and Am. Geologist, vol. III, pp. 391–397.

[3] Prof. Jules Marcou visited this region in 1853 in connection with the Pacific railroad surveys, and his observations were published in vol. III of the reports of that survey, in the Geology of North America, Zurich, 1858, and elsewhere. In an article on "the Mesozoic series of New Mexico" (Am. Geologist, vol. IV, 1889, p. 155–165 and 216–229) the same author gives titles of most of the geological reports relating to New Mexico.

[4] Op. cit., p. 33.

brownish bituminous and calcareous shales. *Inoceramus labiatus* and *Gryphæa newberryi*[1] range from bottom to top of this series, and in the upper portion *Inoceramus fragilis*, *Ostrea congesta*, *O. elegantula*, *Prionotropis woolgari*, etc., also occur.

In western New Mexico and southwestern Colorado the Cretaceous section contains no limestones, or only very thin bands of local extent that are seldom exposed, and the same statement will apply to the entire area between the Continental Divide and the Wasatch mountains. The calcareous beds of the Niobrara division that have served as a convenient reference plane in all the region east of the mountains are absent. The section in the area drained by the San Juan river naturally falls into three lithologic divisions, the lowest of which is a series of coarse sandstones, with some beds of shale, and in the upper portion one or more coal beds. The middle division consists of dark clay shales, 1,200 to 1,500 feet in thickness, and is overlain by a thick series of coal-bearing sandstones, shales and marls forming the upper division. These are the members of Dr. Newberry's general section,[2] and similar divisions have been made by other geologists who have described the region, though they have sometimes been still further subdivided, and there have been differences of opinion as to the correlation of certain parts of the section with the formations east of the mountains. All have agreed, however, that the sandstones at the base (or at least the upper part of them) belong to the Dakota formation and that the Colorado formation is represented in the shales of the middle division.[3]

Here and in other portions of western Colorado the larger part of the coal-bearing sandstones and shales of the upper division was referred to the Fox Hills group by the members of the Geological Survey of the Territories, and it is so mapped in Hayden's Atlas of Colorado, the reason for this reference being that marine Cretaceous (Fox Hills) fossils were found at various horizons above the coal beds.[4] Others have referred all of the productive coal measures of this area to the Laramie,[5] basing their correlation on the stratigraphy, the lithologic character of the beds, and the evidence of the fossil plants. There is no doubt that Fox Hills

[1] Throughout this bulletin the names of fossils are usually changed so as to conform to the nomenclature adopted in the descriptions that are to follow. *Gryphæa newberryi* is the Upper Cretaceous form so frequently referred to in Dr. Newberry's report under the name *Gryphæa pitcheri*.

[2] Op. cit., p. 32.

[3] It should be remarked that the molluscan fossils reported by Dr. Newberry from the lower division seem to belong with the fauna of the overlying shales, and in southern Utah the coal-bearing sandstones at the base of the Cretaceous have yielded fossils that I regard as a part of the Colorado fauna.

[4] For detailed sections and descriptions of Cretaceous in southwestern Colorado, see report of W. H. Holmes in Ann. Rept. U. S. Geol. Sur. Terr. for 1875, pp. 242-267.

In western Colorado: Reports of A. C. Peale, idem, for 1874, pp. 128-155, and for 1876, pp. 170-180; of C. A. White, ibid., pp. 19, 28-34, and other reports in the same series.

[5] Lakes, A.: Geology of Colorado coal fields. Ann. Rept. State School of Mines, Denver, 1889, pp. 19, 148, 162, etc.

Hills, R. C.: Orographic and structural features of Rocky mountain geology. Proc. Colo. Sci. Soc. vol. III, 1890, p. 380 et seq.

species of fossils have been found at several places well up in the series. I have collected *Inoceramus cripsii*, *Mactra alta*, *Cardium*, *Baculites compressus*, and *Placenticeras placenta*, var. *intercalaris*, in Mancos canyon from a bed that seemed to be 800 to 1,000 feet above the base of the coal-bearing sandstones. No evidence of faulting was seen there. It is beyond the scope of this paper, however, to discuss either the age of these upper beds or the more general subject of the delimitation of the Laramie formation. There is need of much detailed work in some parts of the supposed Laramie area, and the evidence from all possible sources must be collected and considered before the latter question can be dismissed with a final solution.

The shales of the middle division attain a thickness of 1,200 to 1,500 feet in the San Juan valley, and farther north in western Colorado they are still thicker. It has already been intimated that these shales are of much the same character throughout and are apparently the product of continuous sedimentation, but the characteristic fossils of the Colorado formation are confined to their lower half. The upper half is usually barren of fossils, though a few species belonging to the Montana fauna have been found at the top. Along the Mancos river north of Mesa Verde and in the valley of Animas river where I have made collections the fossiliferous zones are as follows:

	Feet.
1. Soft dark clay shales resting on Dakota sandstone. Numerous specimens of *Gryphaea newberryi* in upper portion	120
2. Light drab argillaceous limestone with *Inoceramus labiatus*. This is seldom exposed and probably not continuous	4–6
3. Dark clay shales with a large *Inoceramus* covered with *Ostrea congesta*, and calcareous concretions, a few of which contain *Inoceramus* and *Baculites gracilis?*	250
4. Thin bands of brown arenaceous limestone and occasional concretions alternating with shales. Fossils abundant, including *Inoceramus labiatus*, *I. fragilis*, *I. dimidius*, *Ostrea lugubris*, and *Prionocyclus macombi*	8–10

For about 200 feet above this zone there are fragments of a large *Inoceramus*, apparently like *I. deformis*, covered with *Ostrea congesta*. No fossils were found in the 600 or 700 feet of shales above this horizon.

Although the fauna of these beds is not large it contains several characteristic species and it is believed to prove that the fossiliferous beds above described are the approximate equivalent of the Colorado formation and that the overlying shales should not be included in that formation. Wherever fossils have been reported from the upper half of the shale division in western Colorado and eastern Utah they are of Montana formation species and the two faunas never seem to be blended[1] in that region.

Northward, in the valleys of Grand and Gunnison rivers and their tributaries in Colorado and of Green and Price rivers in Utah, the

[1] Mr. W. H. Holmes reports the occurrence of *Scaphites warreni*, *Inoceramus barabini*, and *Baculites ovatus* in the same bed on the San Juan river from about the horizon of the zone No. 4 above described. I have been unable to find this collection, but I have reason to believe that the last two species were incorrectly identified.

Colorado formation is still mainly composed of dark clay shales, though there are occasionally thin intercalations of sandstone. A section on Gunnison river, opposite Roubideau's creek, described by Dr. Peale.[1] which shows the general character well, is as follows:

	Feet.
1. Shaly sandstones, with interlaminated argillaceous beds, extending from the top of the bluff on the river to the base of the first bluff north of the river. The beds are for the most part concealed	175
2. Coarse yellow sandstone with calcite	
3. Gray laminated sandstone	
4. Thin laminæ of grayish sandstone shales, with fine black argillaceous shales, gypsiferous and calcareous, containing *Inoceramus, Ostrea lugubris* (Conrad), and other Cretaceous fossils	125½
5. Yellowish sandstone shales, with quantities of *Inoceramus* and *Ostrea* especially abundant near the top, where there is a layer of black shales	40
6. Black argillaceous shales, partly concealed by débris	38
7. Coarse yellow, gypsiferous, and calcareous sandstones, with layer at top, breaking into pencil-like pieces one to two inches long and an eighth of an inch in thickness	50½
8. Sandstone shales	120
9. Fine black argillaceous shales	
10. Coarse yellow calcareous sandstone, resembling that described under No. 7.	1
11. Fine black argillaceous shales, with bands of sandstone (fossiliferous), species of *Inoceramus* and *Ostrea*	36
12. Hard gray sandstone	1
13. Very fine soft black argillaceous shales, with a few laminæ of gray sandstone. In the lower part of the group the shales are coal-black, but as we ascend they become gray-black. Nearly all the layers are fossiliferous. Among the forms are *Prionocyclus wyomingensis, Scaphites* [*warreni*], and *Inoceramus* [*labiatus*]. They are especially abundant near the top	66½
14. Fine gray and yellowish shales	34
15. About 17 feet of gravel, composed largely of basaltic bowlders, forming the top of the bluff.	
Total, about	687½

These shales rest on sandstones referred to the Dakota. In this district Dr. Peale estimates the total thickness of the shales belonging to the Fort Benton, Niobrara, and Fort Pierre at 1,500 to 2,000 feet.

A large part of Castle valley in eastern Utah is underlain by shales like those above described, and at a horizon in them about 1,000 feet below the Montana sandstones exposed to the Book Cliffs I have collected *Prionocyclus wyomingensis*, *Scaphites warreni*, *Baculites gracilis?*, and *Inoceramus dimidius*.

Farther south in western New Mexico and in Arizona, the sections described by Mr. G. K. Gilbert,[2] contain a greater proportion of sandstone, but the lower 850 feet, which is the only portion from which fossils were obtained, evidently belongs to the Colorado formation, and perhaps in the lowest layers to the Dakota. The highest fossiliferous horizon noted is at Stinking spring, near Fort Wingate, New Mexico, and it yielded *Inoceramus labiatus* and *Ammonites*.

[1] Ann. Rept. U. S. Geol. Sur. Terr. for 1874, p. 136.

[2] U. S. Geog. and Geol. Sur. West one hundredth meridian, vol. III, pp. 544, 549–554.

UTAH.

A portion of the Cretaceous in Utah has already been incidentally described, but two other areas in that territory require separate treatment on account of differences in both lithologic and paleontologic characteristics. One is the neighborhood of Coalville, in northern Utah, and in connection with it certain small areas in southwestern Wyoming may be conveniently discussed. The other is an irregular belt extending across the high plateaus of southern Utah, just south of the escarpment of the Pink cliffs.

In the area last mentioned several sections have been described by Messrs Gilbert[1] and Howell,[2] which show a tripartite division of the Cretaceous like that in the San Juan area with which it is geographically connected, but here the lower division of sandstones carries the principal coal beds, while the upper division has only thin seams. Other differences worthy of note are the occurrence of many marine fossils in the sandstones near the base of the Cretaceous and the more varied fauna of the lower part of the shales.

Some years ago Mr. C. D. Walcott measured a section in Kanab valley and made a considerable collection of Cretaceous fossils there. He has generously placed in my hands his unpublished notes on the Mesozoic portion of this section, and the description given below is based on these notes, supplemented by my own observations made during the summer of 1892, while studying the same section and a neighboring one in Long valley. The measurements are all Mr. Walcott's, but the detailed subdivisions are not given.

Cretaceous section of Upper Kanab valley.

	Feet.
1. Alternating beds of light-colored sandstones, clay shales, arenaceous shales, and coal, the sandstones constituting about one half of the entire thickness. At the base is a thin, irregular band of conglomerate and coarse sandstone resting on softer sandstones and shales that are provisionally referred to the Jurassic. Leaves and other plant remains occur about the middle of the division, and two zones near the top contain numbers of *Corbula nematophora, Cardium pauperculum, Modiola multilinigera, Glauconia coalvillensis,* a small *Ostrea* and an *Anomia*. Thickness	330
2. Arenaceous and clay shales, mostly of a drab color weathering into rounded hills and slopes of soft, more or less sandy clay. Near the base the shales are slightly bituminous and contain many limestone concretions, some of which are filled with well preserved fossils. (See list below.) Thickness	885
3. Rather coarse friable sandstones of light colors (white, gray, and buff), alternating with thinner beds of gray, drab, and purplish arenaceous shales. The lower 50 feet is a massive yellow or buff sandstone, which is overlain by 50 to 60 feet of softer very fossiliferous sandstones, containing great numbers of *Ostrea soleniscus, Admetopsis* (an undescribed species), *Modiola multilinigera?, Cyrena, Anomia,* and a few others, while the upper portion contains plant remains with *Unio holmesianus, Viviparus panguitchensis, Planorbis Physa,* etc., that seem to belong to the Laramie. Thickness	1,700

[1] Op. cit., pp. 158–160.

[2] Ibid, pp. 270–280. Dutton's "Geology of the High Plateaus of Utah" and "Tertiary History of the Grand Cañon District" contain good general descriptions of the stratigraphy.

The coal beds of the lower division vary greatly, both in number and thickness, in sections only a few miles apart. The coal seems to be of inferior quality, but all of the few openings that have been made are small and have not gone beyond the influence of surface weathering. A mine at Glendale, in Long valley, on the uppermost coal bed, which is near the top of the division, shows about 8 feet of coal with two partings of indurated shale. One of these near the base of the bed is full of Unios, while the other about 3 feet above it contains great numbers of *Corbula nematophora*.

The fauna of this division so far as it is known is the same as that of the lower portion of the section at Coalville, Utah, and of the coal-bearing series along the western edge of the high plateau region near Cedar city and Kanarra, which will be considered on following pages.

The general aspect of the middle division is that of drab clay shales, though the upper part is more arenaceous and forms a transition to the sandstones above. The fossiliferous concretions seem to be confined to the lower 40 feet in Kanab valley, but near Mount Carmel in Long valley a few concretions containing *Buchiceras swallovi*, *Liopistha meeki*, and associated forms were found up to 325 feet above the base. This zone has yielded an interesting fauna containing some species not yet found elsewhere, with others that connect it with the Colorado fauna as developed in Huerfano park and in the Eagle Ford shales of Texas, as the following list of those collected in Upper Kanab valley will show:

Gryphæa newberryi.	Lunatia concinna.
Lima utahensis.	Anchura? prolabiata.
Camptonectes platessa.	Anchura ruida.
Inoceramus fragilis.	Tritonium kanabense.
Nemodon sulcatinus?.	Sigaretus textilis.
Lucina subundata.	Helicoceras pariense.
Liopistha meeki.	Baculites gracilis?
Liopistha elongata.	Buchiceras swallovi.
Corbula kanabensis.	Placenticeras.
Turritella whitei.	Acanthoceras kanabense.

At a locality southeast of Paria, Utah, a number of the above species have been found in the same zone and associated with them *Inoceramus labiatus*, *Veniella goniophora*, and *Serpula intrica*.

This list of fossils contains enough characteristic species to furnish a good basis for correlation with the lower part of the Colorado formation, but with our present knowledge it is impossible to locate the upper limit of the formation in this section. It should probably be drawn below the base of the upper sandstone division.

The upper part, and probably almost the whole, of the third division has been correlated with the Laramie with a reasonable degree of certainty. The testimony of the fresh-water invertebrates and of the plants, though rather meager, is all favorable to such a correlation, and the fact that it is overlain by Eocene Tertiary beds without apparent stratigraphic break also points in the same direction. The fossiliferous beds at the base, however, contain only marine- and brackish-water species, and unfortunately these do not furnish a good basis for correlation with any zone in other Cretaceous sections. There is a great abundance of fossils, but only a few species are represented and some of these are forms that have great vertical range, while the others have not been found outside of this district. The fauna as a whole has some resemblance to that of the upper coal horizon (the "third ridge") at Coalville, Utah, which, as will be shown farther on, is fully 1,800 feet below the top of the marine Cretaceous there, but this resemblance can not be accepted as proof of their contemporaneity. In Kanab valley the marine forms were not found more than 100 feet above the base of the sandstone, but in Long valley, only a few miles distant, they occur 100 feet higher. At the former locality fossil plants are abundant in a band of sandstone 275 feet above the top of the fossiliferous marine beds.

The sandstones above the basal massive bed have about the same character throughout. They are rather coarse, in a few instances becoming pebbly conglomerates, and often so friable as to form soft slopes that are easily mistaken for shale exposures. Many of these sandstones are large lenticular masses rather than continuous beds and nearly all of them vary greatly in thickness within short distances, a peculiarity that often makes it difficult to recognize individual beds in two neighboring exposures.

From the above remarks it will be seen that both the Montana and the Laramie formations are believed to be present above the Colorado, but the lower limit of each of them is still undetermined.

Before leaving the consideration of the Cretaceous in the high plateaus of Utah the differences shown on the western escarpment at Cedar city and Kanarra should be mentioned. At these places the equivalent of the lower coal-bearing division of the Kanab section has a much greater development and the other two divisions if present are concealed by a sheet of eruptive rock. At both localities the lower 300 or 400 feet consist of gray and brown sandstones and sandy shales in which no fossils were found excepting fragmentary remains of dicotyledonous plants. Then comes a band of fossiliferous gray shale 30 feet in thickness with a seam of coal at its base and a thicker coal bed above it. The fossils are *Ostrea soleniscus*, *Cardium pauperculum*, *Barbatia micronema*, *Corbula nematophora*, *Cyrena* ——, *Admetopsis rhomboides*, *Eulimella funicula*, *Chemnitzia?* and in some layers *Unio*.

The coal bed immediately above varies in thickness from 6 to 10 feet at different openings. The overlying beds, of which about 350 feet are exposed at Kanarra and fully twice that thickness at Cedar city, consist of light gray and brown sandstones with some bands of shale. *Corbula nematophora*, *Ostrea soleniscus*, and *Admetopsis rhomboides* occur in great numbers at several horizons up to the top of the series.

Specimens of *Inoceramus labiatus* and *Avicula gastrodes* were found about 500 feet above the principal coal bed.

The greater thickness of the lower sandstone division here is an indication that the western border of the sea may have been near during Cretaceous time. Possibly a part of the shales of the Kanab middle division are here represented by sandstones, and the earlier fauna, thus finding a congenial habitat on the sandy bottom, may have survived much longer than it did a little farther east, where the subsidence was greater. If this supposition be granted it will explain the fact that most of the fossils in the uppermost marine bed of the Kanab section are closely related to species that occur 1,000 feet lower, although they are not found in the intervening strata. They have traveled across the area and back again as the shallow waters in which they lived shifted their place.

Cretaceous strata with coal beds and the same species of fossils as those above named in the shale below the coal are exposed in small outcrops among the eruptive rocks near Iron city, 20 miles west of Cedar, and they are known to occur on the same meridian farther south. No Cretaceous exposures are known to occur between this locality and the western slope of the Sierra Nevada.

The coal-bearing Cretaceous beds exposed at Coalville, Utah, and on Bear river, near the mouth of Sulphur creek, Wyoming, have been the subject of considerable discussion, and various opinions concerning their precise age have been published by the several geologists and paleontologists who have visited the localities or examined collections from them. They were referred to the Cretaceous by Messrs. Meek and Engelmann [1] in 1860 and were compared with certain Cretaceous beds at the mouth of Judith river, then regarded as belonging to No. 1 (Dakota) but afterward proved to be of Fox Hills age. When Capt. Simpson's report [2] was published in 1876 Mr. Engelmann again expressed the opinion that these beds are probably "Lower Cretaceous" [Dakota].

They were at first regarded as Tertiary by Messrs. Hayden [3] and Lesquereux.[4] In 1870 Messrs. Meek and Hayden [5] adopted the view that the Coalville beds are Cretaceous but that they "occupy a higher horizon in the Cretaceous than even the Fox Hills beds of the Upper Missouri Cretaceous series."

Mr. Meek visited Coalville in 1872, and after making larger collections and studying the stratigraphy he decided that the entire Upper Missouri Cretaceous section with perhaps some older beds is represented here. The detailed section that he published [6] shows correctly the essential features of the stratigraphy. The opinions that he then

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[1] Proc. Acad. Nat. Sci. Phila., Vol. XII, p. 130.
[2] Exploration across the Great Basin of Utah in 1859, p. 291.
[3] Ann. Rept. U. S. Geol. Sur. Terr. for 1869. p. 91.
[4] Idem for 1873, pp. 366, 371.
[5] Ann. Rept. U. S. Geol. Sur. Terr. for 1870, pp. 168, 291. Idem for 1871, p. 377.
[6] Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 439.

expressed concerning the correlation of these beds were repeated in subsequent publications.[1]

Messrs. King and Emmons[2] assigned the Cretaceous strata at Coalville to the Colorado, Fox Hills, and Laramie formations, and so mapped them in the atlas accompanying their report. The principal (lower) coal bed is included in the Colorado formation and upper one in the Fox Hills, the line between these two formations being drawn in the second ridge above the lower coal bed. It should be remembered that the Colorado formation was then made to include the Fort Pierre division.

Dr. C. A. White studied the section in 1877, and after discussing the fossils collected in it he states[3] that it is impracticable to refer the strata to any one or more of the established Cretaceous groups with certainty, but he thinks there is no reason to doubt that the greater part of the series at least is referable to the Fox Hills.

The entire series at Coalville is characterized by heavy beds of light-gray and yellowish sandstones alternating with clay shales and other soft strata. Consequently, as the beds have a considerable dip, the sandstones form prominent ridges, and these were numbered in Prof. Meek's section, beginning with the first one above the lower coal bed. There are several faults in the area, one series nearly parallel with the strike and another almost at right angles with it, but they do not complicate the section greatly since the prominent sandstones are all fossiliferous and therefore easily identified. The following somewhat generalized description will serve to show the range of the fossils and the reasons for the correlation that follows:

Cretaceous section at Ccalville, Utah.

	Feet.
1. Interstratified sandstones and shales, with heavy bed of coal at the top. The underlying beds are cut off by a fault. Several of the sandstone layers are very fossiliferous. (See list below.) Estimated thickness.	500–600
2. Gray sandstones 30 feet thick forming roof of coal bed, overlain by dark clay shales with numerous specimens of *Inoceramus labiatus*	795
3. Gray and yellowish hard sandstone forming the first and second ridges, with numerous fossils, many of which are identical with species of the Pugnellus sandstone in Huerfano park, Colorado. (See list below)...	100
4. Clays, with thin beds of sandstone..	165
5. Massive conglomerate	60
6. Mostly covered, but showing soft clay shales and thin beds of coarse sandstone where exposed..	845
7. Clay shales interstratified with thin bands of sandstone and two or three thin seams of coal (including the Carleton bed) of no economic importance, near the base. Fossils abundant, including marine, brackish and fresh water invertebrates, and plants. (See list below)..........	110

[1] U. S. Geol. Sur. Terr. Vol. IX, p. XXX; U. S. Geol. Expl. Fortieth Parallel, Vol. IV, p. 11, footnote.
[2] U. S. Geol. Expl. Fortieth Parallel, Vol. I, pp. 316–319, 327–330, and Vol. II. pp. 330–337.
[3] Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 239.

		Feet.
8.	Massive gray and yellowish sandstone forming the third ridge, with *Ostrea soleniscus, Pholadomya subventricosa(?), Cardium,* and a few other marine Cretaceous species	200
9.	Mostly covered, but evidently underlain by shales and soft sandstone. A band of sandstone about the middle of this member yielded specimens of *Mactra, Cardium,* and *Pecten.* Thickness about	1,500
10.	Gray and brownish sandstone, with bands of shale. The upper 30 feet is a massive, irregularly bedded brownish sandstone with many specimens of *Inoceramus erectus, Cardium, Ostrea,* and a few other species mostly in the form of casts	150

The beds above this horizon are shown by the few exposures to consist of shales and beds of soft coarse sandstone with bands of conglomerate in the upper portion. I estimate that there is room for 1,500 feet of strata below the Tertiary Echo canyon conglomerate.

From No. 2 to No. 10, inclusive, the strata were measured by means of a clinometer compass in the manner described by Mr. C. D. Walcott.[1] The thicknesses given are therefore reasonably accurate, the principal source of error being the possible variations in dip within the long covered spaces.

The following species have been found in No. 1 of the section:

Ostrea soleniscus.	Gyrodes depressa.
Modiola multilinigera.	Amauropsis coalvillensis.
Inoceramus labiatus.	Glauconia utahensis.
Barbatia micronema.	Turritella micronema.
Trigonarca obliqua.	Neritina pisum.
Cardium pauperculum.	Neritina patelliformis.
Mactra utahensis.	Chemnitzia coalvillensis.
Mactra emmonsi.	Eulimella funicula.
Parapholas sphenoideus.	Admetopsis rhomboides.
Siliqua huerfanensis.	Admetopsis subfusiformis.
Corbula nematophora.	Fusus gabbi.

No fossils have been found in the lower 300 feet of the section, and nearly all of those above enumerated occur in a zone from 100 to 150 feet below the principal coal bed. Several of the species are very abundant in certain layers of the sandstone.

The thin bed of sandstone immediately above the coal is usually barren of fossils. The only species that have been observed in it are *Ostrea soleniscus* and *Inoceramus labiatus.* The overlying thick bed of soft shales constituting the larger part of No. 2 is seldom seen in natural exposures but two or three shafts have been dug in it while prospecting for coal and the shales thus thrown out show large numbers of *Inoceramus labiatus.*

Certain bands in the heavy bedded sandstone of No. 3, especially near the top, are very fossiliferous. At Coalville this bed is repeated by a fault so that it forms the first and second ridges, but in addition to the structural evidence of the presence of a fault the fossils plainly show the repetition. On Grass creek, about 4 miles from Coalville, this

[1] Proc. U. S. National Museum, Vol. XI, 1888, p. 447.

part of the series is unbroken. This horizon has yielded the following species of fossils:

Gervillia propleura.	Corbula nematophora.
Cardium pauperculum.	Gyrodes depressa.
Tapes cyprimeriformis?	Turritella micronema.
Donax oblonga.	Pugnellus fusiformis.
Tellina? isonema.	Fasciolaria? utahensis.
Tellina modesta.	Pyropsis ——.
Mactra emmonsi.	Prionotropis hyatti?
Anatina lineata?	Placenticeras ——.

On East Canon creek below Parley's park, about 12 miles southwest of Coalville, there are Cretaceous outcrops in which few of the individual beds of the Coalville section can be recognized, but this sandstone (No. 3) is present and easily recognized by its fossils, of which it has yielded the following species:

Trigonarca obliqua.	Mactra emmonsi.
Cardium pauperculum.	Pugnellus fusiformis.
Tellina? isonema.	Baculites gracilis?
Tellina? subalata.	Prionotropis.
Mactra utahensis.	

This outcrop was mapped by the Fortieth Parallel Survey as very near the boundary between the Cretaceous and the Tertiary, but it is at least possible that the heavy bed of coarse conglomerate 275 feet above it and in the same conformable series also belongs to the Cretaceous and simply represents a greater local development of the conglomerate No. 5 of the Coalville section.

The lists of fossils just given clearly show that a single fauna ranges from near the base of the section at least to the top of No. 3, through over a thousand feet of strata. It is true that certain species seem to be confined to particular strata, but other species, and among them some of the most characteristic ones, such as *Inoceramus labiatus*, range through nearly the whole thickness and each zone is connected with the others by interlocking species. The lists also show that certain of these zones are represented in other sections already described. For example, No. 1 contains about all of the species that were found in the lower division of the Upper Kanab section and in the coal-bearing beds near Cedar city and Kanarra, and these strata may be regarded as equivalent. Again, the faunal lists from No. 3 and from the Pugnellus sandstone in Huerfano park, Colorado, have so many species in common that there can be little doubt that these beds are very nearly contemporaneous deposits.

Up to this horizon the Coalville section very clearly belongs to the Colorado formation[1] and apparently represents almost the whole of it as developed elsewhere. In Colorado there is never more than 300 to 400 feet of the Niobrara beds above the horizon of the Pugnellus sandstone. Still it is well to remember that the Niobrara consists largely

[1] The word "formation" is here used in a somewhat loose sense for want of a better term to designate a series of strata containing a single fauna.

of calcareous deposits which may be represented elsewhere by a much greater thickness of shales and sandstones. Provisionally I have taken the base of the conglomerate No. 5 as the top of the Colorado formation at this locality. The soft strata of No. 6 are seldom exposed in the Coalville area and no fossils have been found in them, but they appear to belong with No. 7.

The overlying 1,800 feet of shales and sandstones are fossiliferous at several horizons, but their strict paleontologic correlation with Cretaceous formations of other regions is difficult for several reasons. In the first place several of the most abundant and best preserved species are not known to occur in well defined formations elsewhere. Others again belong to types that are known to have a great vertical distribution and many are not sufficiently well preserved to admit of positive specific determination. And finally, after allowance has been made for all these defects, the evidence seems to be conflicting. Stratigraphically it is evident that these beds hold the position of the Montana formation, but whether they should all be referred to that formation or part of them should be regarded as the time equivalent of the Laramie must still be left an open question. It is a question that may have an important bearing on the more general problem of the condition of the continent during the Laramie epoch. A very promising field for the study of this question is in western Wyoming along the uplift of "Oyster ridge" and west of it, where at least a part of these upper beds and the horizon of the Evanston coal are both represented in the same neighborhood.

Before giving the lists of fossils from these upper beds I will state that there is no doubt concerning their relative positions. The sandstones of No. 8, dipping 20° to 25°, form a nearly vertical escarpment beneath which the softer beds of No. 7 are exposed in a steep bare slope showing in some places almost every layer. The lower 25 feet of No. 7 exposed beneath the coal bed yielded:

Ostrea coalvillensis.
Anomia propatoris.
Modiola multilinigera?
Corbula subtrigonalis?
Cardium.
Barbatia.

The clay shales immediately associated with the coal seams contain large numbers of fossils in which fresh water, brackish water, and marine forms are commingled. The following list includes those recorded by Prof. Meek from the old Carleton coal mine, nearly all of which have been collected by myself at another exposure on the opposite side of the Weber river, and about 3 miles distant:

Modiola multilinigera?
Anomia propatoris.
Cyrena carletoni.
Unio.
Turritella spironema.
Neritina bellatula.
Neritina carditoides.
Neritina bannisteri.
Eulimella? chrysallis.
Eulimella? inconspicua.
Melampus antiquus.
Valvata nana.
Physa carletoni.

For about 50 feet above the coal seams the following species are found, the most of them in abundance:

Ostrea coalvillensis.
Anomia propatoris.
Corbula subtrigonalis?
Cyrena or Corbicula.
Avicula.
Eulimella chrysallis.
Admetopsis.
Chemnitzia?
Melania.

Four feet below the highest band in which these species were found there is a layer of sandstone containing plant remains. They were very abundant and fairly well preserved at one small outcrop where a collection was made. Plants also occur sparingly in other bands of sandstone above this and in the massive sandstones of No. 8. The plants have been examined by Mr. F. H. Knowlton, of the Geological Survey, and in his notes on them he says:

The matrix, a hard, fine-grained brownish sandstone, preserves the outlines and coarse nervation of the plant remains very satisfactorily, but does not well retain the fine nervation. A number of the species, however, are so characteristic that there can be little doubt as to their determination.

The collection consists of thirty-five specimens representing about twelve species, the most important of which belong clearly to the Laramie group. They are as follows:

*Sequoia longifolia Lx.
Sequoia reichenbachi Heer.
Glyptostrobus europaeus ? Heer.
Salix elongata O. Web.
Salix integra Göpp.
Salix sp.
Ficus lanceolata Heer.
Ficus planicostata ? Lx.
*Ficus irregularis ? Lx.
*Viburnum marginatum Lx.
Viburnum sp.
*Cinnamonum affine Lx.
*Magnolia tenuinervis Lx.

Those marked with an asterisk in the above list are, according to Mr. Knowlton, "Laramie species about which there is little doubt as to their correct determination." The others are "either fragmentary and therefore of doubtful determination, or occurring in formations other than the Laramie." Only one species in the list, *Sequoia reichenbachi*, is known to occur below the Laramie and it has a wide range, being found from the Jurassic or Lower Cretaceous to the Tertiary.

If the evidence of these plants were considered alone there could be no hesitation in referring the strata containing them to the Laramie. Some of the invertebrates also from No. 7 are very closely related to Laramie species if not identical with them, but unfortunately the most of them are of types that have a great vertical range and therefore are of little use in correlation. *Ostrea coalvillensis* is probably identical with *O. glabra*. *Corbula subtrigonalis* is a Laramie species, but closely similar forms occur in the Colorado. *Anomia propatoris* also is represented in both of these formations by closely similar or identical forms. *Modiola multilinigera* is a Colorado species and it has near relatives in the Laramie. The form listed as *Melania* seems to be very close to *Melania wyomingensis*, a species that has been considered characteristic of the

Laramie, though it does occur associated with marine forms in the uppermost Fox hills beds. The Admetopsis is apparently the same species that occurs so abundantly with *Ostrea soleniscus*, *Modiola multilinigera?*, etc., near the base of the upper division of the Upper Kanab section. The species of *Neritina* belong to types that range from the Colorado to the Laramie. In fact none of the brackish-water species of these lists would be thought out of place if they were found in the Laramie. But when it is known that the beds containing them are overlain by 1,800 feet of marine Cretaceous strata their Laramie age is rendered very doubtful. In many respects the facts observed recall the Belly River series of the Canadian geologists, but at Coalville the brackish-water conditions seem to have been too limited both in area and duration to be regarded as more than a temporary phase—perhaps an estuary—in a marine formation.

Twenty feet above the bed from which the plants were obtained and in the same exposure a thin layer of sandstone is filled with the remains of marine invertebrates mostly in the form of casts. The following species have been collected from it:

Cardium curtum.
Cardium n. sp.
Mactra arenaria.
Mactra formosa?
Tellina isonema?
Donax cuneata?
Barbatia.
Anatina.
Gyrodes.
Pyropsis.
Fusus.
Baculites ovatus?
Placenticeras placenta var. intercalare.
Scaphites.

The most abundant and best preserved species are *Cardium curtum* and *Mactra arenaria*, neither of which has been found elsewhere than in this immediate region or in the strictly equivalent strata of western Wyoming. Of the others the bivalves and the gasteropods are of doubtful value, and the cephalopods apparently belong to the fauna of the Montana formation, though the *Placenticeras* also occurs in the Colorado formation.

The more massive sandstones of No. 8 have yielded—

Ostrea soleniscus.
Ostrea sannionis.
Tellina subalata?
Mactra formosa?
Mactra arenaria.
Pholadomya subventricosa.
Cardium.
Donax?
Baculites ovatus.
Placenticeras placenta, var. intercalare.

It has already been shown that marine Cretaceous fossils have been found at two other horizons above this, one near the middle of No. 9 and the other in No. 10, and they all belong to the fauna represented in the last two lists.

After attempting to give due weight to each element in this conflicting evidence it seems to me most reasonable to refer the strata containing the "Laramie" plants and the brackish-water invertebrates of

Laramie affinities to the Montana formation. If the true Laramie is present it is represented by the strata above No. 10 of the section and these have yielded no fossils.

The beds beneath the Coalville section are not exposed in the immediate neighborhood, but near Rockport, on the Weber river, 12 miles above Coalville, the continuation of the section down to the Trias may be seen. The strata are highly disturbed, dipping northward at angles varying from 30° to 80°. There are at least two faults in the series, and the great apparent thickness of the section suggests that there may be others by which strata are repeated.

The lowest fossiliferous zone of the Coalville section with the characteristic species, such as *Barbatia micronema*, *Mactra utahensis*, *Modiola multilinigera*, and others, is well developed. Beneath (south of) this bed there are no good exposures for a distance of 2,200 feet. Then come the following strata in descending order:

		Feet.
1.	Alternating beds of coarse sandstone and shale. The beds of sandstone vary in thickness from 10 feet to over 100 feet, and their aggregate thickness is somewhat less than that of the shales. A few specimens of *Ostrea* and casts of *Cardium* and other bivalves were found in the lower portions. Total apparent thickness	2, 500
2.	Drab shales with indurated bands in which numerous scales of fishes and an obscure impression of an Ammonite were collected	215
3.	Covered for a distance of	700
4.	Reddish and brownish shales alternating with thinner beds of coarse gray sandstone, changing to brown pebbly conglomerate in the lower 650 feet	2, 400
5.	Reddish shales with thin beds of brown sandstone	433
6.	Dark greenish gray sandstone, somewhat calcareous, especially toward the top. A specimen of *Trigonia quadrangularis?* and a few other obscure fossils indicate that this bed is Jurassic	55
7.	Gray and reddish sandy shales, with bands of sandstone	1, 295
8.	Yellowish gray shales, becoming calcareous toward the base	935
9.	Blue thin bedded limestone and calcareous shales containing *Pentacrinus asteriscus*, *Pleuromya subcompressa*, and other Jurassic fossils	422
10.	Reddish brown thin bedded Triassic? sandstone, exposed	750

The thicknesses given are from measurements made on the assumption that there is no duplication of strata by faulting. The observed faults that have been mentioned are not within the limits of the section. If the beds down to and including No. 4 be regarded as Cretaceous, this gives an apparent thickness of over 6,000 feet of Cretaceous strata beneath the Coalville section. On East Canyon creek below Parley's park the thickness from the base of the conglomerates, like those of No. 4, to the top of the fossiliferous sandstone there exposed seemed to be a little over 5,000 feet, but that was only an estimate based on observed dips and paced distances.

The conglomerates of No. 4 were mapped as Dakota by Mr. Emmons, and the two other "Dakota" areas that I have visited in this region—one on East Canyon creek and the other on Chalk creek—show the same beds. That they are Cretaceous is very probable, but that they should be strictly correlated with the Dakota sandstone east of the Rocky mountains seems to me doubtful.

In a previous paper[1] already cited, I have shown that in western Wyoming the brackish water Bear River formation, formerly called the Bear River Laramie, is beneath the Colorado, and that it rests on just such a series of shales, sandstones, and conglomerates as is included in No. 4 of the Rockport section. The nearest locality at which Bear River fossils have been found is the well known one on the Union Pacific railroad near the mouth of Sulphur creek, which is about 40 miles from Rockport. The lowest strata there exposed are the upper part of the Jurassic.

The detailed sections as seen in various exposures in the immediate neighborhood of Sulphur creek may be thus epitomized in ascending order:

	Feet.
1. Reddish brown, and bluish shales and shaly sandstones with a thin calcareous band about the middle containing *Belemnites densus, Trigonia quadrangularis,* and *Pleuromya weberensis.* Thickness about	500
2. A heavy bed of brown pebbly conglomerate forming the base of a series of alternating coarse sandstones, and variegated shales that was doubtfully referred to the Dakota. Total thickness	1,600
3. Very fossiliferous dark calcareous shales with a few thin beds of sandstone. Fossils: *Pyrgulifera humerosa, Corbicula durkeei, Unio vetustus, Corbula pyriformis,* etc	840
4. Blue and brownish fissile shales with many scales of fishes, a few fragments of Ammonites and, at a higher horizon, numerous specimens of *Cardium pauperculum.* Some beds of sandstone are probably included. Thickness estimated	1,000–1,500

5. At a higher horizon, the exact position of which could not be determined in the local sections on account of faults, a sandstone accompanying a coal bed yielded *Inoceramus labiatus, Corbula subtrigonalis?, Donax cuneata, Pugnellus fusiformis, Ostrea soleniscus,* and other species that permit its correlation with No. 4 of the Coalville section. There are also higher beds exposed here, but owing to the complicated structure the upper part of the section has not been worked out.

No. 1 is Jurassic, and it is comparable with Nos. 5 and 6 of the Rockport section.

No. 2 is very much like No. 4 of the Rockport section. The conglomerate at the base is of the same character at both places, though near Sulphur creek it reaches a thickness of 150 feet, while at Rockport it is broken up into several thinner beds, the thickest of which is about 50 feet.

No. 3 is the Bear River formation with its characteristic fossils here ranging through only 650 feet of strata, but at other localities farther north the fossils were found to range through a thickness of at least 2,500 feet, extending down almost to the conglomerate at the base of No. 2. The failure to find Bear River fossils at Rockport and in East canyon may be due to the incomplete exposures of strata there, as the por-

[1] Am. Jour. Sci., vol. XLIII, 1892, pp. 98-115.

tions of the section in which they were expected were much covered with débris, but it is quite probable that the fresh and brackish waters in which they flourished did not extend as far south and west as these localities. At any rate, the formation has not been found beyond them in those directions. Although the Bear River formation as such seemed to be absent, nevertheless its position in the Rockport section is plainly indicated by the indirect circumstantial evidence of a similar succession of strata and of apparently identical underlying and overlying beds to be about that of the covered space No. 3 and the upper part of No. 4.

The lower part of the shales overlying the Bear River formation on Sulphur creek are in every respect similar to No. 2 of the Rockport section. In the earlier paper they were referred to the Colorado formation, and they seem to be faunally connected with it, but their position is now seen to be considerably lower than I then suspected, though, owing to the doubt concerning the number of faults in the Rockport section, I am still unable to say how many hundred feet they are below the base of the Coalville section. The very great thickness of strata between the top of the Colorado formation at Coalville and the base of the so-called Dakota conglomerates (it can hardly be less than 5,000 or 6,000 feet) causes me to suspect that the latter are somewhat older than the Dakota sandstone as developed east of the Rocky mountains. After making such allowance for differences in the rate of deposition as the character of the strata will permit and assuming that sedimentation was continuous in both regions, as seems to have been the case, the 1,000 or 1,200 feet of strata in the one region can hardly be regarded as the complete equivalent of 5,000 or 6,000 feet in the other.

From the foregoing descriptions of local sections it is seen that in the larger part of the area the Colorado formation rests with apparent conformability on the Dakota sandstone; that in southern Utah its fauna ranges down to the local base of the Upper Cretaceous and through beds that have usually been correlated with the Dakota, and that in southwestern Wyoming it rests on the Bear River formation, with which it seems to be conformable. It is also shown that the Colorado formation is overlain by the Montana formation with a distinct marine Cretaceous fauna. With the exception of the two or three instances noted no nonconformity has been observed between these two formations.

The accompanying faunal lists show the geographical distribution of nearly all the species and their vertical range within the area here discussed, and they also show the reasons for correlating the different sections.

A more general consideration of the fauna as a whole in its relations to other Cretaceous faunas in this country and in Europe will now be given briefly.

THE RELATIONS OF THE COLORADO FAUNA TO OTHER CRETACEOUS FAUNAS.

Within the geographic limits arbitrarily assigned to the Colorado formation in the early part of this paper there is only one other marine Upper Cretaceous fauna—that of the Montana formation, which immediately overlies it. The larger part of it was described and illustrated by Prof. Meek in his volume on Invertebrate Paleontology,[1] and many additional species have been described by Dr. White, Prof. Whitfield, and others. A comparison of these two successive faunas shows that they are remarkably distinct although, as should be expected, they have some species in common and others that are very closely related. The species that are considered identical nearly all belong to genera whose species are seldom sufficiently differentiated to be depended upon in close geologic correlation. Those that seem to have passed up from the Colorado to the Montana formation are not usually found associated with the typical Montana fauna, but the most of them occur in that peculiar phase of it that was developed along the western shore line.

In the following list of common and closely related species in the two formations the interrogation after a name indicates a doubt as to the identity of closely related forms:

Colorado formation.	Montana formation.
Ostrea soleniscus.	O. soleniscus.
Ostrea prudentia.	O. patina.
Anomia propatoris?	A. propatoris.
Modiola multilinigera.	M. multilinigera?
Inoceramus simpsoni.	I. simpsoni.
Barbatia micronema.	B. micronema?
Nemodon sulcatinus.?	N. sulcatinus.
Lucina subundata.	L. subundata.
Veniella mortoni.	V. humilis.
Anatina lineata.	A. lineata?
Corbula subtrigonalis.	C. subtrigonalis.
Lunatia concinna?	L. concinna.
Baculites asper.	B. asper?
Placenticeras placenta.	P. placenta.

In addition to these the species of *Neritina*, *Eulimella*, *Chemnitzia*, and *Admetopsis*, occurring in the Colorado formation in Utah, belong to types that are also found in the higher beds of the same region.

If we now compare the Colorado fauna with the fauna of the Ripley formation of the southern United States, which is believed to be the equivalent of the Montana formation, some additional resemblances are seen. For example, the genera *Trigonarca*, *Gyrodes*, *Rostellites*, and *Pugnellus* are present in both, and the first two are represented by similar species, but none of the forms that can be considered characteristic of the Colorado fauna are known in any of the more recent faunas.

Before comparing our fauna with others believed to have been con-

[1] U. S. Geol. Surv. Terr., Vol. IX, Pls. 10–39.

temporaneous, it may be well to enumerate some of its most characteristic forms. Those given in the following list are not known to range into strata above the Colorado formation and all are sufficiently abundant and widespread to be of use in correlation. Many others are equally as characteristic, but have been found at only one or two localities:

Ostrea lugubris.	Cardium pauperculum.
Exogyra columbella.	Liopistha (Psilomya) meeki.
Gryphæa newberryi.	Liopistha (Psilomya) concentrica.
Avicula gastrodes.	Turritella whitei.
Gervillia propleura.	Glauconia coalvillensis.
Inoceramus labiatus.	Pugnellus fusiformis.
I. dimidius.	Baculites gracilis.
I. fragilis.	Buchiceras swallovi.
I. umbonatus.	Scaphites warreni.
I. exogyroides.	Prionocyclus.
I. deformis.	Prionotropis.
I. undabundus.	Mortoniceras.

None of the keeled Ammonites included in the last three genera above named have been found above the limits of the Colorado formation and its equivalents in America.

The fauna is also negatively characterized by the absence of many types that form prominent features of the Montana fauna. Among such may be mentioned the genera *Heteroceras*, *Ptychoceras*, and *Anisomyon*, the large species of *Baculites*, such as *B. ovatus*, *grandis*, and *compressus*, *Scaphites conradi* and *Scaphites nodosus*, and the broad compressed forms of *Inoceramus*, like *I. sagensis* and *I. vanuxemi.*

The Eagle ford shales and the Austin limestone of Texas have already been alluded to as the equivalents of the Fort Benton and Niobrara, respectively. This correlation was made on a good paleontological basis by Shumard, Meek, White, and others, and it has never been questioned. The faunal lists published by Mr. R. T. Hill[1] contain the following species that occur in the Colorado formation or are represented by closely related forms:

From the Eagle Ford shales.

Ostrea congesta.	Buchiceras swallovi.
O. bellaplicata [lugubris.]	Mortoniceras shoshonense.
Exogyra columbella.	Prionotropis woolgari.
Inoceramus exogyroides.	Ancyloceras? annulatus.
I. involutus [umbonatus.]	Ammonites graysonensis.[2]
I. labiatus.	Ammonites meekianus.[2]

From the Austin limestone.

Ostrea congesta.	I. labiatus.
Exogyra columbella.	Trigonarca sp.
E. læviuscula.	Nautilus elegans.
E. ponderosa.	Mortoniceras vespertinum (=Amm. texanus).
Inoceramus exogyroides.	Mortoniceras shoshonense.
I. involutus.	Baculites asper.
I. umbonatus.	

[1] Geol. Sur. Tex. Bull. No. 4, Check List, Cret. Invert. Foss. of Tex., pp. 51–53.
[2] These probably are species of Prionotropis.

Associated with these is a large number of other species that have not been recognized in our area. The fauna of the Austin limestone seems to be somewhat more closely related to that of the overlying beds than is the Colorado fauna to the Montana.

Some of the species doubtfully assigned to the Eagle Ford shales are also listed as occurring in the Denison beds at the top of the Comanche series, but this is probably an error, since the species in question are entirely Upper Cretaceous forms and several of them occur in the Colorado formation.

Beneath the Eagle Ford shales the Timber Creek formation (Lower Cross Timber sands of Hill) contains an unstudied marine fauna that will probably prove to be closely related to the Colorado fauna, especially to that part of it that occurs in the lower portion of the formation in Utah.[1]

The Upper Cretaceous faunas of Mexico have not been studied, but the occurrence of *Inoceramus labiatus* at several localities in Chihuahua indicates the presence of the Colorado fauna there, though Dr. White has suggested that the Upper Cretaceous strata of that region are not divisible into distinct formations.

The Colorado fauna has not been recognized in any of the states east of the Mississippi. If it is represented at all in the Alabama-Mississippi region it should be sought in the Tombigbee sands and the Eutaw formation and perhaps the lower part of the "Rotten Limestone," none of which has been much studied paleontologically.

On the Pacific coast of the United States the Cretaceous faunas generally are very different from those occurring east of the mountains, having few if any species in common. None of the characteristic Colorado species has been found there, and it has not yet been determined whether any of the Cretaceous formations of California, Oregon, and Washington are strictly the equivalents of the Colorado formation. Farther north, however, in the upper shales and sandstones of the Queen Charlotte islands *Inoceramus labiatus* is reported[2] to occur, and this may be considered the most characteristic species of the Colorado fauna.

In the Rocky mountain region of British America, Dr. G. M. Dawson[3] obtained the following species that clearly belong to our fauna:

Ostrea congesta.
Inoceramus exogyroides.
I. undabundus.
I. labiatus.
Pholadomya papyracea.
Scaphites warreni.
S. vermiformis?

From the "Niobrara-Benton formation" in the Duck and Riding mountain district of Manitoba, Mr. Whiteaves[4] records the following species:

Serpula semicoalita.
Lingula subspatulata?
Ostrea congesta.
Anomia obliqua.
Inoceramus labiatus.
Modiola tenuisculpta.
Belemnitella manitobensis.
Loricula canadensis.

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[1] Vide White, C. A., Bull. 82, U. S. Geol. Sur., p. 121.
[2] Whiteaves, J. F.: Mesozoic fossils, Vol. 1, p. 193.
[3] Whiteaves, Cont. to Can. Palæont, Vol. I, pp. 83–86.
[4] Ibid., pp. 185–191.

In several of their joint papers Messrs. Meek and Hayden suggested the correlation of the "lower series" of their section with the Lower or Gray Chalk of the English geologists. In 1861 they stated their views[1] thus:

Having now considered, in the order of their succession, the several rocks embraced in the lower series of the Nebraska cretaceous deposits * * * it will be interesting to see how nearly their synchronism with known horizons in the Cretaceous system of the old world can be traced out. With this view we have carefully compared with European forms all the fossils in the several Nebraska collections from the rocks, including those most recently obtained, to which the new species described in this paper belong. These comparisons have satisfied us that the formations under consideration, that is, the Niobrara division, Fort Benton group, and the Dakota group represent together the Lower or Gray Chalk, and probably the Upper Greensand of British geologists (Turonien and Cenomanien of d'Orbigny).

Seven identical or closely related species are listed as occurring in both the American and the foreign formations. In Prof. Meek's latest work, so frequently cited, this correlation is again maintained and based on the same evidence. At that time less than twenty-five species were known to belong to the Colorado fauna.

A comparison of the much greater number of the species now known with those of the European Turonian in the light of more definite statements concerning the vertical range of European species as given by Barrois,[2] Schlüter,[3] Zittel,[4] and others furnishes additional evidence mainly in the same direction. The following comparative lists contain the most prominent examples of identity or close similarity:

From the Colorado formation.	From the Cenomanian.
Nautilus elegans.	Nautilus elegans.
Scaphites warreni. Scaphites larvæformis.	Scaphites æqualis.
	From the Turonian.
Exogyra suborbiculata.	Exogyra suborbiculata.
Anomia subquadrata.	Anomia truncata.
Avicula gastrodes.	Avicula caudigera.
Inoceramus labiatus.	Inoceramus labiatus.
Inoceramus deformis.	Inoceramus cuvieri.
Amauropsis bulbiformis.	Amauropsis bulbiformis.
Rostellites dalli.	Rostellites elongata.
Baculites gracilis.	Baculites bohemicus.
Prionotropis woolgari.	Prionotropis carolinus. Prionotropis woolgari.
Prionotropis lœvianus.	Ammonites nodosoides.
Prionocyclus wyomingensis.	Ammonites germari.

In Germany Dr. C. Schlüter has described, under the name "Emscher Mergel," a formation overlying the Turonian which he regards as intermediate between that formation and the Senonian, though it has

[1] Proc. Acad. Nat. Sci. Phila., 1861, p. 423.

[2] Barrois, C.: Terrain Crétacé de l'Angleterre, Lille, 1876.

[3] Schlüter, C.: Cephalopoden der oberen deutschen Kreide, Palæontographica, Vol. XXIV, 1876, pp. 87–134.

[4] Zittel, K. von.: Handbuch der Palæontologie.

usually been placed at the base of the Senonian. It is especially characterized by the keeled *Ammonites*, such as those we have referred to *Mortoniceras* and *Prioncyclus* and by certain forms of *Inoceramus*. Several species are represented by identical or closely related American forms, as follows:

From the Colorado formation.	From the Emscher Mergel.
Inoceramus umbonatus. Inoceramus exogyroides.	Represented by Inoceramus involutus.
Inoceramus deformis.	Inoceramus cuvieri.
Baculites asper.	Baculites incurvatus.
Mortoniceras shoshonense.	Mortoniceras vespertinum.

On account of the occurrence of these forms and a few others in Texas, Dr. Schlüter[1] has considered the beds (Austin limestone) containing them the equivalent of the Emscher Mergel.

It is interesting to compare these facts with the evidence furnished by vertebrate fossils from the Colorado formation. I can not do this better than by quoting the statements of Prof. E. D. Cope:[2]

> The fauna of the deep sea epoch, the Niobrara, is the best known. Here the remains of *Pythonomorpha* constitutes the prevailing characteristic, while *Elasmosaurus* and *Polycotylus*, with but few species, represent the numerous *Sauropterigia* of Europe. Crocodiles were apparently wanting, while turtles and a peculiar group of *Pterosauria* were only moderately abundant. The fish fauna was very rich and varied. Here the *Saurodontidæ*, like the molluscous family of the *Rudistæ*, appeared and as soon disappeared, accompanied by the peculiar form *Erisicthe* and the family of *Stratodontidæ*. The genera of Mount Lebanon, *Leptobrachelus* and *Spaniodon* occur in this bed in Dakota, but the closest parallelism is exhibited with the Lower Chalk or Turonian of western Europe. The general facies of the reptilian fauna is that of the Lower Chalk, and there is little doubt that several genera are identical in the two continents, e. g., *Elasmosaurus*. The apparent peculiarity of the Chalk in America is the abundance (four genera) of *Pythonomorpha*, with numerous species, while but two genera have yet been found in Europe, and the presence of birds with biconcave vertebræ and teeth. This interesting type, which was first discovered by Seeley in the genus named by him *Enaliornis*, and afterwards found by Marsh to have teeth, has been found at a lower horizon in England, the Upper Greensand. But in England, France, and Westphalia occur the genera of fishes above mentioned, as, *Porthenus*, *Ichthyodectes*, *Saurodon*, *Saurocephalus*, *Erisicthe*, *Empo*, *Pachyrhizodus*, *Enchodus*, *Leptotrachelus*, etc. This close relationship of the horizons permits an identification, and it is the first instance that appears to me susceptible of satisfactory demonstration.

Again, on page 42 in "Resume of Comparisons," he says: "Exact identification of restricted divisions may be made in a few instances only, such as the Turonian and the Niobrara."

Sufficient evidence has been given to show that the invertebrate fauna of the Colorado formation can not be divided into well defined subfaunas or zones corresponding to those that have been recognized in Europe. It is true that certain types seem to be confined to the upper part and others to the lower part of the formation, but some of the most

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[1] Op. cit., p. 113, and Naturh. Ver. pr. Rheinl. Sitzungsb. Jahrg. 44, 1887, p. 47.

[2] Cope, E. D.: Cretaceous Vertebrata. U. S. Geol. Sur. Terr., vol. III, pp. 27, 28.

characteristic species, such as *Inoceramus labiatus*, range from the bottom to the top. The fauna as a whole may be regarded as the approximate taxonomic equivalent of the Turonian, though it is not probable that either the beginning or the end of the epoch was contemporaneous on the two continents. The few species that are compared with Cenomanian forms are not important. One of them, *Nautilus elegans*, occurs in the upper part of the Colorado formation (at least in Texas), while the *Scaphites* are associated with *Inoceramus labiatus*, *Prionotropis woolgari*, and *Prionocyclus wyomingensis* in the Fort Benton shales.

The indefiniteness of the correlation of the upper part of the formation—the Niobrara and its equivalent, the Austin limestone—is shown by the facts above given, the vertebrates belonging to the Turonian types, while the mollusks may be compared in part with Emscher or lowest Senonian forms. As usual when an attempt is made to identify formations in such widely separated regions, the identification is most certain when only one class of facts is examined, and becomes doubtful when the facts are more numerous and are gathered from more varied sources.

DESCRIPTION OF SPECIES.

ECHINODERMATA.

CRINOIDEA.

UINTACRINIDÆ.

Genus UINTACRINUS Grinnell.

UINTACRINUS SOCIALIS Grinnell.

Uintacrinus socialis Grinnell, 1876, Am. Jour. Sci., vol. XII, p. 81; Meek, 1876, Bull. U. S. Geol. Sur. Terr., vol. II, p. 375; Clark, 1893, Bull. U. S. Geol. Sur., No. 97, p. 21, Pl. 1, Figs. 1*a–c*, and Pl. 2, Figs. 1*a–e*.

This species and the following one having been recently described and illustrated in a publication of the U. S. Geological Survey, are listed here simply with references for the sake of completeness.

ECHINOIDEA.

CASSIDULIDÆ.

Genus CASSIDULUS Lamarck.

CASSIDULUS STANTONI Clark.

Cassidulus stantoni Clark, 1891, Johns Hopkins University Circulars, No. 87, p. 76; 1892, Bull. U. S. Geol. Survey, No. 97, p. 73, Pl. 35, Figs. 2*a–d*.

VERMES.

SERPULIDÆ.

Genus SERPULA Linnaeus.

SERPULA INTRICA White.

Pl. I, Fig. 1.

Serpula intrica White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 205, Pl. 15, Fig. 5*a*.

Compare *Serpula gordialis* (Schloth.) Geinitz, Palæontographica, vol. XX, pt. 1, p. 282, Pl. 63, Figs. 2, 3.

"Tubes small, slender, cylindrical, smooth, very long and very tortuous, not perceptibly increasing in size, so far as our examples show, but neither the distal nor proximal extremity of the tube has been found unbroken.

"Diameter of the tube, a little more than 1 millimeter.

"This species is remarkable for the great length and uniform size of the tubes and for the intricacy of their contortions.

"*Position and locality.*—Strata of the Cretaceous period; southeast of Paria, Utah."

SERPULA ? TENUICARINATA Meek and Hayden.

Pl. I, Fig. 2.

Serpula ? tenuicarinatus Meek and Hayden, 1857, Proc. Acad. Nat. Sci. Phila., p. 134; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 507. Pl. 6, Fig. 1.

"Tubes growing in groups, or rarely single, nearly cylindrical, increasing very gradually in size, irregularly curved, but apparently never spirally coiled, attached by the under side throughout most of the entire length; upper side having a distinct, rather sharply elevated, flexuous, longitudinal carina; surface smooth.

"Length unknown; average transverse diameter, 0·14 inch.

"Not having seen entire specimens of this species, it is with some doubt that it has been referred to the genus *Serpula*. It seems never to have internal septa as in *Vermetus*. It was originally placed provisionally in the genus *Serpula* and is here, in the same way, retained in that group.

"*Locality and position.*—Mouth of Vermilion river, [South] Dakota, on the Missouri, in the Fort Benton group of the upper Missouri Cretaceous series."

MOLLUSCA.

PELECYPODA.

OSTREIDAE.

Genus OSTREA Linnaeus.

OSTREA PRUDENTIA White.

Pl. I, Figs. 3 and 4.

Ostrea prudentia White, 1876, U. S. Geol. Sur. West 100th Meridian, vol. IV., p. 171, pl. 14, Figs. 2*a–d*; 1884, 4th Ann. Rept. U. S. Geol. Sur. p. 299, Pl. 40, Figs. 5 and 6.

Compare *Ostrea patina* Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., p. 277; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 16, plates 10 and 11.

Original description:

"Shell neat and symmetrical for a species of this genus, suboval or subcircular in outline when adult, subcircular when young, moderately capacious; beaks small, usually distinct, and approaching so near to each other when the valves are together as to leave only a narrow space between the areas. Lower valve moderately deep; area short and broad; ligamental groove short, broad, and distinct, bounded at each side by a rounded ridge; beak extending very slightly beyond that of the other valve; scar of attachment sometimes occupying one-quarter of the outer surface, sometimes extremely small, and sometimes apparently absent. Upper valve usually flat or a little concave transversely; but a little convex longitudinally in adult shells; area a very little shorter than that of the other valve, moderately convex or nearly flat.

"Surface of both valves marked by distinct lines and laminæ of growth, but this species is rather less laminated and roughened than is usual in the genus *Ostrea*. Somewhat numerous, corrugated, but rather indistinct, radiating costæ are usually to be seen on the ventral valve of young examples, yet these corrugations seldom or never extend to the front half of old shells.

"Length, 6^{cm}.; breadth, 5^{cm}.

"This species is somewhat remarkable for its neatness of form and freedom from the crude extravagances which species of this genus often exhibit.

"*Position and locality.*—Strata of the Cretaceous period, east of Impracticable ridge, Utah."

This species so closely resembles some specimens of *Ostrea patina* M. & H., from the Montana formation, that I have been inclined to treat it as a synonym of that species. In the geology of the Uinta mountains Dr. White gives it in the list of species belonging to the Henry's Fork group, which has since been correlated with the Dakota, but a number of the species in that list have been found to occur in the Colorado formation, and I have included all of them in its fauna, though some of them may have been found at a lower horizon than is usually regarded as the base of that formation.

OSTREA ANOMIOIDES Meek.

Pl. I, Figs. 5 and 6.

Ostrea anomioides Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 488; White, 1880, idem for 1878, p. 10, Pl. 11, Figs. 4*a*, *b*; 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 291, Pl. 39, Figs. 4 and 5.

Original description:

"Shell rather small, very thin, depressed plano-convex, and without any visible scar of attachment, varying from ovate to circular; rounded or sometimes a little straightened on the hinge margin; beaks scarcely projecting beyond the outline of the cardinal margin. Lower valve very shallow; cartilage pit unusually small, shallow, and short. Upper valve almost perfectly flat; cartilage attachment even shorter than that of the other valve, and slightly convex on its inner margin. Muscular scars unknown; surface of both valves with small regular concentric wrinkles most distinctly marked on the central region.

"Greatest diameter of one of the largest oval specimens, 1.70 inches; breadth, 1.40 inches; convexity, 0.23 inch.

"This species is remarkable for the thinness of the shell, the slight concavity of the under valve, and the flatness of the upper, as well as for its rounded or slightly straightened cardinal margin, and the absence of any scar of attachment, or of any traces of muscular impressions within. These external characters, and the regular small concentric wrinkles, give the exterior of the lower valve of circular specimens somewhat the appearance of a *Lucina* or *Dosinia;* while in other individuals it looks more like an *Anomia* or *Placuna*.

"*Locality and position.*—Missouri river, below Gallatin city, Montana. Cretaceous."

OSTREA CONGESTA Conrad.

Pl. II, Figs. 2, 3, and 4.

Ostrea congesta Conrad, 1843, Nicollet's Rept. of Explorations in the Northwest, p. 167; Hall, 1856, Pacific R. R. Reports, vol. III, p. 100, Pl. 1, Fig. 11; Meek, 1876, U. S. Geol. Sur., vol. IX, p. 13, Pl. 9, Figs. 1*a–f;* White, 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 294, Pl. 39, Figs. 11, 12, 13.

Prof. Meek's description is as follows:

"'Shell elongated; upper valve flat; lower valve ventricose, irregular; umbo truncated by a mark of adhesion.' (Conrad.)

"This is a small, thin shell, the individuals of which are often crowded together in considerable numbers, so as to assume quite irregular forms. In cases where the individuals had room to grow without interruption, the young shell is usually found to be of an ovate form, and attached by the whole under surface of the lower valve, the beak of which is pointed, provided with a small triangular area, and usually turned a little to the left. In this form they continue to grow to lengths varying from 0.25 to 1 inch, when the margins are abruptly deflected upward at right angles to the flat attached base, and produced in this direction often for as much as an inch or more; the greatest extension being on the lateral margins and at the extremity opposite the beaks. When seen at this stage of their growth, separated from the body to which they were originally attached, and lying partly embedded in the matrix, with the beak side down, they look like short cylindrical tubes, with one end abruptly truncated and closed by the flat surface of attachment; so that what was originally the whole under surface of the valve now appears like the truncated umbo.

"The other valve is quite flat, or sometimes a little concave, and always retains the form possessed by the attached valve at the time its margins became deflected upward, after which it seems to have increased very little in size. Its umbo is usually a little less pointed than that of the other valve, and provided with a shorter area, on each side of which its margins are sometimes slightly crenulated.

"The muscular impressions of both valves are obscure, and the surface is nearly smooth, or only marked by fine, indistinct lines of growth.

"*Locality and position.*—At numerous places along the Missouri between the Big Sioux and the Great Bend; also on the Little Blue river, near the Kansas and Nebraska line, and near the Black hills, on Cheyenne river, as well as on the North Platte; in the Niobrara group, or formation No. 3, where it is usually found attached to fragments of a large *Inoceramus*. It likewise occurs at several localities in New Mexico and Colorado, probably in the same position."

OSTREA SOLENISCUS Meek.

Pl. II, Fig. 1; Pl. III, Figs. 1 and 2.

Ostrea soleniscus Meek, 1871, Proc. Am. Philos. Soc., vol. XI, p. 430; 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 487; White, 1880, *idem* for 1878, p. 9, Pl. 11, Figs. 2*a*, *b*; 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 300, Pl. 42, Fig. 1.

Ostrea cortex White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 170, Pl. 15, Fig. 2*a–c*.

Not *Ostrea cortex* Conrad, 1857, U. S. and Mex. Bound. Sur., vol. I, p. 157, Pl. 11, Fig. 4*a–d*.

"Shell attaining a large size, becoming rather thick in adult examples, generally straight, greatly elongated, and comparatively very narrow, with parallel lateral margins. Lower valve with moderate internal concavity, and having the appearance of a little gutter or elongated trough; beak usually nearly straight, rather obtusely pointed, and more or less distorted by the scar of attachment; ligament area of moderate size, strongly striated transversely, and provided with a large, deep longitudinal furrow; surface apparently only with moderately distinct marks of growth. Upper valve almost nearly flat externally, but nearly as concave as the other within; beak usually a little truncated; ligament area marked with strong transverse striæ, and having its mesial ridge very prominent, and occupying as much as one-third its breadth; surface as in the other valve, or perhaps a little smoother.

"Length of adult examples about 18 inches; breadth of same about 2·50 to 3 inches.

"Although not a very uncommon species, I have seen no entire specimens of this remarkable shell. It will be readily known by its usually narrow, elongated, and generally straight form. The shell is usually found broken into several pieces, but casts of the internal cavity are not unfrequently met with entire. One of these before me is nearly 1 foot in length and only 2 inches in breadth. It often had a curious habit of growing in groups of three shells, attached to each other by the backs of their beaks. I have seen large numbers of them closely arranged, or nearly in contact with each other, at Coalville, all with their beaks downward, or at right angles to the planes of the sandstone strata. When found where it grows isolated, the shell is sometimes arched to one side.

"*Locality and position.*—This species ranges through nearly the whole thickness of the Cretaceous sandstones near Coalville, Utah, and is also found in the Cretaceous coal-bearing sandstones at Bear River city, Wyoming, as well as in a sandstone ridge of same age on Union Pacific railroad, a few miles east of the latter locality."

The above is Prof. Meek's revised description of this species, which, as he intimates, ranges from beds containing an undoubted Colorado fauna far up into those that probably belong to the Montana.

Associated with the very slender forms there are other shorter ones broadly ovate in outline that apparently belong to the same species. The specimens from southern Utah that were referred to *Ostrea cortex* are of this character. The beaks are usually more or less exogyrate in form, this feature being most marked on the upper valve of the broader specimens. The same species occurs in the Lower Cross Timber sands stone of Denton county, Tex.

OSTREA MALACHITENSIS n. sp.

Pl. II, Figs. 5, 6, 7, and 8.

Shell rather small, irregularly subtriangular in outline; cardinal margin long and nearly straight, more or less distinctly auriculate in front of the beaks, which are small and inconspicuous; lower valve moderately convex, with the greatest convexity along an oblique line from the beak to the middle of the postero-basal margin, which is there broadly emarginate, thus giving the shell a saddle-shaped or bilobate form. The outline of the shell, exclusive of this broad lobe and the small triangular anterior alation, is oblong oval. Upper valve nearly flat or slightly concave, excepting on the posterior margin, where there is a broad downward flexure corresponding to the emargination and the convexity of the lower valve. Surface of both valves marked only by lines of growth and a few concentric laminæ.

The largest examples measure 45^{mm} from beak to base, and about the same in the greatest length at right angles to that line.

The numerous examples from several localities show less variation in form than is usual in species of *Ostrea*. Its outline suggests *O. malleiformis* Gabb from the Chico group of California, but the differences seem to be sufficiently great and constant to warrant their separation.

Locality and position.—In the Pugnellus sandstone near Malachite post-office, Poison canyon, and other localities in Huerfano park, Colorado, and at about the same horizon 20 miles above Pueblo.

OSTREA LUGUBRIS Conrad.

Pl. IV, Figs. 1–10.

Ostrea lugubris Conrad, 1857, U. S. and Mex. Boundary Rept., vol. I, p. 156, Pl. 10, Figs. 5*a*, *b*; Meek, 1876, Macomb's Expl. Exped. from Santa Fé to Junct. of Grand and Green rivers, p. 123, Pl. 1, Figs. 1*a–d*; White, 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 297, Pl. 51, Fig. 3.

Ostrea bellaplicata Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 608; White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 276, Pl. 4, Figs. 3*a*, *b*, and Pl. 8, Figs. 2*a*, *b*; White, 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 292, Pl. 78, Figs. 1, 2, 3.

Ostrea (Alectryonia) blackii White, 1880, Proc. U. S. National Museum, vol. II, p. 293, Pl. 4, Figs. 1, 2; Ann. Rept. U. S. Geol. Sur. Terr. for 1878, p. 11, Pl. 14, Figs. 1*a*, *b*, Pl. 17, Fig. 4; 4th Ann. Rept. U. S. Geol. Sur., p. 292, Pl. 45, Fig. 1, and Pl. 46, Fig. 2.

Shell varying in size from small to medium; outline usually broad, subovate, but in small specimens often nearly circular and in larger ones occasionally subtriangular; lower valve moderately convex, the greatest convexity being along the median line, which is often subangular in large shells; beak usually small and inconspicuous, but sometimes more prominent and curved laterally, often obscured by the scar of attachment, which is usually present and is proportionately very large in the dwarf variety represented by Conrad's type. Surface marked by from twelve to eighteen strong plications, that radiate from the beak or the scar of attachment, and by strong concentric lines, and sometimes by imbrications of growth. The plications are usually simple, but occasionally they bifurcate. Upper valve nearly flat or sometimes slightly concave, with an outline similar to that of the other valve, excepting that it is somewhat more narrow along the hinge line. Its surface is smooth for some distance around the beak and the plications toward the margin are not as strongly developed as on the lower valve, which it resembles in other respects. The muscular scars are reniform and subcentral; ligamental area varying greatly in size and form, but never very large.

Conrad's type (lower valve) measures 17mm from beak to base, 15mm in breadth, and 5mm in convexity, while the corresponding measurements of *Ostrea blackii*, which is the largest variety of the species, are 68, 62, and 32mm, respectively.

The extreme varieties of the three forms included in the above description differ greatly from each other, and when the intermediate forms and the facts concerning their distribution were unknown it was natural that they should be regarded as distinct species. Conrad's types were small specimens from "east of Red river (Canadian), New Mexico, Santa Fé road," where they occur in a band of brown calcareous sandstone containing *Prionocyclus macombi*, sharks' teeth, etc. The same dwarf form is found in a similar rock in New Mexico and southern and southwestern Colorado. In Huerfano park and adjacent regions of Colorado the position of this brown band, which is from two to four feet thick, is at the base of the Niobrara limestone, and the paleontological evidence shows that it is on about the same horizon at the other localities. In Huerfano park the Pugnellus sandstone, which immediately underlies this brown band, contains great numbers of a larger *Ostrea* that is absolutely identical in form with some of the Texan specimens of *Ostrea bellaplicata*, but associated with them are smaller individuals with larger scars of attachment showing every gradation from the *bellaplicata* to the *lugubris* form. At Rattlesnake butte, Colorado, *O. lugubris* was found in the brown band, while the shales beneath yielded fragments showing all the characters of the large *O. blackii.* The collections from Texas show the forms intermediate between *O. blackii* and *O. bellaplicata*, both of which came from the Eagle Ford shales, the equivalent of the beds from which the Colorado and New Mexican specimens were obtained. From the above facts it seems to me evident that Conrad's type specimens were representatives of a variety that was dwarfed by unfavorable conditions, while the same species under more favorable circumstances reach the large size of *O. bellaplicata* and *blackii.* The examples selected for illustration represent most of the varieties excepting the largest ones, figures of which may be found in the Fourth Annual Report U. S. Geological Survey.

OSTREA UNIFORMIS Meek.

Pl. III, Figs. 3 and 4.

Ostrea (*Gryphœa?*) *uniformis* Meek, 1876, Macomb's Expl. Exped. from Santa Fé to Junct. Grand and Green rivers, p. 124, Pl. 1, Figs. 2*a*, *b*, *c*; White, 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 302, Pl. 48, Figs. 6 and 7.

Original description:

"Shell small, rather thin, trigonal-ovate or subcircular in form, not oblique; under valve rather deep, subcarinate along the middle, and arched beneath from the beak to the opposite margin; beak curved upward, but truncated by the area so as to rise little above the margins;

area small; margins on each side of the area sometimes faintly marked by fine crenulations along the groove for the reception of the edge of the upper valve; surface marked by about three or four rather regular plications on each side of the larger mesial fold or carina; lines of growth obscure; muscular scar transversely oval, moderately distinct; upper valve unknown.

"Length from the beak to the opposite extremity, 1.16 inches; antero-posterior diameter, about 1 inch; convexity or depth of the under valve, 0.65 inch.

"This is a very peculiar shell, and can not be confounded with any other species with which I am acquainted. Its large, prominent, mesial fold, extending from near the beak of the under valve to the opposite extremity, with three or four smaller plications on each side, give it much the appearance of some of the plicated brachiopoda when viewed on the under side. The folds, or plications, vary somewhat on different specimens; but usually they are remarkably uniform for a species of this genus, and impart to the free margin opposite the beak a zigzag character, very similar to the front of some species of *Spirifer*. No specimens of the upper valve were obtained; but it will probably be found to have a large mesial sinus corresponding to the elevation of the other valve, and must possess a projection, curving down at the middle of the free margin opposite the beaks, to fill the deep notch in the margin of the other valve.

"Thinking this species might be identical with one or the other of two peculiar oysters described by Dr. Shumard, from the Cretaceous rocks of Texas, under the names *O. bellaplicata* and *O. quadriplicata*, I sent him sketches of our shell, and he wrote that it is most nearly like his *O. bellaplicata*, though he thinks clearly distinct. The *O. bellaplicata* attains a much larger size, some of the specimens being as much as 3 inches in indiameter, while its hinge-line is proportionally much longer, and its surface distinctly ornamented with concentric markings."

Locality and position.—Near the base of the Colorado shales at Pagosa springs, Colorado, where it is associated with *Ostrea lugubris*, *Inoceramus labiatus* (=*I. problematicus*), and *I. fragilis*.

Genus GRYPHÆA Lamarck.

GRYPHÆA NEWBERRYI n. sp.

Pl. V, Figs. 1–5.

Gryphæa pitcheri White, 1876, U. S. Geog. and Geol. Sur. west 100th meridian, vol. IV, p. 171, Pl. 17, Figs. 1a–f.

Gryphæa pitcheri Newberry and Meek, 1876, in Macomb's Expl. Exped. from Santa Fé to Junct. of Grand and Green rivers.

Not *Gryphæa pitcheri* Morton, 1834, Synopsis Org. Rem. Cret. Group, p. 55, Pl. 15, Fig. 9.

The following is a copy of Dr. White's description and comments:

"Shell reaching a moderately large size, very variable in shape, generally having an irregularly subovate marginal outline, often much longer than broad, but sometimes shorter than broad. Larger valve capacious, scaphoid, arcuate, more or less distinctly lobed, the posterior lobe occasionally somewhat wing-like; test rather thick; umbo large, prominent, and incurved, or flattened and short; scar of attachment small or wanting; surface sometimes distinctly lamellose, but generally somewhat smooth, although marked by concentric lines of growth.

"Upper valve nearly flat, moderately thick in the umbonal region; hinge line well defined, straight; area distinct; ligamental groove small; inner surface smooth, more or less distinctly crenulated at the lateral edges; outer surface marked by numerous concentric, imbricating lines of growth, and sometimes also by faint, impressed radiating striæ.

"The collections contain numerous examples of this widely-known species, none of which, however, are of so large a size as are some of those figured by Roemer, Conrad, and others. In selecting examples for illustration I have chosen representatives of two extremes of form from among others of all intermediate gradations. Mr. Conrad states (loc. cit.) that there are two distinct varietal types of this species, one of which resembles *G. vesicularis* Lamarck, and which was the typical form described and figured by Dr. Morton; and the other he designates as var. *navia*. The collections under examination, however, although they contain representatives of the two forms referred to by Mr. Conrad, seem to indicate no constancy of separate varietal character, either of those forms or any others.

"The largest specimens in the collections have a length of only about 37 millimeters from the umbo to the basal margin, which is considerably less than that of some examples reported by other authors."

It is with much hesitation that I propose a new name for this form, because as a rule species of the Ostreidæ are difficult to define, and because I do not wish to add to the confusion that has long prevailed concerning *Gryphæa pitcheri*.[1] The latter species is very abundant in, and has been regarded as characteristic of, the Comanche series, or Lower Cretaceous, of Texas and adjacent regions.

The form now under consideration occurs in great numbers in the lower part of the Upper Cretaceous shales in southeastern Utah and adjacent portions of Colorado, Arizona, and New Mexico, where it is associated with characteristic fossils of the Colorado formation, such as *Inoceramus labiatus*, *Inoceramus fragilis*, and many others. It is reported from this horizon at many localities by Dr. Newberry.[2]

It was collected by Mr. C. D. Walcott about 350 feet above the base of his Cretaceous section in Upper Kanab valley, Utah, and the speci-

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[1] For discussions of *Gryphæa pitcheri* and its varieties see R. T. Hill in Ann. Rept. Arkansas Geol. Sur., 1888, Vol. II, pp. 168–174, and Bull. No. 4, Tex. Geol. Sur., p. 4, and Jules Marcou, Am. Geologist, Vol. III, p. 188.

[2] Macomb's Expl. Exped. Geol. Rept., pp. 33, 52, 71, 87, 107, etc.

mens described by Dr. White came from the same general region. I have collected it near Mancos, in southwestern Colorado, from shales overlying sandstones referable to the Dakota formation and just beneath a band of limestone containing *Inoceramus labiatus*. This difference in geologic horizon would not justify the separation of these fossils from *G. pitcheri* if they were identical in form. But while there is a general resemblance, and possibly examples of the *G. pitcheri* of Texas might be selected that could not be distinguished from some of the western ones, the differences are as a rule sufficient to make them easily separable. The fact that the western form occurs in later beds and that all its faunal associates are different necessarily gives greater importance to slight differences in form. Compared with typical examples of *G. pitcheri* it has broader and less distinct beaks, smoother surface and more rounded outlines, and it never attains so large a size. The specimen represented by Pl. v, Figs. 3 and 4, is the largest I have seen.

Some of the smaller examples have a superficial resemblance to *Gryphæa vesicularis* var. *aucella* Roemer, but the latter is more alate and its beak is not so much incurved.

Of European species small examples of *Ostrea proboscidea* Archiac and some specimens of *Ostrea vesiculosa* Guéranger as figured by Coquand[1] closely resemble this species.

Genus EXOGYRA Say.

EXOGYRA SUBORBICULATA Lamarck (sp.).

Pl. v, Fig. 6; Pl. vi, Figs. 1 and 2; Pl. viii, Fig. 1.

Gryphæa suborbiculata Lamarck, 1802, Système des Animaux sans Vertébres, p. 398.
Gryphites ratisbonensis Schlotheim, 1813, Min. Tasch., vol. vii, p. 105.
Gryphæa columba Lamarck, 1819, op. cit., vol. vi, p. 198.
Ostrea ratisbonensis Coquand, 1869 (with full synonymy), Monog. Gen. Ostrea, Terr. Crét., p. 121.
Exogyra suborbiculata Stoliczka, 1871, Cret. Pelecypoda of Southern India, p. 462.

Shell large, comparatively thin, irregularly suborbicular or subovate in outline. Lower valve very convex; umbonal region narrow and prominent; beaks relatively small, distinctly coiled, more or less separated from the body of the shell. Full-grown individuals have a broad distinct furrow or depression extending obliquely from the umbonal region to the postero-basal margin. Surface smooth, marked only by lines of growth. Upper valve represented in the collection by fragments that show that it was suborbiculate, nearly flat, with distinctly coiled beak and marked by obscure concentric ridges near the periphery.

An average sized specimen gives the following measurements: Length from beak to base, 82^{mm}; greatest transverse breadth, 80^{mm}; convexity, about 43^{mm}.

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[1] Monog. Genre Ostrea, Terr. Crét., pls. 16 and 59.

The fossils from Colorado above described seem to agree in every respect with many of the published figures of the common European species that is usually described under the name of *Ostrea* or *Exogyra columba.* The differences are certainly not greater than those shown by some of the forms referred to the species by European authors. The species is known to have a wide geographic distribution, occurring throughout Europe and in southern India in the Middle Cretaceous (Cenomanian and Turonian). It is said to be best developed in the zone with *Inoceramus labiatus.* With these facts before us it ought not to be surprising to find the species associated with a similar fauna in this country. On the contrary, it is strange that it has so long escaped observation here.

Exogyra columbella Meek may prove to be only the young or a variety of this species, but the two forms have not yet been found associated at the same localities, and it is thought best to treat them separately for the present.

Locality and position.—In the Pugnellus sandstone near Malachite post-office and Poison canyon, in Huerfano park, and at about the same horizon at Rattlesnake butte and on the Arkansas river, 20 miles above Pueblo, Colo.

Exogyra columbella Meek.

Pl. VIII, Figs. 2, 3, and 4.

Exogyra costata, var. *fluminis* White, 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 174, Pl. 17, Figs. 3*a–d*.

Exogyra columbella Meek, 1876, Macomb's Expl. Exped. from Santa Fé to junction of Grand and Green rivers, p. 124, Pl. I, Figs. 3*a–d;* White, 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 304, Pl. 55, Figs. 5 and 6.

Prof. Meek's description and comments are as follows:

"Shell small, rather thin, ovate; posterior side forming a semioval curve from the umbo to the ventral edge; anterior side rounded below the beak; ventral margin rounded. Lower valve convex, the most gibbous part sometimes forming an obtuse umbonal prominence, which is not separated from the front by a sulcus; beak slender, pointed, and distinctly coiled to the left; surface ornamented by small, but distinct, rather regular, radiating costæ, which bifurcate along the umbonal ridge; marks of growth rather obscure. Upper valve flat, oval, apparently smooth, or only having obscure lines of growth.

"Length from the most prominent part of the umbo to the ventral margin, 1 inch; transverse breadth, 0.72 inch; depth or convexity, about 0.42 inch.

"It is possible that this shell may be identical with *E. læviuscula* of Roemer,[1] but with the means of comparison now within my reach I can but regard it as distinct. All the specimens of it that I have yet seen are more oval in form and have a less distinctly spiral beak than the form

[1] Kreid. von Texas, Pl. IX, Fig. 3*a, b, c.*

described by Roemer. They also differ in having the under valve always marked by regular radiating costæ, while that of *E. læviuscula* is generally quite smooth, or rarely presents traces of nearly obsolete, rather broad, plications, as represented by Fig. 3*c* of Roemer's Pl. IX (Kreid. von Texas). It seems likewise to be a thinner and less robust shell than Roemer's species, and holds a lower stratigraphical position. In surface markings, as well as in general form, it closely resembles young specimens of *E. columba* of Lamarck (Anim. sans Vert., VI, 198), as figured by Goldfuss in his Petrefact. Germ., and by d'Orbigny in the Paleont. Français. It never attains more than one-eighth the size of adult individuals of that species, however, and differs in having an oval instead of a circular upper valve."

Locality and position.—From the Lower Cretaceous of Dr. Newberry's New Mexican section at Covero, New Mexico, and from the base of the Middle Cretaceous of the same section at Galisteo, and in the Sierra Abajo. The specimens described by Dr. White came from the east bank of Rio Puerco, 6 miles below Casa Salazan, New Mexico, and it has also been collected in the Lower Cross Timber sands and in the Eagle Ford shales of Texas.

EXOGYRA LÆVIUSCULA Roemer.

Pl. VIII, Figs. 5 and 6.

Exogyra læviuscula Roemer, 1852, Kreidebildungen von Texas, p. 70, Pl. 9, Figs. 3*a–c;* Conrad, 1857, U. S. & Mex. Bound. Sur., p. 154, Pl. 7, Figs. 4*a, b;* White, 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, p. 173, Pl. 17, Figs. 2*a–d;* 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 305, Pl. 52, Figs. 3, 4, 5.

Ostrea ferdinandi Coquand, 1869, Monog. Gen. Ostrea, Terr. Crét., p. 33.

Exogyra ponderosa Hill, 1889, Check List Cret. Invert. Fossils of Texas, p. 6.

"Shell of moderate size, capacious, somewhat semiovate in form, suborbicular in marginal outline; test not massive; larger valve much inflated and subhemispherical; a very indistinctly defined umbonal ridge is to be seen upon some examples, especially near the beak, but in others this feature is wanting.

"Umbo small, distinctly spiral, making about two volutions, sometimes nearly free, but often very closely curved, giving the posterior side an umbilicated character, sometimes having a very small scar of attachment, but often without such a scar, and always quite symmetrical, or at least not distorted, as the beak often is in other species of this genus; periphery of its curve usually extending beyond the hinge line, but sometimes not. The smaller valve is nearly flat, or slightly and somewhat irregularly concave, suborbicular in outline. Surface of both valves having a smooth aspect, but it is marked with such lines of growth as are common to other genera of shells, and free from the lamination of surface so common in the Ostreidæ.

"Diameter of the largest example in the collection, from umbo to basal margin, 47^{mm}; transverse diameter, 42^{mm}; depth of the larger valve, 28^{mm}.

"The collections contain numerous examples of this species, the type specimens of which were obtained by Dr. Roemer from near San Antonio, Texas. The figure given by Dr. Roemer (loc. cit.) represents the the umbo of the larger valve more nearly free than that of any of our examples is, the umbo in all of our examples being closely incurved. In this respect ours are more nearly like those figured and described by Conrad.

"*Position and locality.*—Strata of the Cretaceous period, Linear plateau, southeastern Utah."

The above description is quoted from Dr. White's report in the Survey West of the one hundredth Meridian. Coquand proposed a new name for the species because Münster had previously described an *Ostrea læviuscula*, but as Münster's species was not an *Exogyra* the change was unnecessary.

It may be that Mr. R. T. Hill is right in regarding these fossils as young individuals of *Exogyra ponderosa*. The fact that they occur together would cause one to suspect their identity, but those described under the name *E. læviuscula* are smoother shells, with a more nearly circular outline and less angular umbonal region than *E. ponderosa*, even when of the same size.

EXOGYRA PONDEROSA Roemer.

Pl. VII, Figs. 1, 2.

Exogyra ponderosa Roemer, 1852, Kreidebildungen von Texas, p. 71, Pl. 9, Figs. 2*a*, *b*; White, 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 172, Pl. 14, Figs. 1*a*–*c*; 1884, 4th Ann. Rept. U. S. Geol. Sur., p. 306, Pl. 50, Figs. 1, 2, 3.
Exogyra costata, var. Con., 1857, U. S. & Mex. Bound. Sur., vol. I, p. 154, Pl. 8, Fig. 3, Pl. 9, Fig. 1.
?*Exogyra fimbriata* Con., 1857, Ibid., Pl. 7, Figs. 2*a*, *b*.

"Shell large, capacious; marginal outline irregularly subovate; larger valve very gibbous; umbo distinctly spiral, but the coil is usually obscured by a large scar of attachment; umbonal half obtusely carinate, the sides sloping abruptly from the carina to the margins; basal half not so deeply, but more regularly convex than the other. Test very massive, sometimes having a solid thickness of five or six centimeters, lamellose, so much so that the valve often splits into numerous pieces along the surfaces of the layers of growth; inner surface smooth; muscular scar of moderate size, somewhat deep, placed about midlength of the valve, and, as usual, a little nearer to the posterior than to the anterior side; surface marked by strong, irregular, imbricating lamellæ of growth, which become laciniate at and near the margins; surface also marked by fine concentric striæ, and by irregular, indistinct, radiating costæ, the latter being usually removed by exfoliation from old shells. The collections do not contain any example of the upper valve, but both Roemer and Conrad describe it as thick, concentrically laminated; smooth within; umbo horizontal, distinctly spiral.

"Length of an example rather under the average size, from umbo to basal margin, about 1^{dm}; breadth, 8^{cm}; convexity of the large valve, nearly 6^{cm}.

"Among the numerous examples of this species in the collections, none, except the one figured, show the radiating costæ, and these costæ seem to be quite different from those, at least of the typical forms, of *E. costata* Say. Mr. Conrad states, however, that in New Jersey, Alabama, and Texas every intermediate gradation of form and character is found, from typical forms of *E. costata* to *E. ponderosa*. Judging from our examples alone, no person would suspect such specific relationship; and, in want of any intermediate forms for personal examination, I prefer at present to place our examples under the designation given by Dr. Roemer.

"*Position and locality.*—Strata of the Cretaceous period; east of Impracticable ridge, Utah."

The above is Dr. White's description of the Utah fossils which do not differ in any respect from examples collected at Roemer's typical locality. Mr. R. T. Hill has shown that in Texas the typical *Exogyra costata* is characteristic of the uppermost beds of the Cretaceous, while *E. ponderosa* occurs at a lower horizon, ranging down as low as the Austin limestone. My observations in Texas and several other southern states have confirmed this fact. It is therefore better as a matter of convenience and for use in geologic work to keep these varieties under separate specific names.

ANOMIIDÆ.

Genus ANOMIA Linnæus.

ANOMIA SUBQUADRATA n. sp.

Pl. VIII, Figs. 8 and 9.

Upper valve subquadrate in outline, thin and pearly, varying greatly in convexity; cardinal margin straight, or very slightly arched, about half as long as the greatest antero-posterior diameter of the shell; posterior margin nearly straight in the middle and rather abruptly rounded above and below to join the cardinal and ventral margins respectively; ventral and anterior margins forming a continuous curve, which is more narrowly rounded in the middle; beak inconspicuous, submarginal. Surface marked by obscure, concentric undulations and lines of growth, and very faint traces of radiating striæ.

The figured types have the following dimensions: Height, 20 and 23^{mm}; transverse diameter, 22 and 23^{mm}; convexity, 6 and 3^{mm}.

This species has some resemblance to *Anomia nitida* Meek.[1] It is possible that they may prove to be identical when good material for

[1] Macomb's Expl. Exped. from Santa Fé to junction of Grand and Green rivers, Geol. Rept., p. 125, pl. 1, Figs. 4*a* and *b*.

comparison is secured, but as *A. nitida* comes from a considerably higher horizon and the original description and figures show a different outline, as well as differences in the surface characters, it is thought best to treat them as distinct.

Anomia truncata Geinitz, as figured by Reuss,[1] is very much like this species.

Locality and position.—In the Pugnellus sandstone on Williams creek, Huerfano park, Colorado.

ANOMIA CONCENTRICA Meek.

Pl. VIII, Fig. 7.

Anomia concentrica Meek, 1860, Proc. Acad. Nat. Sci. Phila., vol. 12, p. 311;—1876. Simpson's Rept. Expl. across Great Basin of Utah, p. 359, Pl. 4, Fig. 3.

Original description:

"Shell small, thin, subcircular or transversely a little oval; lateral extremities nearly equally rounded; cardinal margin rather straight or but slightly arched; beak very small, central, compressed, marginal, not projecting beyond the cardinal border; surface of upper valve ornamented by moderately distinct regular, concentric undulations, and much smaller obscure lines of growth. Transverse diameter 0.64 inch; length from hinge to the opposite margin 0.50 inch."

Locality and position.—On Sulphur creek near Bear river, Wyoming, in whitish sandstone associated with *Inoceramus* and *Ostrea soleniscus.* I am not positive whether this comes from the bed containing *I. labiatus* and *Pugnellus fusiformis* or from a somewhat higher horizon.

ANOMIA PROPATORIS White?

Pl. VIII, Fig. 10.

Anomia propatoris White, 1880, Contributions to Paleontology, Nos. 2–8, p. 14, Pl. 12, Figs. 15 *a* and *b*, Ann. Rept. U. S. Geol. Sur. Terr. for 1878.

"Shell rather small, irregular, and a little obliquely subovate or subcircular in marginal outline; test pearlaceous and moderately thin as is usual in *Anomia.* Upper valve convex; beak small, depressed, not quite marginal; surface marked by somewhat coarse, irregular wrinkles of growth, by a few radiating wrinkles in the umbonal region and by fine, close-set, raised, radiating striæ, the latter appearing more distinctly on the forward part of the shell than elsewhere. Under valve unknown.

"Length of the most perfect example in the collection, 11^{mm}; breadth, 10^{mm}; convexity, 5^{mm}.

"This shell resembles *A. gryphorhynchus* Meek, the typical examples of which are from the Laramie strata of the Bitter Creek series, south-

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[1] Verstein Böhm. Kreidef., II, p. 45, pl. 31, Figs. 12–14.

ern Wyoming, but it differs from that species in having a less promiinent and rounded umbo; in possessing radiating and concentric wrinkles and radiating raised striæ, while that species is an unusually smooth one. In the possession of the radiating raised striæ it corresponds closely with *A. micronema* Meek, which is so commonly distributed throughout the Laramie group. As this striation constitutes a more important characteristic than mere form, which is always variable in this genus, it strongly suggests an intimate generic relation for our shell with *A. micronema*."

The specimen now under consideration is slightly more irregular in form and bears rather stronger radiating striæ than the type, but the variation is not greater than is often observed in species of this genus.

At Coalville, Utah, in the same stratum from which the type was obtained, much larger specimens have been found that doubtless belong to this species. They have the same form of outline, but are less convex. Casts of similar specimens occur in Huerfano park, Colorado, where they are associated with others (described above) that seem to be specifically distinct.

Locality and position.—The specimen figured is from the Pugnellus sandstone on Muddy creek, Huerfano park, Colorado. The type of the species was found at a higher horizon in the "third ridge" at Coalville, Utah.

ANOMIA? OBLIQUA M. & H.

Anomia obliqua Meek & Hayden, 1860, Proc. Acad. Nat. Sci., Phila., p. 181.
Anomia? obliqua Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 22, Pl. 9, Fig. 2.

This species, which is represented by a single valve, the type, is said to come from the Niobrara division of the Upper Missouri Cretaceous, near the mouth of the Niobrara river. Although the internal characters can not be seen, I am confident that the type is an Ostrea, and probably an immature individual of *O. patina*, M. & H.

Genus PLACUNOPSIS Morris & Lycett.

PLACUNOPSIS? HILLIARDENSIS White.

Pl. VIII, Fig. 11.

Placunopsis hilliardensis White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 278, Pl. 7, Fig. 14*a*.

Original description:

"Shell small, broadly oval or subcircular, slightly oblique; test thin, fragile, papyraceous; margins somewhat irregular; upper valve moderately convex; umbo submarginal, the apex depressed and not clearly defined. Surface conspicuously marked with numerous coarse, radiating, irregularly undulating, abruptly raised lines, which are wider than the space between them, and some of which appear to have ended at the border, or upon imbricating concentric lines, as tubular or semicylindrical processes. Diameter of the few examples obtained, about 12^{mm}.

"Although the hinge and interior of this shell are not known, it seems to be a species of true *Placunopsis* Morris & Lycett, and to be nearly related to their typical species, although the latter (*P. jurensis* M. & L., Monog. Gr. Ool. Mol., p. 6, Pl. 6, Figs. 8, 8*a*, and 8*b*) is of Jurassic age, while the former is Cretaceous. This appears to be the only known species of this genus in the Cretaceous rocks of the United States, but Mr. Meek[1] suggests that the *Anomia subtrigonalis* of Meek and Hayden from the Fort Pierre group of the Upper Missouri probably belongs to the genus *Placunopsis*. Our species differ conspicuously from that one in being radiately marked, and also in the character of its marginal outline and general aspect.

"It is true that neither the under valve nor the interior of our species is known; but the characters, so far as they are known, very plainly indicate the genus to which it is referred. In its marginal outline and surface markings it resembles the *Capulus occidentalis* of Hall and Meek, from the Upper Missouri river region, as figured by those authors, but the distinct laminated pearly texture of the shell substance would forbid its reference to that genus if its other characters were less doubtful.

"*Position and locality.*—Strata of the Fox Hills group, near Hilliard station, Union Pacific railroad, Wyoming."

Additional collections from the neighborhood of the original locality have added nothing to our knowledge of the generic relationship of this species. It seems to me that shells of this type should be referred to *Anomia*, at least until their internal structure is known. When this description was written all of the Cretaceous sandstones in the neighborhood of Hilliard, which is on Sulphur creek not far from Bear river, were referred to the "Fox Hills" or Montana formation. It is now known that a large part of these sandstones belong to the Colorado, but it has not been definitely determined whether the uppermost beds containing this species, *Neritina incompta* and a few other forms, should be assigned to it or to the Montana.

SPONDYLIDÆ.

GENUS PLICATULA LAMARCK.

PLICATULA HYDROTHECA White.

Pl. IX, Figs 1 and 2.

Plicatula hydrotheca White, 1876, Geol. Uinta. Mts. p. 113; 1879, 11th Ann. Rept. U. S. Geol. Sur. Terr., p. 279, Pl. 6, Figs. 3*a* and *b*.

Revised description:

"Shell of ordinary size, a little obliquely and irregularly subovate in marginal outline; rostral region narrowed, its sides nearly straight

[1] U. S. Geol. Surv. Terr., vol. IX, 4to., p. 23.

or only slightly convex; the remainder of the free border somewhat regularly convex or rounded; lower valve broadly convex; hinge-teeth well developed; ligamental fosset moderately large; upper valve nearly flat or slightly concave in the rostral region. Surface of both valves marked by small, slightly raised, radiating plications, which are crenulated, a little irregular, increase in number both by bifurcation and implantation, and are more or less distinct upon all parts of the surface of both valves.

"Length, 3^{cm}; greatest breadth, 24^{mm}.

"*Position and locality.*—Cretaceous strata, probably equivalent with the lower portion of the Colorado Group; head of Water-pocket canyon, southern Utah.

"Collected by Mr. G. K. Gilbert."

Only the original types, which are imperfect casts in sandstone, have been found. It is possible that better collections would show that this species is the same as *Plicatula arenaria* Meek, but with only the imperfect material now in hand it is necessary to keep them separate.

PLICATULA ARENARIA MEEK.

Pl. IX, Figs. 3 and 4.

Plicatula arenaria Meek, 1876, Macomb's Expedition from Santa Fé to junction of Grand and Green rivers, Geol. Rept., p. 126, Pl. 1, Figs. 5 *a*, *b*, and *c*.

Original description:

"Shell small, broad-ovate, usually a little oblique; ventral margin rounded; sides converging to the beaks at an angle of about 70° to 80°; beaks more or less angular. Under valve moderately convex. Upper valve nearly or quite flat. Surface of each valve ornamented by eighteen to twenty small, rather sharply elevated plications, only about half of which extend to the beaks, while the intermediate ones usually extend from one-third to one-half way from the free margins; concentric markings rather obscure.

"Length from beak to the most prominent part of ventral margin, 0.50 inch; transverse diameter, 0.43 inch; convexity, 0.11 inch.

"Resembles, in size and form, *P. incongrua*, Conrad (United States and Mexican Boundary Report, vol. I, Pl. 6, Fig. 10, 1857), but differs in not having squamose concentric markings, as well as in having shorter plications intercalated between those that extend to the umbo. The substance of the shell must be thin, since the plications are rather distinctly marked on internal casts.

"*Locality and position.*—Covero [New Mexico]; Lower Cretaceous of Dr. Newberry's section."

LIMIDÆ.

Genus LIMA Bruguiére.

LIMA UTAHENSIS n. sp.

Pl. IX, Fig. 5.

Lima wacoensis White, 1876, U. S. Geog. & Geol. Expl. West 100th Meridian, vol. IV, p. 176, Pl. 17, Figs. 4*a*, *b*, and *c*.
Not *Lima wacoensis* Roem., 1852, Kreide. von Texas, p. 63, Pl. 8, Fig. 7*a*, *b*.

Dr. White's description is as follows:

"Shell rather small, moderately convex, oblique, irregularly oval in marginal outline; antero-basal margin broadly rounded; posterior margin regularly, but more shortly rounded than the base; front margin subtruncate; postero-dorsal margin nearly straight or slightly convex, and nearly parallel with the antero-basal margin; hinge short; ears of about equal size, small, but distinct, each forming an obtuse angle by the cardinal border, and the anterior and posterior borders respectively; beaks small, distinctly defined, projecting a very little over the cardinal border. Surface marked by numerous radiating costæ, which have interspaces of similar or slightly greater width between them; costæ becoming smaller upon each side of the umbonal region, and absent from the ears.

"The long diameter of the largest example contained in the collections is about 17^{mm}; short diameter, 14^{mm}."

Comparison of the Utah specimens above described with examples of Roemer's species from Texas shows that they are specifically distinct. *Lima utahensis* differs from *L. wacoensis* in the following particulars: In form it is considerably less oblique and proportionally more ventricose; the radiating costæ are more slender and less angulated, more uniform in size, more regularly arranged, and they never bifurcate in any of the specimens examined; it is a somewhat smaller species, though the valve now figured measures about one-fifth more than the dimensions above given.

The fact that *Lima wacoensis* occurs in the Comanche series associated with a fauna that is entirely distinct from that in which *L. utahensis* occurs is an additional reason for their separation.

Locality and position.—The types are from "southeast of Paria, Utah." The specimen figured in this bulletin was collected by Mr. C. D. Walcott in Upper Kanab valley, about 350 feet above the base of the Cretaceous section there.

PECTINIDÆ.

Genus CAMPTONECTES (Agassiz) Meek.

CAMPTONECTES PLATESSA White.

Pl. IX, Fig. 6.

Camptonectes platessa White, 1874, Expl. & Sur. West of 100th Meridian, Prelim. Rept. Invert. Foss., p. 25;—1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 176, Pl. 17, Fig. 5*a*.

Revised description:

"Shell thin, suborbicular in outline; length of hinge-line about equal to one-half the transverse diameter; ears well defined by auricular furrows; posterior ear short, flat, its outer margin slightly concave; anterior ear moderately large, marked by distinct lines of growth and obscure radiating striæ. The anterior ear of the right valve separated from the body portion by a deep, rather narrow, and somewhat angular sinus, the depth of which is equal to about one-half the length of the ear from its outer extremity to the beak. Radiating striæ of the surface moderately fine, increasing in number so rapidly that the direction of the outer ends of those above the middle of the valve is transverse, and farther toward the hinge they are distinctly recurving; the radiating lines crossed by fine concentric striæ, and occasionally by more distinct lines of growth.

"Height and transverse diameter each about 45 mm.

"This species somewhat resembles *C. bellistriata* Meek and Hayden from the Jurassic strata of Dakota; but is proportionally not so broad from front to rear, the ears are proportionally a little longer, and the radiating striæ a little coarser.

"*Locality and position.*—Strata of the Cretaceous period; 50 miles north of Camp Apache, and 5 miles west of Mineral Spring, Arizona."

It also occurs about 350 feet above the base of the Cretaceous in Upper Kanab valley, and at the head of Water-pocket canyon, Utah.

AVICULIDÆ.

Genus AVICULA (Klein) Bruguiére.

AVICULA GASTRODES Meek.

Pl. IX, Figs. 7–10.

Avicula (*Oxytoma?*) *gastrodes* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 491.

Pteria (*Oxytoma?*) *gastrodes* White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 280, Pl. 10, Fig. 1*a*.

Pteria (*Oxytoma*) *erecta* White, 1880, Proc. U. S. Nat. Mus., vol. III, p. 157, and vol. IV, Figs. 7 and 8 of plate opposite p. 139.

Compare *Avicula caudigera* Zittel, 1866, Bivalven der Gosaugebilde, Pl. 12, Figs. 12*a* and 12*b*.

Original description:

"Shell (as determined from a left valve) attaining a moderately large size, subtrigonal in general outline, rather distinctly convex, and having a very slight backward obliquity; basal outline very profoundly rounded, the deepest or most prominent part being in advance of the middle; posterior margin moderately sinuous below the wing, from the extremity of which it ranges obliquely forward and downward, rounding regularly into the base below; anterior margin strongly and subangularly sinuous under the wing, thence descending with a slight forward obliquity and rounding rather abruptly into the base; hinge margin longer than the height of the valve, the antero-posterior diameter of which (at any point below) it also decidedly exceeds, ranging nearly at right angles to the vertical axis of the shell; beaks distinctly convex, rising above the hinge margin, strongly incurved, without obliquity, and situated less than one-third the length of the hinge margin from the extremity of the anterior wing, which is subtrigonal in form, somewhat convex, a little rounded at the extremity, and very strongly separated from the abrupt shell of the umbo by a deep rounded concavity extending from the beak obliquely to the marginal sinus below; posterior wing longer and more compressed, narrower, and more angular than the other; both wings, particularly the posterior one, projecting decidedly beyond the margin of the valve below. Surface only showing more or less distinct lines of growth. (Right valve unknown.)

"Height of left valve, 1.50 inches; length of same below the wings, about 1.30 inches; length of hinge-line, 1.90 inches; convexity (of left valve alone), 0.40 inch."

The types of *Pteria (Oxytoma) erecta* are small individuals that apparently belong to the same species. Dr. White's description is as follows:

"Shell rather small, appearing to be nearly erect, but the axis is slightly oblique to the hinge-line; both valves convex, but the right one less than the left; hinge-line long, much longer than the axial length of the shell; posterior wing large, its extremity acutely angular and moderately prominent; anterior wing comparatively large, prominent, obtusely pointed, defined from the body of the shell by a sinus or furrow in both valves, the direction of which forms a slightly obtuse or nearly right angle with the hinge-line; front, exclusive of the anterior wing, nearly perpendicular, the margin forming a nearly regular curve from the front all the way around to the posterior side, where it is flexed with a backward curve to meet the extremity of the hinge-line; umbones somewhat prominent, especially that of the left valve. Surface having a nearly smooth appearance, but the lens reveals the presence of somewhat regularly disposed concentric lines.

"Length of hinge-line, 32^{mm}; axial length of the shell, 26^{mm}. (Museum No., 8771.)

"This shell was formerly referred by me (loc. cit.) to the *Avicula linguiformis* of Shumard, but it differs from that species by having larger wings, a much longer hinge-line, and a much less oblique axis. It may be compared with *P.* (*O.*) *salinensis* White,[1] but it differs in being less

[1] Proc. U. S. Nat. Mus., vol. II, p. 296, Pl. 5, Figs. 1 and 2.

robust, having proportionally larger wings, narrower body, and a more nearly erect axis."

All the types are in the form of casts in sandstone and more or less distorted by pressure. In Huerfano park, Colorado, specimens were found that agree very well in form with the types, but some of them are very much larger. These retain portions of the shell, showing that it was unusually thick, especially in the umbonal region, and that the surface is marked by fine, closely arranged, concentric lines. Associated with these in the same bed there are other, smaller individuals that are much more oblique, some of which are scarcely distinguishable from some specimens of *Avicula linguiformis*. (See Pl. ix, Figs. 9 and 10.) But such specimens as that represented by Fig. 8 of the same plate are so nearly intermediate between the two extremes that I prefer to keep them for the present under the one name. *Avicula caudigera* Zittel, from the Cretaceous of Gosau, is a closely related species.

The largest specimen seen, a left valve, measures 73^{mm} in height and 61^{mm} in length just below the wings; greatest convexity of the single valve about 15^{mm}.

Locality and position.—The type came from the "second ridge" at Coalville, Utah, where it is associated with *Gervillia propleura*, *Pugnellus fusiformis*, etc.; the types of *Pteria erecta* were found at probably about the same horizon in Lower Potato valley, southern Utah, and the specimens now figured come from the Pugnellus sandstone in Poison canyon and on Williams creek, Huerfano park, Colorado.

Genus GERVILLIA Defrance.

GERVILLIA PROPLEURA Meek (sp.).

Pl. x, Figs. 1, 2, and 3.

Avicula (*Pseudoptera*) *propleura* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 489.

Avicula (*Pseudoptera*) *rhytophora* Meek, 1873, ibid., p. 490.

Pteria (*Pseudoptera*) *propleura* White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 281, Pl. 10, Figs. 2*a*, *b*, *c*.

Compare *Gervillia gregaria* Shumard, 1860, Trans. St. Louis Acad. Sci., vol. 1, p. 606.

Shell very inequivalve, more or less oblique, varying in outline from obliquely ovate-subtrigonal to rhombic-suboblong, nearly twice as high as wide; left valve moderately convex, with the greatest convexity toward the anterior side just below the beaks on the umbonal slope, which is here somewhat angular, but becomes broad and flat towards the basal margin; beak small, pointed, almost terminal and projecting but little beyond the hinge line; the small area in front of the beak rather abruptly depressed, forming a more or less distinct anterior auricle; posterior alation represented by a broad triangular flattened area, not distinctly defined from the body of the shell; hinge-line straight, about as long as the greatest antero-posterior diameter, and forming an angle of 50° to 70° with the umbonal ridge; hinge area comparatively narrow, with five or six (or possibly more) large cartilage pits, each of which is nearly twice as broad as the space between them; posterior margin nearly straight in the middle, but curving slightly forward above, where it joins the hinge-line at an angle of 100° or more, while below it curves more sharply into the rather narrowly rounded base; anterior margin almost parallel with the posterior, slightly convex in outline; surface with more or less distinct lines of growth, which are crossed on the anterior part of the valve by several fine radiating lines and one or two stronger costæ that extend above the umbonal slope, giving it an angular appearance. These radiating lines are usually distinct on young individuals and become obsolete or disappear entirely on adult shells. Right valve known only by fragmentary casts, which show that it was flat and smooth and did not have a byssal notch.

Height of left valve of a large specimen, 87^{mm}; length of the hinge-line, 52^{mm}; convexity, 22^{mm}.

The types of this species, which was originally described under the two specific names cited above, came from the sandstones of the "first ridge" at Coalville, Utah, where the fossils are preserved in the form of casts that retain both the external and internal features to some extent without showing either very clearly. Afterward Dr. White obtained larger collections from the same place which enabled him to prove that the two forms are not specifically distinct. In my collections made in Huerfano park, Colorado, from about the same horizon there are several better preserved specimens, clearly belonging to the same species, in which the cartilage pits were observed, though the hinge can not be well figured from the material in hand. The transverse folds along the hinge-line, shown in one of the types, doubtless represent the cartilage pits as modified by pressure, though, of course, they do not show their form. Some of the casts show traces of two or three very oblique linear teeth below the pits. Traces of the same hinge structure are observable on some of the Coalville specimens. These facts are considered sufficient to justify the reference of the species to *Gervillia*. The published figure of *Gervillia gregaria* Shumard, which comes from approximately the same horizon in Texas, is very similar to small specimens of this species.

Locality and position.—Sandstones of the first and second ridges about 800 feet above the lower bed of coal at Coalville, Utah. It also occurs in the Pugnellus sandstone on Williams creek and Muddy creek, Huerfano park, Colorado, and I have collected the same species near the base of the Upper Cretaceous on the Chattahoochee river, 9 to 12 miles below Columbus, Ga.

Genus INOCERAMUS Sowerby.

INOCERAMUS FRAGILIS H. and M.

Pl. XI, Figs. 1–5.

Inoceramus fragilis Hall and Meek, 1856, Mem. Am. Acad. Arts. and Sci. n. s., vol. v, p. 388, Pl. 2, Fig. 6*a* and *b;* White, 1876, U. S. Geog. and Geol. Sur. west of 100th Meridian, vol. IV, p. 178, Pl. 15, Fig. 3; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 42, Figs. 1 and 2 in text and Pl. 5, Fig. 5; Meek, 1876, Macomb's Expedition from Santa Fé to junction of Grand and Green rivers, Geol. Rept., p. 127, Pl. 1, Fig. 6; Whitfield, 1880, Geol. Black Hills of Dakota, p. 390, Pl. 9, Fig. 10.

Inoceramus howelli White, 1876, Geol. Uinta Mts., p. 114; 1879, 11th Ann. Rept. U. S. Geol. Sur. Terr., p. 284, Pl. 4, Figs. 1*a*, *b*, *c*.

Inoceramus perplexus Whitfield, 1880, Geol. Black Hills of Dakota, p. 392, Pl. 8, Fig. 3, and Pl. 10, Figs. 4 and 5.

The original description and figures were taken from a small imperfect specimen in which the anterior border was mistaken for the hinge line. After studying better material from the same horizon and in part from the typical locality, Prof. Meek drew up the following description:

"Shell thin, broad-subovate, higher than long, moderately convex, subequivalve; anterior side vertically truncate from the beaks with a slightly concave outline; basal and posterior borders forming a more or less regular, nearly semicircular curve; hinge line rather short, and standing nearly at right angles to the truncate anterior. Beaks pointed equal, scarcely rising above the hinge, curving inward and slightly forward at the points. Surface marked by fine lines of growth, and a few obscure traces of concentric undulation.

"Height, about 1.43 inches; length, 1.07 inches."

The study of a considerable number of good specimens from Upper Kanab valley, southern Utah, and from Huerfano park, Colorado, in connection with the types of *Inoceramus perplexus* and *I. howelli* and the specimens of *I. fragilis* figured by Meek, have convinced me that these all belong to one variable species. The differences observed, however, are partly due to differences in the state of preservation. In some individuals the surface is almost smooth, even when the shell has attained considerable size, while others, such as the types of *I. perplexus,* are marked with very distinct concentric ridges. The variety to which the name *I. howelli* was given differs from the typical form in being slightly more convex and more inequivalve, in having a distinct posterior auriculation and a broad, shallow furrow on each valve extending from the umbonal region to the postero-basal margin, where it forms a slight emargination. Nearly all of the specimens from Huerfano park, Colorado, might be referred to this variety, but none of the features on which it is based are constant, so that in a large series every gradation between it and the typical form may be found.

Locality and position.—The original type came from near the mouth of Vermilion river, on the Missouri, at or near the base of the Fort Benton group. It has also been found at about the same horizon near Fort Benton, Montana, in the Black hills of Dakota, and at the Vado del Chama, New Mexico. It occurs about 350 feet above the base of the Cretaceous section in the Upper Kanab valley, southern Utah; also in Lower Potato valley and on Ashley's fork, Utah; at the latter place in strata that were probably erroneously referred to the Fox Hills. It is abundant in the Pugnellus sandstone which caps the Benton shales in Huerfano park, Colorado.

INOCERAMUS LABIATUS Schlotheim.

Pl. X, Fig. 4; Pl. XIV, Fig. 2.

Ostracites labiatus Schloth., 1813, Bronn's Jahrb., vol. VII, p. 93.
Mytulites problematicus Schloth., 1820, Petrefactenk. I, p. 302.
Inoceramus mytiloides Mantell, 1822, Geol. of Sussex, p. 215, Pl. 28, Fig. 2.
?*Inoceramus confertim-annulatus* Schiel, 1855, Pacific R. R. Reports, vol. II, Pt. 2, p. 108, Pl. 2, Fig. 7.
?*Inoceramus pseudo-mytiloides* Schiel, 1855, *Ibid.*, Pl. 3, Fig. 8.
Inoceramus mytiloides (Mantell) Roem., 1852, Kreide. von Texas, p. 60, Pl. 7, Fig. 5.
Inoceramus mytilopsis Conrad, 1857, U. S. Mexican Boundary Sur., vol. I, Pt. 2, p. 152, Pl. 5, Figs. 6*a* and 6*b*.
Inoceramus problematicus (Schloth.) Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 62, Pl. 9, Figs. 3 *a* and *b*.
Inoceramus aviculoides M. and H., 1860, Proc. Acad. Nat. Sci., Phila., p. 181.
Inoceramus problematicus var. *aviculoides* Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 63, Pl. 9, Fig. 4.
Inoceramus problematicus, mytiloides or *labiatus* of many authors.

The following is Meek's description of the species:

"Shell obliquely elongate-oval, subelliptical or ovate, nearly or quite equivalve, rather compressed, thin and fragile; anterior side forming a slightly convex curve from the beaks obliquely downward and backward; postero-basal extremity rather narrowly rounded; postero-dorsal margin very oblique, compressed, nearly straight, or sometimes a little convex in outline below the middle, and slightly concave above; cardinal border short, straight, compressed, and forming an angle of about 45 degrees with the longest diameter of the shell; beaks terminal, rather small, nearly equal, obtusely-pointed, rising little above the hinge, and not much incurved. Surface ornamented by more or less regular, concentric undulations, and smaller marks of growth.

"Greatest length, 4 inches; breadth, at right angles to the longest diameter, about 2 inches; convexity of the two valves, about 0.80 inch."

The name *Inoceramus aviculoides* was applied by Meek and Hayden to a variety with a longer hinge line, greater convexity and more prominent beak of the left valve, and with the dorsal region more alate than is usual in the species. After studying larger collections Prof. Meek found that there were many graduations between this and the typical form, and he therefore treated it as only a variety. Like all species of the genus, it is subject to considerable variation in form, yet it is always easily recognized by its obliquely elongate outline and by the character of the surface markings.

It is unfortunate that the law of priority compels us to drop the name that has for many years been applied to this species by all American writers who have referred to it, and it is the more unfortunate because the species is so well known under that name as the most abundant characteristic fossil of the Colorado formation. There is no doubt, however, that the American fossil belongs to the species to which European paleontologists now apply the earliest name, *Inoceramus labiatus.*

Locality and position.—The species is common in the Niobrara limestone of Kansas, Nebraska, Colorado, and throughout the upper Missouri river region. It is also very abundant in calcareous layers of the Fort Benton shales wherever they occur in the same regions, and it is found in the equivalent strata in Utah, New Mexico, Texas, Northern Mexico, etc. In Europe the species is said to be confined to the Lower Turonian and in southern India it is found only in the Ootatoor group which forms the base of the Upper Cretaceous section of that region.

INOCERAMUS DIMIDIUS White.

Pl. x, Figs. 5 and 6.

Inoceramus dimidius White, 1874, Expl. and Sur. West 100th Meridian, Prelim. Rept. Invert. Foss., p. 25; 1876, U. S. Geog. and Geol. Sur. West of the 100th Meridian, vol. IV, p. 181, Pl. 16, Figs 2*a*, *b*, *c*, and *d*.

The revised description is as follows:

"Shell very small for one of this genus, inflated, sometimes much so, obliquely subovate in outline; valves subequal, the left one being a very little more capacious than the other; test thin; beaks small, prominent, acute, incurving, and pointing a very little forward; hinge-line straight or nearly so, rather short.

"Surface marked by more or less regular and more or less strong concentric folds or undulations. In some cases these undulations continued to be formed only until the shell had attained about half its full size, when they ceased, the remainder of the surface being marked only by ordinary concentric lines of growth. This irregularity in the formation of concentric folds is sometimes connected with considerable distortion of the usual symmetry of the shell.

"The long diameter of an average example from the umbo to the postero-ventral margin, 26^{mm}; greatest breadth, 18^{mm}; thickness, 16^{mm}.

"This species is especially distinguished by its small size. Its other more conspicuous specific characters are the small but prominent and pointed beaks and subequal valves. From the young of *I. problematicus*, the valves of which are also subequal, it differs in the character of the beaks just mentioned, the much greater convexity of the valves, and other evidences of mature growth.

"The collections contain quite a large number of examples of this neat little species, both valves of which, in a majority of cases, are together in their natural position.

"*Position and locality.*—Strata of the Cretaceous period; Ojo del Piscado, New Mexico."

This species is common at the base of Mesa Verde, near Mancos, Colo., where it occurs in the Colorado formation about 400 feet above its base, associated with *Prionocyclus macombi* and *Ostrea lugubris*. Some examples are much larger than the type, measuring 5^{cm}. in length. All the larger specimens are irregular and distorted in shape and with an almost smooth surface excepting near the beaks.

INOCERAMUS SIMPSONI Meek.

Pl. XII, Fig. 1.

Inoceramus simpsoni Meek, 1860, Proc. Acad. Nat. Sci., Phila., p. 312; 1876, Simpson's Expl. across Great Basin of Utah, p. 360, Pl. 4, Fig. 4; 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, pt. 1, p. 142, Pl. 13, Fig. 4; Whitfield, 1880, Geol. Black Hills of Dakota, p. 395, Pl. 8, Fig. 1.

Meek's description:

"Shell (right valve) attaining a rather large size, transversely oval-suboblong, gibbous, the greatest convexity being in the antero-central region, cuneate posteriorly; length nearly twice the height; anterior end very short and rounded from the beaks; base forming a long, semi-elliptic curve, most prominent near the middle and somewhat straightened, or even slightly sinuous, posteriorly; hinge-line long, straight, and ranging parallel to the longer axis of the shell; posterior margin subtruncated, with a slight backward slope above, and forming an abrupt curve into the oblique posterior basal margin; beaks depressed so as to project a little above the hinge-line, incurved, and placed nearly over the anterior margin. Surface ornamented with moderately distinct, regular, concentric undulations and lines of growth.

"Length, 8.10 inches; height, about 4.30 inches; convexity of right valve, nearly 2 inches."

Locality and position.—The type specimen, and the only one that Meek examined, comes from "North Platte river, above Platte bridge, in Dakota Territory, from the Cretaceous formation No. 2 or 3 of the upper Missouri section." The Dakota examples described by Whitfield are from the Old Woman fork in the Fort Pierre group, and from the east fork of Beaver creek, in probably the Fort Benton.

INOCERAMUS GILBERTI White.

Pl. XIV, Figs. 3 and 4.

Inoceramus gilberti White, 1876, Geol. Uinta Mts., p. 113; 1879, 11th Ann. Rept. U. S. Geol. Sur. Terr., p. 285, Pl. 3, Figs. 1 *a*, *b*, *c*.

The revised description is as follows:

"Shell irregularly suboval in marginal outline, the transverse diameter being greater than the vertical; front more or less flattened; valves nearly or quite equal, the left one, if either, the larger, both of them gibbous, and sometimes quite ventricose; umbones broad and elevated; beaks very near the front, incurved, but not projecting beyond the front margin; front nearly straight vertically, or sometimes more rounded, in the former case forming nearly a right angle with the hinge; front margin rounded below to the basal margin, which is broadly convex for more than half the length of the shell; postero-basal margin extending obliquely upward, with a slight emargination, to the posterior extremity, which is abruptly rounded to meet the downward-sloping postero-dorsal margin; dorsal margin straight, its length equaling more than half the long diameter of the shell. Upon each valve there is an obscure radiating depression, or ill-defined furrow extending from the umbonal region to the postero-basal border, and ending there at the emargination before mentioned.

"Surface marked by the usual lines of growth, and also by numerous extravagant, irregular, concentric folds or wrinkles.

"This species belongs to a section of the comprehensive genus *Inoceramus* that Brongniart designated under the name *Catillus*. It is a peculiarly well-marked species and readily distinguishable from any other published species from American strata.

"Transverse length of an average-sized specimen, $7\frac{1}{2}^{cm}$; height from base to hinge, 5^{cm}.

"*Position and locality.*—Cretaceous strata, probably of the Fox Hills group; near Last Chance creek, southern Utah, where it was collected by Mr. G. K. Gilbert."

At the time the above description was written the author of the species referred to the Fox Hills group almost all of the Coalville section, a large part of which is now known to belong to the Colorado. In many respects this species resembles some examples of *Inoceramus flaccidus*, which certainly come from the Colorado formation. For these reasons it is now placed with doubt in the Colorado fauna.

INOCERAMUS FLACCIDUS White.

Pl. XIII, Fig. 1.

Inoceramus flaccidus White, 1876, U. S. Geog. & Geol. Sur. West of the 100th Meridian, vol. IV, p. 178, Pl. 16, Figs. 1*a* and 1*b*.

Original description:

"Shell large, irregularly subovate in marginal outline, exclusive of the ears, valves subequal, not much inflated; wing moderately large, well defined at its inner side by an auricular furrow; hinge line not very long, nearly at right angles with the front of the shell, and only a little oblique with the axis; a more or less distinct, but somewhat irregular furrow extending the whole length of the shell from the posterior side of the umbo to the postero-basal margin, giving each valve an obscurely bilobed appearance; crenulated face of the hinge narrow, crenulations small; umbonal region narrow; beaks prominent, curved forward and inward; test comparatively thin throughout the whole shell, surface having the ordinary concentric lines of growth, and the test is also thrown into numerous rude and irregular concentric undulations.

"Length of the largest example in the collection, about 22cm; greatest breadth, about 15cm.

"This species is remarkable for the rudeness and extravagant irregularity of the undulations of the surface, of which irregularity the outline also partakes, giving the shell a flaccid aspect. The specimens of the collection are almost wholly in the form of natural casts, being preserved in a fine-grained calcareous sandstone, some of which is crowded with specimens of this species.

"*Position and locality.*—Strata of the Cretaceous period, 5 miles above Pueblo, Colorado."

This species is not known from any other locality. The only American species resembling it in surface features is *Inoceramus gilberti* White, but the form is quite different in the type specimens.

INOCERAMUS UMBONATUS M. & H.

Pl. XVIII, Figs. 1 and 2.

Inoceramus umbonatus Meek and Hayden, 1858, Proc. Acad. Nat. Sci., Phila., p. 50; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 44, Pl. 3, Figs. 1*a*, *b*, *c*, and Pl. 4, Figs. 1*a*, *b*, and 2*a*, *b*.

Compare *Inoceramus involutus* Sowerby, 1828, Min. Conch, vol VI, p. 160, Pl. 583.

Compare also *Inoceramus exogyroides* M. and H., 1862, *I. tenuirostratus* M. and H.; 1862, and *I. capulus* Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 606.

Revised description:

"Shell attaining a rather large size, vertically subovate, extremely inequivalve; height more than one-third greater than the anterior-posterior diameter; base regularly rounded; hinge and interior unknown. Left valve very convex; beak greatly elevated, gibbous, strongly and somewhat obliquely involute, so as to form one and a half to two entire turns, the point terminating near the anterior side; surface unknown, that of internal casts sometimes showing faint traces of concentric undulations. Right valve subcircular, or a little oval transversely, much compressed or nearly flat, excepting in the central and umbonal regions, which are moderately convex; beaks rather oblique, projecting little above the hinge, and but slightly incurved; surface (of an internal cast) ornamented with regular, rather prominent, subangular, concentric undulations, separated by wider rounded depressions.

"Height of left valve, about 7 inches; antero-posterior diameter, 5·10 inches; convexity, 4·50 inches. Right valve, height, about 5·70 inches; antero-posterior diameter, 5·10 inches; convexity, about 1·60 inches.

"I had at first remarked that this species is related to *I. involutus* of Sowerby, but I was not at that time aware how very closely it is allied to Sowerby's species. After a careful comparison of the additional specimens alluded to, with figures and descriptions of *I. involutus*, they are found to agree in so many respects that I would not be surprised if a comparison of specimens from these two distant localities should prove these shells to be specifically identical. The only differences that have thus far been discovered between them are the following: In the first place the antero-posterior diameter of *I. involutus* is less in proportion to the height of its left valve than in our Nebraska shell. Again, the aperture of its left valve is more nearly circular, being slightly higher than wide, while in the shell under consideration, it is somewhat oval transversely, being slightly wider than high. A more important reason, however, for regarding these shells as probably belonging to different species, is the fact that *I. involutus* occurs in France and England in the Upper or White Chalk, while our Nebraska shell comes from a formation we have reason to regard as equivalent to the Lower or Gray Chalk.

"From the same locality and position as those from which the species under consideration was collected, Lieutenant Mullan's party obtained another somewhat analogous species, which we have described in the Proceed. Acad. Nat. Sci. Phila. under the name of *I. exogyroides*. Like *I. umbonatus*, it has a very gibbous left valve, and probably a nearly flat right valve; but it will be readily distinguished by the much more depressed and oblique umbo of its left valve. This depression of the umbo gives it a nearly circular instead of a vertically oval outline.

"*Locality and position.*—Twenty miles below Fort Benton, on the Upper Missouri; from the Fort Benton group, or No. 2 of the Cretaceous series."

In this country the species has been found only at or near the original locality and in the Austin limestone of Texas. Dr. C. Schlüter[1] regards involute specimens as belonging to *I. involutus* and retains the name *I. umbonatus* for those (including *I. exogyroides*) in which the beaks are not coiled. He states, however, that as all three forms are associated in the same strata both in Europe and America, it will probably be found that the greater or less amount of coiling in the beaks is not an essential specific character. It should be stated that *I. involutus* occurs in Germany, in Schlüter's "Emscher Mergel" and in equivalent strata in other parts of Europe, at the base of Senonian, where it is associated with *Ammonites texanus* and *Ammonites tricarinatus*. The relative position of these analogous if not identical form, therefore, is not very different on the two continents.

[1] Palæontographica, vol. XXIV, p. 272.

INOCERAMUS EXOGYROIDES M. & H.

Pl. XVII, Figs. 1 and 2.

Inoceramus exogyroides Meek & Hayden, 1862, Proc. Acad. Nat. Sci., Phila., p. 26; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 46, Pl. 5, Figs. 3*a*, *b*, *c*.

Revised description:

"Shell rather large; left valve suborbicular, its height being a little greater than its length from the anterior to the posterior side, very gibbous; anterior and posterior sides rounded, and forming with the base about three-fourths of a circle, the posterior curve being broader than the other; cardinal margin comparatively short, and apparently a little arched; beak large, elevated, gibbous, distinctly incurved and directed obliquely forward, so as to bring its point near the anterior margin; surface of cast smooth, or marked by obscure concentric undulations. (Right valve unknown.)

"Length from anterior to posterior margin, 5 inches; height, 5.50 inches; convexity, near 3 inches.

"No right valves of this species have yet been found; but, judging from the gibbous character and involuted beak of the left valve, it is probable that the right will be found to be much more compressed, so as to make the shell very distinctly inequivalve. The lateral curvature of the beak of the left valve, together with its general form, give it much the appearance of some species of *Exogyra*, as viewed from the inner side. Its aperture is transversely oval, the height being to the length about as four to five. Remaining portions of the shell show it to have been quite thick about the beak, and, as in other species, distinctly fibrous.

"Specifically, this shell differs from the last in being much more depressed and in having its left beak considerably less elevated and directed much more obliquely forward, as will be seen by comparing Fig. 3 *a*, Pl. 5, with Fig. 2 *b*, Pl. 4. It probably belongs, however, to the *Volviceramus* group.

"*Locality and position.*—Chippewa point, near Fort Benton, on the upper Missouri; from the same horizon as the last."

Larger collections will probably show that this is identical with *I. umbonatus*.

INOCERAMUS TENUIROSTRATUS M. & H.

Pl. XVI, Figs. 3 and 4.

Inoceramus tenuirostratus Meek & Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 27.
Inoceramus tenuirostris Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 59, Fig. 5 in text.

Revised description:

"Left valve very gibbous, subquadrate in outline; anterior margin very short or vertically truncated, with a slightly convex outline, immediately in front of the beak, and rounded into the base below; ventral margin nearly semi-elliptical; posterior side rounded, or sometimes subtruncated, with a slightly convex outline above, and a little more prominent and rounding into the base below; hinge of moderate length, with cartilage furrows small, there being about five of them in a space 0.20 inch; beak very gibbous, prominent, narrowed, strongly incurved, and directed a little forward, its point being immediately over the anterior margin. Surface of internal cast smooth over the gibbous umbonal region, but showing traces of small, concentric undulations below the middle. (Right valve unknown.)

"Length, 2.10 inches; height from base to hinge, 1.82 inches; height to top of umbo, 2.13 inches; convexity of left valve, 0.90 inch.

"This shell has a more prominent, attenuated, and strongly incurved left beak than any other species of the *Catillus* group with which I am acquainted, being in this respect more like many species of typical *Inoceramus*, while its general form places it with the former section. No specimens of its right valve are yet known, but it is probably much less convex than the left; I know of no other species with which it is liable to be confounded.

"*Locality and position.*—Chippewa point, Montana; Fort Benton group."

This species is known only by the single type specimen, which is evidently somewhat distorted by pressure. I suspect that it is only an immature individual of *I. umbonatus*, although Prof. Meek placed it in a different subgenus.

INOCERAMUS UNDABUNDUS M. & H.

Pl. XVI, Figs. 1 and 2.

Inoceramus undabundus Meek & Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 26; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 60, Pl. 3, Figs. 2*a*, *b*.

The following is quoted from the revised description:

"Shell obliquely rhombic-subovate or subquadrate, gibbous; anterior side very short, and rounding obliquely downward into the base; posterior basal extremity prominently rounded; posterior margin broadly rounded or subtruncated; dorsal and anterior margin diverging from the beaks at an angle of about 90°; hinge short; beaks moderately prominent and nearly terminal, that of the left valve rather strongly incurved and directed obliquely forward, while in the right it is straighter and less elevated; umbonal axis ranging at an angle of about 70° to the hinge line. Surface of both valves (in the condition of casts) ornamented by regular, strong, subangular, concentric undulations, separated by wider, rounded depressions.

"Height from the most prominent part of the base to the hinge margin, 2.90 inches; height to top of umbo, 3.36 inches; convexity of left valve, 1.84 inches.

"The strong, subangular undulations, and gibbous, obliquely subrhombic outline of this species, will readily distinguish it from all the other known forms of the genus in our rocks; and I know of no foreign species nearly enough related to it to render a comparison necessary. Both of its valves are quite convex, but the left one is rather decidedly more so than the right.

"One of the specimens of the right valve has its beak so nearly terminal and its anterior margin below it so straightened in outline as to present much the appearance of a typical *Inoceramus*; but as the others, as well as the left valve we have figured, have the anterior margin more prominent, it is probable that the straightness of the anterior outline in the single specimen mentioned may be, to some extent, due to accidental distortion.

"*Locality and position.*—Chippewa point on the Missouri, near Fort Benton; from the Fort Benton group of the upper Missouri Cretaceous series. Collected by Lieut. Mullan."

INOCERAMUS DEFORMIS Meek.

Pl. XIV, Fig. 1; Pl. XV, Figs. 1 and 2.

Inoceramus deformis Meek, 1871, Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 296.
Haploscapha capax Conrad, 1874, Ann. Rept. U. S. Geol. Sur. Terr. for 1873, p. 456.
?*Haploscapha grandis* and *Haploscapha eccentrica* Conrad, 1875, U. S. Geol. Sur. Terr., vol. II, pp. 23 and 24, Pls. 66 and 67.
Inoceramus deformis White, 1876, U. S. Geog. and Geol. Sur. West one hundredth Meridian, vol. IV, p. 179, Pl. 15, Figs. 1*a* and *b*.
Inoceramus deformis Meek, 1877, U. S. Geol. Expl. Fortieth parallel, vol. IV. pt. 1, p. 146, Pl. 14, Figs. 4 and 4*a*.
Inoceramus ——? Hall, 1845, Fremont's Rept. Expl. Rocky Mts., p. 310, Pl. 4, Fig. 2.

The following is Meek's description:

"Shell attaining a rather large size, obliquely ovate, and rather compressed in young examples, but more rounded, gibbous, and irregular, as well as much less oblique, in adult specimens; more or less inequivalve, but never very decidedly so; posterior and basal margins rounded; the latter curving up more gradually and obliquely to the short anterior margin; hinge short and usually not very oblique; beaks moderately prominent, and placed between the middle and anterior margin; neither greatly more elevated than the other. Surface ornamented with large, strong, concentric undulations, which are sometimes moderately regular, but often very irregular, and generally becoming rather abruptly smaller on the umbones, where their curves indicate the greater obliquity of the young shell.

"Height of a medium-sized specimen, about 4.50 inches; length of same, 4.30 inches; convexity of right valve, about 2.50 inches.

"I have frequently had under examination, during the last twelve years, specimens of this shell, without being able to identify them with any described species. Nearly all of the explorers who have visited the eastern slope of the Rocky mountains between the south branch of the Platte river and New Mexico have brought in specimens of it, but almost always in a distorted or broken condition. Its distortion, however, is evidently not always due to accident, since it often resulted from one of the depressions between two of the undulations being so much larger and deeper than the others, as to give the valves a remarkably constricted appearance. In other cases it resulted, in part at least, from the great irregularity in the size of the undulations themselves. Although it is often found distorted in general form by accidental pressure, it was evidently also naturally quite variable in outline, particularly in convexity."

The name *Inoceramus deformis* was first used by Meek in a list without description, but with a reference to Hall's figure in Fremont's report. Conrad refers to the same figure in describing *Haploscapha capax*. His genus *Haploscapha* was based on specimens, probably belonging to this species, in which the surface of the shell was completely covered and cemented together by *Ostrea congesta* so that the interior only could be seen.

Inoceramus erectus Meek, from the upper portion of the Cretaceous section at Coalville, Utah, is closely related to this species, though it occurs at a much higher horizon. It seems, however, to be a more constant and regular form.

Locality and position.—Very common in the Niobrara limestone along the eastern base of the Front range in Colorado, *e. g.*, at Boulder, Morrison, Canyon city, Colorado Springs, near Pueblo, and in Huerfano park. In this region it seems to be confined to the Niobrara. It is also common in Kansas and Nebraska, and I have seen specimens that probably belong to this species from the Austin limestone, near Dallas, Texas.

INOCERAMUS CONRADI H. and M.

Inoceramus conradi Hall and Meek, 1856, Mem. Am. Acad. Arts. and Sci., n. s., vol. v, p.387, Pl. 2, Figs. 5*a* and *b*.

This species is based on a single imperfect, crushed specimen which was obtained from the lower part of the Fort Benton shales on the Missouri, 5 miles below the mouth of Vermilion river. No other examples of it have been recorded, probably because well-preserved specimens could not be identified by means of the figure.

MYTILIDÆ.

Genus MODIOLA Lamarck.

MODIOLA (BRACHYDONTES) MULTILINIGERA Meek.

Pl. XIX, Fig. 3.

Modiola (*Brachydontes*) *multilinigera* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 492.

Volsella (*Brachydontes*) *multilinigera* White, 1880, Cont. to Paleontology Nos. 2–8, p. 14, Pl. 12, Figs. 15*a* and *b*. < Ann. Rept. U. S. Geol. Sur. Terr. for 1878.

Compare *Modiola tenuisculpta* Whiteaves, 1889, Cont. to Can. Paleontology, vol. I, p. 188, Pl. 26, Figs. 2 and 2*a*.

Original description:

"Shell rather above medium size, obliquely arcuate-subovate; valves strongly convex along the umbonal slopes, thence cuneate posteriorly, and abruptly curved inward below the middle in front; posterior margin forming a broad, regular, convex curve, from the end of the hinge downward to the anterior basal extremity, which is very narrowly and abruptly rounded; anterior margin ranging obliquely backward and downward to the narrow basal extremity, and strongly sinuous along the middle, above which it projects more or less beyond the umbonal ridge, so as to form a moderately prominent, somewhat compressed protuberance; hinge margin nearly or quite straight, running at an angle of 50° to 60° above an imaginary line drawn from the beaks to the most prominent parts of the basal outline, and equaling about half the greatest oblique length of the valves; beaks nearly terminal, rather compressed, very oblique, and scarcely rising above the hinge margin; umbonal slopes prominent and more or less strongly arcuate. Surface ornamented by fine lines of growth, crossed by regular radiating lines that are very fine and crowded on the anterior part of the valves, but become coarser above and behind the umbonal ridge, the largest being near the dorsal side, where they bifurcate so as to become very fine, and curve more or less upward before reaching the cardinal margin.

"Greatest length, measuring obliquely from the beaks to the most prominent part of the basal margin of a large specimen, 1.90 inches; greatest breadth at right angles to the same, 1 inch; convexity, 0.76 inch.

"On first examining some imperfect casts of this shell, brought by Dr. Hayden from near Coalville, Utah, I was led to think it probably the form described by Dr. Roemer from Texas, under the name *Modiola pedernalis*, to which I referred it provisionally, in making out the list of Cretaceous fossils for Dr. Hayden's report of 1870. Further comparisons of better specimens collected during the past summer at the same locality, however, have satisfied me that it presents well-marked and constant differences from the Texas shell. In the first place, it is distinctly more arcuate, so much so, that when placed with its hinge line in a horizontal position, the outline of its posterior margin, instead of forming an oblique backward descending curve, ranges nearly vertically. Again, the most prominent part of its posterior basal margin is very narrowly rounded, instead of forming a regular curve. Its umbonal ridges are likewise more prominent, more arched, and extend down to the narrowly rounded posterior basal extremity. The lobe-like projection of the upper part of its anterior margin, under the beak and in front of the umbonal ridge, also differs in being proportionally much smaller than Dr. Roemer's species, in which it forms about one-third of the entire valve, as seen in a side view, while in our shell it scarcely forms more than one-sixth. Of course the specimens are more or less variable in these characters, but the two forms can always be readily distinguished when good examples can be had for comparison.

"In its more arcuate form our shell agrees more nearly with *Modiola ornata* Gabb, from the Cretaceous rocks of California; but that shell differs very markedly in having its beaks decidedly less nearly terminal, and a more decided and much more prominent lobe in front of them. Another important difference is to be observed in the radiating striæ, which, on the anterior side of our shell are very minute and closely crowded, while on that part of Mr. Gabb's species they are as large and distant from each other as on any other part of the valves."

Whiteaves states that *Modiola tenuisculpata* is very closely related to Meek's species, and as it comes from approximately the same horizon in Manitoba it will probably prove to be a synonym.

Locality and position.—The types came from the lowest fossiliferous bed of the Cretaceous section at Coalville, Utah, where it is abundant. It also occurs at a much higher horizon in the "third ridge" of the same section and at several localities in southern Utah. It is common in the Colorado Cretaceous beds at Bear River city, Wyoming, and the same or a closely related species has been found in the Bear River formation on Twin creek, Wyoming.

PINNIDÆ.

Genus PINNA Linnæus.

PINNA PETRINA White.

Pl. XIX, Fig. 4; Pl. XX, Fig. 1.

Pinna petrina White, 1874, Expl. & Sur. West of 100th Meridian, Prelim. Rept. Invert. Foss., p. 24; 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 182, Pl. 13, Figs. 7*a* and *b*.

Pinna stevensoni White, 1880, Proc. U. S. Nat. Mus., vol. III, p. 47.

Revised description:

"Shell moderately large, broad, rather thick, rapidly expanding in height as it increases in length; dorsal margin concave; ventral margin convex; a more or less strongly-raised carina extending from the beak to the posterior margin, defining a prominent longitudinal angle along the median portion of each valve, which is placed a little nearer the ventral than the dorsal border; transverse section rhomboidal, the sides of the rhomb slightly convex; posterior margin oblique with the axis of the shell, forming a distinct but obtuse angle with the dorsal margin. The acute angle which it would form with the ventral margin if continued all the way to it in a direct course is abruptly rounded.

"Surface marked by strong, distinct lines of growth, which run obliquely downward and backward in a nearly direct course from the dorsal margin, across the mesial angle, to near the ventral margin, where they are abruptly flexed forward, and blend with the ventral border. Crossing the lines of growth upon the surface above the mesial angle, there are coarse but indistinct radiating striæ, and occasionally still more indistinct traces of similar ones below that angle, all of which are more discernible upon the anterior than upon the posterior part of the shell. More or less of the test is preserved upon all the specimens; but no trace of the pearly layer has been detected, all the test having the usual prismatic structure.

"Some of the largest examples measure 7½^{cm} in width along the posterior margin, and they must have been not less than 17^{cm} in length when entire. The large size, proportionally great width, and angular aspect of this shell distinguish it from any other likely to be confounded with it. It resembles *P. renauxiana* d'Orbigny, as figured by him in Paléontologie Française, but it expands much more rapidly in width than that species does, is not proportionally so thick, and has a very different posterior marginal outline. In that shell it is the middle of the posterior margin that is most extended, while in ours the greatest extension is much below the middle.

"*Position and locality*.—Strata of the Cretaceous period; east of Mount Taylor, 1 mile south of Pajuate, New Mexico."

The type of *Pinna stevensoni*, which was found near Fort Wingate, New Mexico, only a few miles from the typical locality of *P. petrina*, seems to be only an unusually large specimen of the latter species. The absence of the anterior portion, which is always more angular and often bears radiating lines, gives this specimen an unusual aspect.

The exact position of the beds from which the types came is not known. The species is not uncommon in the Pugnellus sandstone of Huerfano park, Colorado, and a few examples were found in the Benton shales on the Arkansas river, 20 miles above Pueblo, Colorado. A *Pinna* occurs in the sandstone of the "second ridge" at Coalville, Utah, that may be this species.

ARCIDÆ.

Genus BARBATIA Gray.

BARBATIA MICRONEMA Meek (sp.).

Pl. XXI, Figs. 1–4.

Trapezium micronema Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 493.—White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 293, Pl. 10, Fig. 5.
Arca? coalvillensis White, 1876, Geol. Uinta Mts., p. 115.
Barbatia coalvillensis White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 286, Pl. 6, Figs. 2*a* and *b*.

The type of this species is a cast of both valves on which the surface markings are partially preserved, but it is broken and distorted by pressure, so that the generic features are obscured and the outline is not complete. This specimen is from Cretaceous coal-bearing sandstones at Bear River city, Wyoming, and Prof. Meek recognized the species in sandstone near the base of the section at Coalville, Utah, in the same layers from which the types of *Barbatia coalvillensis* were obtained. A study of all these types and of large collections from the same localities has convinced me that they belong to a single species, and that the smaller shells called "*Macrodon* (undetermined sp.)" by Meek are the young of the same species.

White's revised description of the Coalville specimens is as follows:

"Shell not large, moderately gibbous, transverse length from two-fifths greater to nearly twice as great as the height; beaks depressed, situated near the anterior end; umbones broad, not prominent; anterior end rounded or subtruncate; base usually nearly straight, but sometimes slightly convex and sometimes a little emarginate about the midlength; postero-basal border rounded upward to the posterior extremity, which is abruptly rounded up to the downward sloping, nearly straight postero-dorsal border, the latter forming a rounded obtuse angle with the cardinal border; hinge equal in length to about two-thirds the entire length of the shell, consisting of a moderately slender hinge plate bearing numerous transverse teeth with about equal spaces between them. The posterior teeth have an oblique direction downward and a little forward, which obliquity diminishes towards the front, so that the teeth from about midlength of the hinge to the center of the beak are directly transverse. These central transverse teeth are a little narrower than those farther back, but the two or three teeth in front of the center of the beak are larger than any of the others, and a little curved.

"Area apparently nearly obsolete, or at least it is very narrow. Internal markings unknown. A slight depression or flattened space upon the outer surface extends from the umbo of each valve to its base, meeting there the straight or slightly emarginated portion of the basal margin before mentioned.

"Surface marked by the ordinary lines of growth and also by fine radiating lines, which are often obscure.

"Length of an example a little above the ordinary size, 5^{cm}; height, 33^{cm}."

Additional material from the original locality shows that in adult shells the hinge line is curved downward at each end and in these curved portions the teeth are large, slightly curved, and oblique to the hinge line, those at the extreme ends, especially the anterior one, becoming almost parallel with it. The medial portion of the hinge is not so well preserved in any of the specimens, but there are obscure impressions of small, closely arranged, transverse teeth. The ligamental area is narrow, with two or three well-defined grooves, posterior to the beak and nearly parallel with the hinge. These features are all made out from casts and impressions in sandstone.

In the Timber Creek beds, near Lewisville, Denton county, Texas, Prof. W. F. Cummins and Dr. C. A. White some years ago obtained large numbers of well preserved shells which I believe to belong to this species. At any rate, the characters that are preserved in the Coalville specimens agree in every particular with those from Texas, figures of which are given for comparison.

The species attains a considerably larger size than is indicated by the dimensions above given.

Locality and position.—Abundant near the base of the Cretaceous section at Coalville, Utah, and occasionally found much higher in the same section in the lower part of the "third ridge"; also in equivalent strata at Bear River city, Wyoming. The Texas specimens come from the Timber Creek beds of Denton county, near the base of the Upper Cretaceous section of that region.

Genus NEMODON Conrad.

NEMODON SULCATINUS Evans & Shumard (sp.)?

Pl. XXI, Fig. 5.

Arca sulcatina Evans & Shumard, 1857, Trans. St. Louis Acad. Sci., vol. I, p. 39.
Nemodon sulcatinus Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 82, Pl. 15, Fig. 6.

Shell small, transversely elongate, ventricose, basal margin parallel to the dorsal, nearly straight, but slightly sinuous in the middle; front broadly rounded from the base to the hinge line, which it joins nearly at a right angle; posterior end obliquely truncate, strongly sinuous above the middle, and narrowly rounded into the base below; beaks slightly in advance of the middle, prominent, incurved, and rather distant; posterior umbonal slope oblique, narrowly rounded. A narrow, deep sulcus, almost at right angles to the hinge, runs from the beak to the middle of the base. Surface of the casts with faint radiating striæ, and the free margins crenate. A natural mold of the surface of the shell shows about 25 fine radiating lines.

Length, 6^{mm}; height, 3^{mm}; convexity of one valve, about 1.6^{mm}.

The specimens here described are a few small casts, the largest of which is figured, collected by Mr. C. D. Walcott in the lower part of his Upper Kanab valley Cretaceous section, where it is associated with many species of the Colorado fauna. The types of the species came from near Grand river, Dakota, and the only other reported locality is on the Yellowstone river, 150 miles above its mouth, where it is associated with species belonging to the Montana formation. The Kanab specimens show slight differences when compared with those from the Yellowstone, and it is possible that better material will show that they are really distinct; but the general resemblance is very close, and I think it best to call them by the same name for the present.

Genus TRIGONARCA Conrad.

TRIGONARCA OBLIQUA Meek.

Pl. XIX, Fig. 1; Pl. XX, Figs. 2–6.

Cucullæa (*Trigonarca?*) *obliqua* Meek, 1877, U. S. Geol. Expl. Fortieth Parallel, vol. IV, pt. I, p. 148, Pl. 14, Figs. 1, 1*a*, *b*.

Original description:

"Shell attaining about a medium size, rhombic-subovate, moderately convex, the greatest convexity being along the posterior umbonal slope, while the anterior ventral region is abruptly cuneate; anterior margin rounded in outline; base with a shallow semiovate outline, being usually slightly more prominent in advance of the middle; posterior margin long and very obliquely truncated, with a slightly convex outline from the hinge to the posterior basal extremity, which is prominent and subangular; hinge margin very short, or little more than equaling one-third the length of the valves; posterior umbonal slope prominent, and more or less angular from the beaks to the posterior basal angle; cardinal area short and rather narrow; beaks moderately prominent, incurved, and placed one-fourth to one-third the length of the valves from the anterior margin. Surface ornamented by moderately distinct lines of growth, crossed by obscure radiating costæ that are wider than the mere linear furrows between.

"Length, 1.50 inches; height, 1 inch; convexity, about .70 inch."

This description was based on sandstone casts that retain the surface markings to some extent and at the same time show more or less of the internal features.

The collections from several localities in Huerfano park, Colorado, contain numerous well preserved specimens of this species, which show that the surface is usually marked only by lines of growth, and that the obscure radiating costæ above described are on the interior of the shell, and therefore preserved on internal casts. A few of the smaller specimens show obscure radiating lines on the surface, and especially on the umbonal ridge. There is considerable variation in outline, some specimens having almost the form of *Ideonarca depressa* White. These two species seem to be more closely allied than one would think from the examination of the types alone, but they are probably distinct. The ligamental area is depressed, triangular, with five or six divaricate cartilage furrows. Hinge line curved as in *Pectunculus* with subequal transverse teeth, some of which toward the posterior end are slightly larger and curved. Both muscular impressions are bordered by elevated ridges, the posterior one being much the stronger. In all these generic features *Trigonarca obliqua* agrees with the forms on which Conrad founded the genus, and specifically it is very closely allied to *T. triquetra* Conrad, from the Cretaceous of North Carolina.

Locality and position.—The types were collected in Cretaceous sandstones on East canyon creek, Wasatch range, Utah. The species has been found near the base of the Cretaceous section at Coalville, Utah, and it is common in the Pugnellus sandstone on Williams and Muddy creeks, and in Poison canyon, Huerfano county, Colorado.

TRIGONARCA DEPRESSA White (sp.)

Pl. XIX, Fig. 2.

Idonearca depressa White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 183, Pl. 18, Figs. 13*a*, *b*.

Original description:

"Shell of moderate size, gibbous, irregularly trapezoidal or subovate in marginal outline; posterior half of the basal margin nearly straight, broadly rounding upward anteriorly, and sharply rounding the end of the umbonal ridge to meet the posterior margin; anterior margin regularly rounded up to the hinge-line; posterior margin long, about equal in length to the full height of the shell, nearly straight or slighly convex, extending obliquely downward and backward; hinge line equal to a little more than half the length of the shell; areas small, narrow, well defined, slightly concave; beaks very small, depressed, a little incurved; umbonal ridges very prominent, each bounding anteriorly a flattened, three-sided space, along the middle of which there is a radiating, raised line.

"Surface marked by the usual lines of growth and also by numerous small, flat, radiating costæ of unequal width, with narrow, sharply impressed interspaces between them; costæ largest upon and near the umbonal ridge, becoming obsolete near the cardinal border, anteriorly and posteriorly.

"Length, measuring across at about midheight of the shell, 28^{mm}; height, from base to umbo, 23^{mm}; thickness, both valves together, about 20^{mm}.

"This species is not fully represented in the collections, but its specific characters are very satisfactorily shown. A full collection of examples would probably show variations of outline, due to sex, in some cases, whereby the aspect of the shell may be a little different from that of the figure. It is perhaps as nearly related to *I. Shumardi* Meek and Hayden as to any other described species, but it is clearly distinguished from that by its depressed beaks and prominent umbonal ridges.

"*Position and locality.*—Strata of the Cretaceous period; east bank of Rio Puerco, 6 miles below Casa Salazan, New Mexico."

The species associated with this at the typical locality belong to the Colorado fauna. I have no doubt that it is generically related to *Trigonarca obliqua* and additional collections may show that it is still more closely allied to that species.

NUCULIDÆ.

Genus NUCULA Lamarck.

NUCULA COLORADOENSIS n. sp.

Pl. XXI, Fig. 9.

Shell small, transversely ovate subtrigonal, moderately convex; dorsal margin in front of the beak slightly convex, declining to the subangular anterior end; posterior end very short, truncate almost at right angles to the dorsum; basal margin forming a regular curve, finely crenate within; beak rather prominent, incurved, very near the posterior end of the valve. Surface marked by faint, closely arranged radiating lines and by large irregular concentric ridges and lines of growth.

Length, 12^{mm}; height, 10^{mm}; convexity of single valve, 3^{mm}.

Only a single well preserved valve of this little shell was found, and, not being able to identify it with any of the described Cretaceous species from the Rocky mountain region, I have thought it best to give it a provisional name. The fact that the most nearly related forms come from a much higher horizon renders it more probable that this is a distinct species. In form it is similar to both *Nucula planimarginata* M. & H. and *Nucula cancellata* M. & H., but the posterior end of our species is proportionally much shorter and there are other slight differences in outline. In surface ornamentation it is more nearly like *N. planimarginata*, but its crenate inner margin would prevent its identification with that species.

Locality and position.—On Williams creek, Huerfano park, Colorado, in concretions near the base of the Fort Benton shales, associated with *Crassatella excavata.*

Genus YOLDIA Möller.

YOLDIA SUBELLIPTICA n. sp.

Pl. XXI, Figs. 6 and 7.

Shell small, thin, transversely elongate subelliptical in outline, moderately convex in the umbonal region, depressed towards the extremities; dorsal margin declining slightly and equally in both directions from the beaks; both ends of the shell subangular above and broadly rounded below; basal margin almost straight; beaks rather prominent, tumid, situated a little behind the middle.

Surface marked by minute concentric lines. Hinge and interior features unknown.

Length, 7^{mm}; height, 4^{mm}; greatest convexity of both valves united, 3^{mm}.

Not having seen the hinge of this species I am not certain that it belongs to the genus to which it is provisionally referred.

Locality and position.—In the Pugnellus sandstone, Poison canyon, Huerfano park, Colorado. Only one specimen has been found.

TRIGONIIDÆ.

Genus TRIGONIA Bruguière.

TRIGONIA ———?

Trigonia ——— Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, pp. 474, 475.

A few imperfect specimens of a *Trigonia* allied to *T. evansana* Meek have been collected at Cinnabar mountain and near Gallatin city, Montana. The specific characters are not sufficiently well preserved to be described. It is remarkable that these are the only specimens of *Trigonia* reported from the Upper Cretaceous of the north interior region. The genus is well represented in the beds of the same age in the Atlantic and Gulf border regions from New Jersey to Texas, and also on the Pacific coast.

UNIONIDÆ.

Genus UNIO Retzius.

UNIO ———?

Pl. XXII, Fig. 1.

Fragments of *Unio* are not uncommon, associated with the coal beds near the base of the Colorado formation in southern Utah. One of the best preserved specimens obtained at Glendale, Utah, is figured. This form, which is abundantly represented there by fragments and casts, seems to be distinct from all the described Cretaceous species, though the material in hand is hardly sufficient to characterize it. It is a rather slender, compressed form, its outline broadly lanceolate. The beaks, which are not very prominent, are situated one-third to one-fourth the length of the shell from the anterior end. The cardinal and basal margins are subparallel, the anterior end regularly rounded, and the posterior end more narrowly rounded or subtruncate. The surface is smooth, excepting the posterior third, which is marked by two obscure radiating folds or plications. Length of the figured specimen, 66^{mm}; height, 26^{mm}. Some of the fragments belonged to shells nearly twice as large as this.

SOLEMYIDÆ.

Genus SOLEMYA Lamarck.

SOLEMYA? OBSCURA n. sp.

Pl. XXI, Fig. 8.

Shell small, thin, elongate, subcylindrical; ventral and dorsal margins nearly parallel; anterior? end regularly rounded; posterior? end contracted immediately behind the beak, rather narrowly rounded; beak broad, incurved, not very prominent, situated near the posterior?

end. Surface ornamented with faint lines of growth and very obscure, distant, radiating lines that are preserved only on the anterior? portion.

Length, 15mm; height, 6mm; greatest convexity of single valve, about 2mm.

The type is a single valve, retaining only a portion of the shell. As neither the hinge nor the pallial line has been seen, its generic reference is only provisional.

Locality and position.—In the Pugnellus sandstone, Poison canyon, Huerfano park, Colorado.

CRASSATELLIDÆ.

Genus CRASSATELLA Lamarck.

CRASSATELLA EXCAVATA n. sp.

Pl. XXI, Figs. 10–13.

Shell small, depressed subquadrate in outline; dorsal margin nearly straight, declining slightly from the beak to the posterior end, which is truncate almost vertically; front slightly concave above for over half the distance from the beak to the base and regularly curved below; ventral margin forming a broadly ovate curve; lunule broadly lanceolate and very deep; escutcheon long and well defined, but not nearly so deep as the lunule; beaks near the anterior end, small, pointed, approximate, and directed forward. Posterior to the umbonal slope, which is broadly rounded and not very well defined, the shell is compressed. Surface marked by fine lines of growth and by narrow, subequal, somewhat irregularly arranged, concentric ridges.

The hinge has the structure characteristic of the genus and the free margin of the shell is crenate. Represented by three well preserved valves.

Length, 16mm; height, 15mm; convexity of one valve, 4mm.

The most nearly related species with which I am acquainted is *Crassatella cimarronensis* White, which has nearly the same outline when viewed from the side, but it differs from the present one in its greater convexity, larger size, and in the character of its surface. Its lunule is proportionally much more shallow and its hinge is broader and stronger.

Locality and position.—From concretions in the Fort Benton shales on Williams creek, Huerfano park, Colorado.

RUDISTÆ.

Genus RADIOLITES Lamarck.

RADIOLITES ———?

A single fragment of a large species of *Radiolites*, or *Sphærulites* has been collected by Mr. Edwin Blackburn in the Niobrara limestone at Morrison, near Denver, Colorado, and I have seen a similar specimen, probably from about the same horizon, that was found near Canyon city, Colorado.

The specimen from Morrison is a part of the thick outer layer of the lower valve. It shows the characteristic structure of *Radiolites*, consisting of large prismatic cells arranged in layers parallel with the upper surface of the shell, and the surface of each layer showing impressions of a few slender, branched, radiating ridges on one side and corresponding furrows on the other. A little of the outer surface of the shell is preserved, showing narrow longitudinal ridges and grooves each about a millimeter wide. The individual to which this fragment belonged must have been 6 or 8 inches in diameter. The shell substance is over 2 inches thick.

Compared with *Radiolites austinensis* Roemer, which occurs in the equivalent of the Colorado formation in Texas, this specimen seems to have narrower ridges and grooves on the outer surface, while the prismatic cells of the thick shell are larger. It is doubtful, however, whether these differences are of specific importance, and I think it probable that better material will show that the Colorado specimens belong to *R. austinensis*.

Large specimens of "*Hippurites*" probably belonging to this genus have been reported from the Niobrara beds of Kansas.

LUCINIDÆ.

Genus LUCINA Bruguiére.

Lucina subundata H. & M.

Pl. XXII, Figs. 5 and 6.

Lucina subundata Hall and Meek, 1856, Mem. Am. Acad. Arts and Sci., vol. V (n. s.) Pl. 1, Fig. 6; White, 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 184, Pl. 18, Fig. 12*a*; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 133, Pl. 17, Figs. 2*a*, *b*, *c*, *d*, *e*; Whitfield, 1880, Geol. Black Hills of Dakota, p. 411, Pl. 11, Figs. 17 and 18.

The following is Meek's description:

"Shell small, subcircular, compressed, very thin; anterior side broadly rounded; basal margin semiovate, the most prominent part being toward the front, more or less contracted behind, smooth within; posterior side narrower than the other, and usually subtruncate at the extremity; dorsal margin concave in outline just before and convex just behind the beaks, which are rather prominent, pointed, and nearly central. Surface ornamented by small concentric undulations and very small parallel striæ, which are sometimes crossed by obscure traces of very fine, nearly obsolete, radiating striæ.

"Length, 0.42 inch; height, 0.32 inch; convexity, 0.12 inch.

"This little shell evidently varies much in form, some specimens having the anterior portion of the ventral margin much more prominent and the posterior side more contracted than others. Generally there is an obscure depression extending obliquely backward and downward from the posterior side of the beaks, and a stronger one passing from the front side of the beaks to the upper part of the anterior margin. Sometimes both of these impressions are obsolete, while in other cases they are quite distinct, and there seem to be all gradations between."

The specimens now under consideration, two of which are figured, are in the form of casts retaining only small portions of the shell. They seem to agree in every respect with the types of the species, although they come from a much lower horizon.

Locality and position.—About 350 feet above the base of the Cretaceous section in Upper Kanab valley, Utah, where it is associated with many species characteristic of the Colorado formation. Those described by Dr. White came from probably the same horizon southeast of Paria, Utah, and it occurs in the lower part of the Coalville section. The types and all the other described specimens above referred to were collected in the upper part of the Fort Pierre shales on Cheyenne river, South Dakota.

LUCINA JUVENIS n. sp.

Pl. XXII, Figs. 2–4.

Compare *Lucina subundata* M. & H.

Shell small, relatively thick, moderately convex, subcircular in outline; beaks small, central, approximate; dorsal margin slightly concave in front of the beaks and convex behind them; posterior end subtruncate, the rest of the outline forming a regular curve. A narrow posterior portion of the shell is considerably depressed. Surface marked by distinct regular concentric undulations, each of which is about half as broad as the intervening furrows. More numerous fine lines of growth are visible under a lens. Length of the largest specimen, 6.4^{mm}; height, 6^{mm}; convexity of the two valves united, about 3^{mm}.

The specimens above described are not easily distinguishable from young individuals of *Lucina subundata*, and if they had been found associated with that species they probably would not have been separated. Several examples were collected, all of about the same size, and no larger shells of the genus were found in the same beds with them.

Comparison with the types of *L. subundata* and with the fossils from southern Utah that are referred to the same species, show that this little shell has relatively less prominent beaks, its outline is more nearly circular, and the concentric undulations are proportionally larger.

Locality and position.—In the Pugnellus sandstone near Malachite post-office and in Poison canyon, Huerfano park, Colorado.

CARDIIDÆ.

Genus CARDIUM Linnæus.

CARDIUM PAUPERCULUM Meek.

Pl. XXII, Figs. 9–12.

Cardium pauperculum Meek, 1871, Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 306; White, 1879, idem for 1877, p. 291, Pl. 9, Fig. 3*a*.
Cardium subcurtum Meek, 1873, idem for 1872, p. 476; 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, p. 152, Pl. 15, Fig. 3*a*.

Original description:

"Shell small, very thin, rather compressed, subovate or subcircular; beaks moderately prominent and nearly central; surface ornamented by about thirty regular, simple, distinctly defined, radiating costæ, which about equal the intermediate furrows, and (owing to the thinness of the valves) are well defined internally, and thus impart a plicated or crenated character to the margins; crossing these are numerous very regular, well-defined, delicate marks of growth that are usually less distinct on the posterior third, but give a neatly crenulated appearance to the costæ further forward.

"The specimens yet seen of this little shell are rarely more than about 0.50 inch in diameter, and are all more or less flattened or otherwise distorted. Sometimes they are distorted by antero-posterior pressure, so as to present somewhat the appearance and outline of a *Lima*, being higher than wide, and more or less oblique, while in other examples they are distorted by vertical pressure, so as to present little or no obliquity, and to show a greater antero-posterior diameter than height. I have not seen the hinge, but some impressions in the matrix show that it has anterior and posterior lateral teeth like those of *Cardium;* it, however, does not belong properly to the typical section of that genus."

The types are distorted internal casts and molds of the surface, some of which show the natural form, and Meek's figure published by White (loc. cit.) is an incorrect restoration. The comparison of a large series of specimens in all states of preservation has fully established the identity of *Cardium subcurtum* with *C. pauperculum*. The sandstone casts to which the former name was given were thus described:

"Shell under medium size, truncato-suborbicular, about as high as wide, rather convex, and but very slightly oblique; beaks nearly central, rather prominent, distinctly incurved almost at right angles to the hinge; posterior margin truncated with a slight forward obliquity, so as to connect with the dorsal margin at an obtuse angle; anterior margin rounding regularly into the base, which describes a slightly oblique semiovate curve, being more prominent behind, where it rounds up very abruptly to the posterior margin, so as to give a subangular outline to the posterior basal extremity; umbonal slopes rather prominent, but not angular; hinge margin shorter than the length of the valves Surface ornamented by small, regular, simple, radiating costæ, and moderately distinct lines of growth."

The costæ vary in number from thirty to thirty-five and three or four of those on the posterior umbonal slope are more elevated, more angular, and farther apart than the others, giving that region of the shell an angular appearance when they are not eroded.

Some specimens are nearly circular in outline, the height and length being equal, but in most cases the height from beak to ventral margin is greater than the length or antero-posterior diameter.

The specimens selected for illustration are somewhat smaller than the average size. One from Huerfano park, Colorado, measures 14^{mm} in length, 16^{mm} in height, and the convexity of the single valve is 6^{mm}. A few examples have been collected that are considerably larger.

Locality and position.—The types are from dark fissile shales near the lower part of the Colorado formation, 20 miles west of Fort Bridger, Wyoming. It is abundant at the same horizon on Sulphur creek, Wyoming, and occurs in the coal-bearing sandstones at that locality. The types of *Cardium subcurtum* were collected in the sandstone of the "second ridge" at Coalville, Utah, and it is found near the base of the same section; also in the Pugnellus sandstone at several localities in Huerfano park, Colorado.

CARDIUM TRITE White.

Pl. XXII, Figs. 7 and 8.

Cardium trite White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 291, Pl. 5, Figs. 4*a* and *b*.

Original description:

"Shell broadly subovate or suborbicular, height and width about equal; valves gibbous, regularly arching from beak to base; median portion regularly convex; sides a little flattened above the middle; rostral portion narrowed, elevated, arched; beaks situated well toward the front, much elevated above the hinge-line, prominent, incurved, approximate, and turned very slightly, if any, forward; hinge-margin moderately long for a species of this genus; front having a short, oblique truncation above, from the lower end of which the whole free margin of the shell is continuously rounded to the posterior extremity of the hinge, the convexity varying, but not very greatly, in different parts. Surface marked by very numerous fine costæ of nearly uniform size on all parts of the shell, every third one of which only bears upon its back many small nodes or short spines.

"Height from base to beak, 35^{mm}; width, 36^{mm}. The height is, however, sometimes greater than the width.

"This species bears more resemblance to *C. curtum* Meek & Hayden than to any other species of *Cardium* yet described from the Cretaceous rocks of the West, but the prominent umbonal ridge, and the coarser and nonspiniferous costæ of that species, besides many other details, clearly separate it from the species here described; the peculiar character of the surface markings also separate it from any other described species with which it is in any danger of being confounded.

"*Position and locality.*—Cretaceous strata, probably equivalent with the lower portion of the Colorado group; head of Waterpocket canyon, southern Utah. Collected by Mr. G. K. Gilbert."

CYRENIDÆ.

Genus CYRENA Lamarck.

CYRENA (VELORITINA) SECURIS Meek.

Pl. XXIII, Figs. 1–3.

Corbicula (*Cyrena?*) *securis* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 494; White, 1879, idem for 1877, p. 289, Pl. 3, Fig. 2, *a*, *b*, *c*.
Cyrena (*Veloritina*) *erecta* White, 1876, Geol. Uinta Mts., p. 117.
Compare *Cyrena* (*Veloritina*) *durkeei* (Meek) White, 1876, U. S. Geog. and Geol. Surv. West 100th Meridian, vol. IV, p. 207, Pl. 21, Figs. 13*a*, *b*.

The original description was based on an internal cast. Near the same locality Dr. White obtained well preserved examples which he described as follows:

"Shell of medium size, obliquely subovate in marginal outline when adult, but subcircular when young, gibbous, especially the upper median portion, but somewhat laterally compressed at the postero-basal portion; antero-basal, basal, and postero-basal borders forming a continuous, almost regular, curve; the dorsal outline, by lateral view, also broadly rounded from the beaks to the postero-basal border; front a little concave transversely below the beaks, and also vertically concave from the beaks to a point a little below the midheight of the shell; beaks prominent, approximate, and curved forward; ligament short and narrow. This concavity of the dorsum resembles an escutcheon, except that it is not defined, especially at the ends; it is moderately deep, narrow, and bounded at the sides by the abrupt rounding inward and downward of the surface from the outer side of each valve, so that the hinge margin is wholly hidden from sight by a side view of the shell; hinge and interior unknown. Surface marked by the ordinary lines and imbrications of growth.

"Height, 33^{mm}; antero-posterior width the same; thickness about 22^{mm}."

The additional specimen now before me, though slightly crushed just behind the beak, shows the larger part of the hinge. There are three rather small, slightly divergent cardinal teeth (in the left valve) of which the middle one is somewhat larger than the others. The lateral teeth are long and prominent, apparently not striate.

Both Prof. Meek and Dr. White have pointed out the close resemblance of this form to *Corbicula* (*Veloritina*) *durkeei*, a common species of the Bear River formation which underlies the beds containing *Cyrena securis*. Some individuals of the former have almost exactly the outline of this species, but they are usually larger and thicker shells and the hinge seems to be proportionally stronger and with more divergent teeth. I think, however, that they belong to the same genus. In southern Utah several forms of *Cyrena* are common near the base of the Colorado formation, where they are associated with *Glauconia coalvillensis*, *Barbatia micronema*, *Admetopsis*, etc. The specimen described by Dr. White as *Cyrena* (*Veloritina*) *durkeei* came from this horizon and might be referred with equal propriety to *C. securis*. Others associated with them approach the form of *Cyrena inflexa*, and still others differ from all those species, though I suspect that they all belong to one variable species. (See Pl. XXIII, Figs. 3 and 4.)

None of the species herein referred to *Cyrena* are typical examples of that genus. They all seem to belong to Meek's subgenus *Veloritina*, which he regarded as belonging to *Corbicula* and which combines some of the features of *Corbicula*, *Velorita*, and *Cyrena*, though, as it seems to me, somewhat more nearly related to Cyrena than to the other two genera.

Locality and position.—From the coal-bearing sandstones at Bear River city and near Hilliard station, Wyoming, probably near the top of the Colorado formation.

CYRENA ÆQUILATERALIS Meek?

Pl. XXII, Figs. 14 and 15.

Corbicula æquilateralis Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 495.

Original description:

"Shell (as determined from an internal cast) subtrigonal, and nearly or quite equilateral, rather convex; height about five-sixths the length; anterior and posterior extremities nearly equally, and rather narrowly rounded; ventral margin forming a nearly semielliptic curve, the most prominent part being at the middle; beaks rather prominent, and very nearly, if not quite, central; umbonal slopes not prominently rounded; dorsal outline declining subequally from the beaks in front and rear, the posterior slope being convex in outline, and the anterior concave; muscular impressions shallow. (Surface and hinge unknown.)

"Length, 1.72 inches; height, 1.45 inches; convexity, about 0.92 inch."

This species has never been figured and the type has not been preserved. Recent collections from the typical locality contain casts that agree well with the description and associated with them, one specimen retaining the shell, which is believed to belong to the same species. The beak is about half way between the middle and the anterior end, but the cast of the same specimen would be much more nearly equilateral. The surface is smooth with obscure lines of growth. The details of the hinge are almost precisely the same as in the preceding species, excepting that the anterior lateral tooth is much smaller. In form the species is closely related to *C. inflexa* Meek.

Locality and position.—From the coal-bearing sandstones at Bear River city, Wyoming, probably near the top of the Colorado formation.

CYRENA INFLEXA Meek.

Pl. XXII, Fig. 13.

Corbicula (Veloritina) inflexa Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 493.
Cyrena inflexa White, 1879, idem for 1877, p. 290, Pl. 10, Figs. 7*a* and *b*.

Original description:

"Shell longitudinally ovate, a little less than two-thirds as high as long, moderately convex; posterior extremity rather narrowly rounded or apparently sometimes faintly subtruncated; anterior very short, subtruncated, or more or less sinuous in outline just in advance of the beaks on the abrupt forward slope above, and rather abruptly rounded below; basal margin semiovate or semielliptic; dorsal margins inflected and forming a long convex slope from the umbonal region posteriorly; beaks rather depressed, oblique, incurved, and placed near the anterior end; umbonal slopes not prominently rounded; surface merely showing fine, rather obscure marks of growth; anterior muscular impression rather strongly defined and obliquely ovate; posterior muscular impression larger and obscure; pallial line showing a deep, angular, ascending sinus; posterior lateral teeth of hinge very long, linear, and nearly or quite smooth; anterior short; cardinal teeth very oblique.

"Length of a specimen, a little under medium size, 1.35 inches; height, 0.39 inch; convexity, 0.68 inch.

"This species is more depressed and elongated than any of those hitherto described from the far western localities, excepting one or two from the coal formations on Bitter creek, Wyoming, from which it differs in having its beaks placed farther forward. It will also be readily distinguished from those shells, as well as from all of the other species of the genus yet known, from any of our rocks, by having an angular, ascending, and comparatively deep sinus in its pallial line, almost like that seen in many types of the Veneridæ. This character is so strongly marked that it was not until I had succeeded in getting a tolerably clear idea of the nature of the hinge that I could believe the shell related to the group to which I have referred it. As was pointed out by Mr. Tryon, some years back, the existing American species of *Cyrena* and *Corbicula* have the pallial line more or less sinuous; while in nearly all of those from foreign countries it is simple. I have also ascertained that nearly all the extinct North American species yet known have the pallial line sinuous. The sinus, however, is usually shallow and rounded, or obtuse, in our fossil species; that of the shell here under consideration being unusually deep and angular.

"*Locality and position.*—Near Missouri river, below Gallatin city, Montana, where it occurs, associated with *Trigonia*, *Inoceramus*, *Cardium*, *Ostrea*, and other marine Cretaceous fossils."

CYPRINIDÆ.

Genus VENIELLA Stoliczka.

VENIELLA MORTONI M. & H.

Pl. XXIII, Figs. 6–9.

Venilia mortoni Meek and Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 27.
Veniella mortoni Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 154, Pl. 4, Figs. 3*a*, *b*.

Revised description:

"Shell transversely oblong, or subtrapezoidal in outline, gibbous, thick, and strong; base nearly straight, but rounding up in front; dorsal margin parallel to the base, excepting where it declines, at first gently, then abruptly, into the obliquely-truncated posterior; anterior side truncated vertically immediately in front of the beaks, just below which there is a slight sinuosity of outline, as seen in a side view; posterior basal extremity narrowly rounded, or subangular; beaks very oblique, strongly incurved, gibbous, and placed directly over the anterior; umbonal slopes forming a prominent, rather angular, oblique ridge, from each beak to the posterior basal extremity; lunule and escutcheon impressed, but without strongly defined margins; surface marked with distinct concentric striæ, and stronger, irregular ridges, the latter of which sometimes pass into regular, rather distant, low varices on the umbones.

"Length, 1.66 inches; height, 1.40 inches; convexity, 1.17 inches.

"This species is nearly related, at least in external characters, to *V. Conradi* Morton, but differs in being more oblique and more depressed at the beaks, which are also placed directly over the more truncated anterior margin. Its dorsal margin is also longer and less sloping than in Morton's species. It will be more readily distinguished from the last by its greater proportional length, less angular umbonal slopes, and rougher surface.

"I have not seen the hinge of this species; but from its form and general external appearance, there is little reason for doubting that it belongs to the genus under which it is placed.

"*Locality and position.*—Chippewa point, on the upper Missouri, near Fort Benton; from the Fort Benton group of the Cretaceous."

The specimens that are figured on Pl. XXIII came from the upper part of the Fort Benton shales on the Arkansas river, 20 miles west of

Pueblo, Colorado. They differ from the type in that the beaks are not quite so near the anterior end and the posterior end is more narrowly rounded, but these differences are not regarded of specific importance. This species may also be compared with *Veniella humilis* M. & H., which is found at the top of the Montana formation.

The hinge (of the left valve) is very much like that of *V. conradi*, the type of the genus there being three strong, thick cardinal teeth and a long posterior lateral tooth.

Veniella goniophora Meek.

Pl. XXIII, Fig. 5.

Veniella goniophora Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 152, Fig. 12 in text, and Pl. 4, Fig. 4.

"Shell rather thin, short, subquadrate or subtrapezoidal, with length only slightly greater than the height, becoming extremely gibbous with age, the convexity of large specimens sometimes equaling the length; dorsal outline more or less straightened, or, in large adult specimens, curving downward somewhat posteriorly to the rather short, truncated, posterior margin; basal margin generally rather deeply rounded in outline anteriorly, and straightened or even slightly sinuous and ascending posteriorly, to the posterior basal extremity, which is distinctly angular; anterior side narrowly rounded below, and deeply sinuous under the beaks above; beaks prominent, very gibbous, obliquely and strongly incurved, in young shells located near the anterior side, though not quite as prominent as the margin below, but in the adult sometimes overhanging the anterior margin; lunule excavated, but apparently not defined by a marginal ridge; posterior umbonal ridge very prominent and strongly angular from the beaks to the posterior basal angle, while the space between it and the dorsal margin is concave; surface showing concentric striæ, and generally a few stronger ridges.

"Length of the largest specimen seen, 1.60 inches; height of same, 1.38 inches; convexity, 1.55 inches.

"Casts of this species show the posterior lateral teeth of the hinge to present the usual characters of the genus; while in one specimen the posterior cardinal tooth of the right valve can be seen to be strong and deeply bifid. Another specimen shows the middle cardinal tooth of the left valve to be strong, prominent, broadly trigonoid conical, and slightly curved upward at the end, as in the type-species, and the posterior cardinal to be narrow and arcuate; the oblique, trigonal pit for the middle cardinal tooth of the other valve occupying the space between the two. None of the specimens show the anterior cardinal tooth of either valve; but enough of the hinge and other characters can be determined to remove all doubt in regard to its being a true typical *Veniella* and not a *Venilicardia*.

"Generally, the internal casts of this species retain no traces of the surface-markings, but sometimes they present faint remains of concentric undulations. The posterior umbonal ridges, however, are always strongly defined, and angular even on internal casts. Some large specimens have, in casts, a strong, obtuse ridge near the dorsal margin of each valve, apparently bounding a kind of broad lanceolate escutcheon, the middle and deeper part of which is occupied by the rather narrow ligament.

"Young specimens of this shell present much the general outline of small individuals of *Veniella* (*Venilicardia obtruncata*) Stoliczka, (Palæont. Ind., III, Pl. VIII, Figs. 7 and 7*a*, *b*); but they have the umbonal ridge of each valve much more deeply defined, while the hinge characters of the two shells are altogether different. Of course, if Dr. Morton's name *Venilia* should be retained for this genus, the name of this species would become *Venilia goniophora*.

"*Locality and position.*—Missouri river, near Fort Benton; Fort Benton group of the Cretaceous."

Dr. White reports the species from "southeast of Paria, Utah."[1]

There is some reason for doubting that this is really distinct from *Veniella mortoni*.

VENERIDÆ.

Genus TAPES Megerle v. Mühlfeldt.

TAPES CYRIMERIFORMIS n. sp.

Pl. XXIV, Figs. 1–6.

Shell of medium size, equivalve, moderately convex, subcircular in outline; beaks small, approximate, situated a little in advance of the middle; cardinal margin sloping with nearly equal gentle convexity in both directions from the beaks; anterior end broadly and regularly rounded; posterior end slightly subangular above and rounded below; basal margin forming a regular gentle curve. Surface marked by fine lines of growth. There is no distinctly defined lunule. The ligament, which is preserved on some specimens, is relatively large and prominent.

Hinge of right valve with three strong, divergent, cardinal teeth, of which the posterior is deeply bifid and the other two are smaller and more approximate. In the left valve, which also has three teeth, the anterior tooth is very small, the middle one is larger and slightly bifid, and the posterior one is very long and oblique and situated near the outer margin of the hinge.

The muscular scars are large, ovate, not very strongly marked; pallial sinus deep, ascending and narrowly rounded at the extremity.

One of the type specimens measures 49^{mm} in length, 42^{mm} in height, and 16^{mm} in convexity of both valves united. The corresponding meas-

[1] See U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 185.

urements of another specimen, that is much more convex than any of the others, are: Length, 44mm; height, 36mm; convexity, 18mm. Other examples are somewhat larger than either of these.

This species would probably be included in *Cyprimeria* as extended and defined by Zittel in the Handbuch der Palæontologie, but it differs from the typical species of that genus in that it is equivalve, its valves are not twisted, and its pallial sinus is deep. The hinge resembles that of *Cyprimeria* in a general way, especially if the two anterior teeth of the right valve be regarded as one bifid tooth. *Venus faba* Sow., which is apparently a closely related form showing precisely the same generic characters, has been referred by some authors to *Cyprimeria*, but Holzapfel[1] has recently regarded it as a *Tapes*, and after comparing the Colorado fossils with recent species of that genus the reference seems to me a natural one.

Locality and position.—In the Pugnellus sandstone on Williams creek, Muddy creek, and Poison canyon, Huerfano park, Colorado. Casts that are believed to belong to this species have been found in the "first ridge" at Coalville, Utah.

Genus LEGUMEN Conrad.

This genus was described in 1858[2] and the description was supplemented in 1860[3] after the hinge of both valves had been studied. The type is *Legumen ellipticum*, from the cretaceous beds near Ripley, Mississippi.

It has always referred to the Solenidæ, but in form and in the details of the hinge it agrees very closely with *Tapes fragilis* (d'Orb.), and I believe that it is congeneric with that species which is the type of Stoliczka's genus *Baroda*. If this proves to be true *Baroda*, being a later name, should be treated as a synonym.

In Tryon's Structural and Systematic Conchology, vol. III, p. 132, this genus is erroneously called *Legumenaia* Conrad.

LEGUMEN, sp.

Pl. XXIV, Fig. 11.

In the Pugnellus sandstone in Poison canyon, Colorado, a single specimen was found that probably belongs to this genus. It is a cast of a left valve retaining a little of the shell near the dorsal margin, but it does not show the structure of the hinge nor the pallial line.

In outline it is not very different from *Baroda wyomingensis* Meek, from the upper portion of the Montana formation, and it is still more nearly like the forms from the Ripley beds on which Conrad founded his genus *Legumen*.

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[1] Die Mollusken d. Aachener Kreide, II. Abtheil., p. 165, Pl. 13, Figs. 7–10, Palæontographica, vol. 35.
[2] Jour. Acad. Nat. Sci. Phila., 2d ser., vol. III, p. 325.
[3] Idem, vol. IV, p. 277.

Genus CALLISTA Poli.

CALLISTA (DOSINIOPSIS?) ORBICULATA H. & M.

PL. XXIV, Figs. 9 and 10.

Cytherea orbiculata Hall and Meek, 1856, Mem. Am. Acad. Arts and Sci. n. s., vol V, p. 382, Pl. 1, Fig. 7.
Meretrix orbiculata Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., p. 185.
Dione orbiculata Meek, 1864, Smithsonian Check List Invert. Foss. of N. A., p. 13.
Callista (*Dosiniopsis*) *orbiculata* Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 186, Pl. 5, Figs. 2 *a–c*.

Revised description:

"Shell thick, suborbicular; beak moderately elevated and near the anterior side; posterior margin regularly rounded; surface marked by fine, equal, concentric lines.

"Length, 1.08 inches; height, 1 inch; width, 0.66 inch.

"Our specimens of this species are merely internal casts, with portions of the shell attached. Like that first figured by Prof. Hall and the writer, they present no characters by which we can determine definitely its generic relations. Some of the specimens show the muscular impressions to be shallow and ovate in form; the posterior impression being, as usual, broader than the anterior. The pallial line is provided with a triangular sinus, which extends a little obliquely upward and forward, about two-thirds of the distance from its base toward the middle of the valves, its sides converging at an angle of about 125° to 130°.

"Although some of our specimens present exactly the form of the figure above cited, the majority of them differ considerably, being more nearly transversely-ovate in outline, in consequence of the posterior side being more extended and less broadly rounded. These may belong to a different species; but as they vary in this respect, and their muscular and pallial impressions, as well as the thickness of the shell, are exactly as in the more orbicular individuals, I do not think it advisable to separate them without being satisfied, from the comparison of better specimens, that they are distinct.

"Should these more nearly ovate specimens be identical with *C. orbiculata*, as believed, the specimen first figured in the memoirs of the American Academy of Arts and Sciences must give an incorrect idea of the general form of this species, since a majority of the specimens are much less broadly rounded posteriorly.

"Some varieties of this species, especially the broader forms, resemble somewhat the species *C. Owenana*, but they are usually less concave in outline just in advance of the beaks, and the pallial sinus is always different in form, as may be seen by the figures. Some of the varieties also resemble our *C. Deweyi* in form, as well as in the pallial sinus and muscular impressions, but it is evidently a much thicker shell, and often distinctly more gibbous.

"*Locality and position.*—Five miles below the mouth of James river, at the base of the Fort Benton group, or formation No. 2 of the Upper Missouri Cretaceous. It was from this same locality and position that the specimen first figured by Prof. Hall and the writer was obtained."

CALLISTA (APHRODINA?) TENUIS H. & M.

Pl. XXIV, Figs. 7 and 8.

Cytherea tenuis Hall and Meek, 1856, Mem. Am. Acad. Arts and Sci., n. s., vol. V, p. 383, Pl. 1, Fig. 5.
Meretrix tenuis Meek and Hayden, 1860, Proc. Acad. Nat. Sci., Phila., p. 185.
Dione ? tenuis Meek, 1864, Smithsonian Check-List, Invert. Foss. of N. A., p. 13.
Callista (*Aphrodina?*) *tenuis* Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 188, Pl. 5, Figs. 1, *a–d*.

Revised description:

"Shell thin, varying in form from subcircular to transversely ovate, rather gibbous at maturity. Anterior side rather short, obliquely subtruncate above, and abruptly rounded below; base forming a semi-ovate curve, being a little more prominent before than behind the middle; posterior side narrowly rounded, or subtruncate; beaks moderately prominent, somewhat gibbous in old shells, incurved, contiguous, and placed nearly halfway between the middle and anterior side; lunule obovate, flat, and not very distinctly defined. Surface marked by fine, crowded, concentric striæ, and sometimes a few, obscure, parallel furrows near the border.

"Length of an adult shell (oval var.), 1 inch; height, 0.78 inch; convexity, 0.56 inch.

"None of our specimens expose the interior, but internal casts show that the muscular impressions are faintly marked and of a rather narrow ovate form, both before and behind. The pallial line is also seen to be provided with a broad, shallow sinus, having nearly the form of an equilateral triangle. Little or nothing being known in regard to the teeth of its hinge, it is, like the last, only referred doubtfully to this group. By working carefully about the hinge, however, and grinding down some of the specimens, I have nearly satisfied myself that it has a small anterior lateral tooth as in *Meretrix* (= *Cytherea*) and *Callista;* and as the pallial sinus is distinctly triangular, as in some sections of the latter, I think there is not very much reason for doubting the propriety of placing it, at least provisionally, in the latter genus; though better specimens may show it to belong to some other group.

"*Locality and position.*—South fork of Cheyenne river, near the base of the Black hills, in the Fort Union [Benton] group, or formation No. 2 of the Upper Missouri Cretaceous. The specimens first described in the paper cited at the head of this description were collected from the same formation on the Missouri river, 5 miles below the mouth of James river.

DONACIDÆ.

Genus DONAX Linnæus.

DONAX CUNEATA n. sp.

Pl. xxv, Fig. 1.

Shell transversely elongate-triangular, moderately thick, somewhat compressed, especially toward the front; anterior end very greatly produced, narrowly rounded at the extremity and slightly curved upward, the dorsal margin being gently concave and the base somewhat convex in outline; posterior end abruptly truncate about at right angles to the longer axis of the shell; the truncate portion bordered by the sharp prominent vertical umbonal ridge extending from the beak to the postero-basal angle; beak rather prominent, directed slightly forward, nearly or quite terminal (at the posterior end).

Surface apparently smooth and the free margins not crenate within.

The hinge has not been exposed sufficiently for figuring, but its structure can be seen fairly well in the type, which is a right valve. There are two approximate cardinal teeth under the beak, and both the anterior and posterior lateral teeth are well developed, the former being elongate and located a considerable distance in front of the beak, while the latter is shorter and is near the cardinal teeth.

Length, 27^{mm}; height at posterior end, 16^{mm}; convexity of single valve at posterior end, 45^{mm}.

The type of this species is a right valve from which most of the shell has been eroded. A smaller sandstone cast from another locality and a higher horizon has the same outline and probably belongs to the same species. With such limited and imperfect material it is of course impossible to say positively whether the generic reference above given is correct, but the form and the internal features, so far as they are known, agree very well with some living species of *Donax*. If it really is a *Donax* it is one of the oldest known species. The oldest previously described American form that has been referred to the genus is *D. lata* Gabb, from the Tejon group of California. Stoliczka figures a specimen which he says seems to be a true *Donax* from the upper part of the Cretaceous of southern India. The same author states that other described Cretaceous species probably do not belong to this genus.

I do not know any fossil form hitherto described with which this species need be compared.

From the species described below it differs in that its anterior end is proportionally longer, more slender, and more narrowly rounded in front, while its posterior end is much shorter.

Locality and position.—The type is from coal-bearing sandstone at Bear River city, Wyoming, where it is associated with *Inoceramus labiatus*, *Pugnellus fusiformis*, *Cardium pauperculum*, etc. The other specimen above mentioned is from the "third ridge" of the section at Coalville, Utah, which is a considerably higher horizon and probably in the Montana formation.

DONAX? OBLONGA n. sp.

Pl. XXV, Fig. 2.

Shell rather large, moderately convex, transversely oblong, with the short posterior end obliquely truncate; dorsal and ventral margins nearly parallel; anterior end produced, broadly rounded at the extremity with the greatest convexity of the curve above; posterior umbonal slope prominent and angular, varying considerably in obliquity, but always more oblique than in *D. cuneata;* beak rather prominent, incurved. Surface and hinge unknown. The casts show a few distant concentric furrows.

Length of the largest specimen, 45^{mm}; height, 28^{mm}; greatest convexity of single valve, 8^{mm}.

Besides the large specimen that is figured there are six other much smaller ones that were found associated with it and doubtless belong to the same species. They are all internal casts in sandstone, showing none of the generic features excepting the form, but they are apparently related to the preceding species, and are therefore referred to the same genus.

I dislike to describe and name such obscure fossils, but in the present case, as the form is very different from any of its associates, it can be easily identified if better preserved examples are ever found, and meanwhile the species is just as useful for geological purposes as it would be if all its characteristics were known.

Locality and position.—In the "second ridge" of the Cretaceous section at Coalville, Utah, which is approximately the same horizon from which the preceding species were obtained.

TELLINIDÆ.

Genus TELLINA Linnæus.

TELLINA MODESTA Meek.

Pl. XXV, Fig. 3.

Tellina modesta Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, p. 157, Pl. 15, Figs. 4 and 5.

Original description:

"Shell rather small, transversely elongate-subelliptic, being twice as long as high, rather distinctly compressed; anterior margin narrowly rounded; base forming a long, semielliptic curve; posterior extremity more narrowly and less regularly rounded than the other, apparently slightly bent to the left; dorsal margin declining very slightly, with convex slopes, both in front and behind the beaks; beaks very nearly central and inconspicuous, being depressed and compressed. Surface of casts smooth, but probably on well-preserved shells marked with fine concentric striæ. Hinge and interior unknown, with the exception of some appearances of lateral teeth seen in casts.

"Length, 0.86 inch; height, 0.44 inch; convexity, 0.10 inch."

The name of this species was first used in a list of fossils from Coalville, Utah, published in the Ann. Rept. U. S. Geol. Sur. Terr. for 1872, but it was not then described. All the specimens yet found are casts in sandstone that show neither the natural surface nor the internal features. It does not resemble any known form in the Cretaceous of the interior region, but there is a closely related undescribed species in the Ripley beds of Texas, and when describing it Prof. Meek pointed out its resemblance to *T. ashburneri* which occurs in the Chico series of California.

Locality and position.—Whitish Cretaceous sandstone on East Canyon creek, Wasatch range, Utah. The specimen figured is from the "second ridge," at Coalville, Utah.

TELLINA (PALÆOMŒRA?) WHITEI n. sp.

Pl. XXV, Figs. 4–7.

Shell of medium size, inequilateral, subovate, moderately convex; beaks rather broad and flat, situated behind the middle and directed backward; posterior end descending abruptly from the beak in a broad somewhat irregular curve to the base, where it is obscurely subangular; cardinal margin in front of the beaks, straight, descending with a more gentle declivity to the anterior end, which is regularly rounded and slightly narrower than the posterior end; base nearly straight in the middle, more strongly curved toward the ends. Surface marked by fine concentric striæ and lines of growth. An obscure ridge extends from the umbonal region near the margin of the valve to the posterobasal angle, and a short distance in front of it the shell is slightly bent to the right. One of the specimens shows traces of a few faint impressed radiating lines near the posterior end.

The ligament is rather prominent and there is a deep lanceolate area in front of the beaks. The pallial sinus is broad and deep.

Length of the larger type specimen, 35^{mm}; height, 25^{mm}; convexity of both valves united, 12^{mm}.

As neither of the two types shows the hinge the generic relations of this species are doubtful, but the features above described are deemed sufficient to warrant its assignment to the Tellinidæ, and on account of its general resemblance to *Tellina* (*Palæomœra*) *inconspicua* Forbes as figured by Stoliczka[1] it is provisionally placed in the same subgenus.

Locality and position.—In the Pugnellus sandstone on Williams creek, Huerfano park, Colorado.

[1] Cret. Pelec. of S. India, pl. 4, figs. 6–8.

TELLINA? SUBALATA Meek (sp.).

Pl. XXV, Fig. 9.

Cyprimera subalata Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 476.
Cyprimeria? subalata Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, Pt. 1, p. 158, Pl. 15, Fig. 7.

Revised description:

"Shell transversely broad-subovate or subelliptic, strongly compressed; extremities rather narrowly and nearly equally rounded; basal margin forming a regular semielliptic curve, being most prominent along the middle, and rounding up gradually and equally into the anterior and posterior lateral margins; dorsal margin sloping from the beaks, the posterior slope being more convex in outline than the anterior; beaks small, scarcely projecting above the hinge-margin, very nearly or exactly central, and almost entirely without obliquity. Surface apparently smooth, or only showing very fine, obscure, concentric striæ. (Hinge and interior unknown.)

"Length, 1.22 inches; height, 0.90 inch; convexity of left valve, only about 0.12 inch."

The type specimen bears the label *Tellina* (*Arcop.*) *subalata* in Mr. Meek's handwriting, but after comparing it with *Cyprimeria depressa* Conrad he concluded that it belonged to the same genus on account of a resemblance in form. The additional material recently collected at Coalville, Utah, is in the form of casts, one of which retains impressions of two cardinal teeth, showing that it belongs to the Tellinidæ rather than the Veneridæ.

Locality and position.—The type is from whitish Cretaceous sandstone, East Canyon creek, Wasatch range, Utah, where it is associated with *Trigonarca obliqua* and other Colorado species. At Coalville it was found in the sandstone of the "third ridge," which is believed to belong to the Montana formation.

TELLINA?? ISONEMA Meek.

Pl. XXV, Fig. 8.

Tellina?? isonema Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, pt. 1, p. 156, Pl. 15, Fig. 6.

Original description:

"Shell transverse, elliptic-subtrigonal in outline, compressed, and nearly or quite equilateral; anterior margin narrowly rounded; base forming a semi-elliptic curve; posterior end narrowly rounded or subangular at the termination of a slight, oblique flexure of the valves; dorsal margin sloping from the beaks to the extremities, with a moderately convex outline; beaks almost central, rather small, and projecting a little above the cardinal margin, incurved with scarcely any visible obliquity; hinge and interior unknown. Surface ornamented by fine, perfectly regular, concentric, thread-like lines, gradually becoming smaller and more crowded toward the umbones, on which they are nearly or quite obsolete.

"Length, 0.90 inch; height, 0.60 inch; convexity, about 0.20 inch."

Prof. Meek explains that the species is known only in the form of sandstone casts that do not show the hinge nor any other internal characters and that its reference to *Tellina* is very doubtful. It seems to me more probable that it is a *Mactra*, but as I have not been able to demonstrate the character of the hinge it is left under the original name.

Locality and position.—East Canyon creek, Wasatch range, Utah; sandstone of the "second ridge" at Coalville, Utah. A cast that seems to belong to this species was found in the "third ridge" of the same section.

SOLENIDÆ.

Genus SILIQUA Megerle *v.* Mühlfeldt.

SILIQUA HUERFANENSIS n. sp.

Pl. XXV, Figs. 10 and 11.

Shell long and narrow, inequilateral, somewhat compressed, gaping at both ends; dorsal margin very slightly convex; basal margin nearly straight or slightly sinuous in the middle; both ends broadly rounded, but the anterior end slightly narrower than the posterior; beaks very small and inconspicuous, located a little in advance of the middle. Substance of the shell thin, marked on the surface by very faint lines of growth and by a few larger irregularly arranged concentric undulations.

Pallial sinus broad, rounded and rather deep. Muscular impressions near the cardinal margin, well marked on adult shells; the anterior one elongate and narrow, just in front of the beak; posterior impression ovate, about half way between the beak and the posterior end. An internal rib runs obliquely downward and forward from the beak, gradually becoming less prominent and ending about half way between the dorsal and ventral margins. The structure of the hinge has not been satisfactorily made out, but some of the casts show impressions of two or three very small cardinal teeth.

Length of medium-sized specimen, 58^{mm}; greatest height, 18^{mm}; convexity of the two valves united, about 9^{mm}.

In outline this shell is very similar to some recent species of *Pharella*, but the presence of the internal rib and the large size of the pallial sinus will not allow a reference to that genus, and on account of these features it is provisionally referred to *Siliqua*. I think that *Pharella ? dakotensis* M. & H., from the Dakota formation near the mouth of Big

Sioux river, is closely related to this species, though probably distinct.

Locality and position.—In the Pugnellus sandstone on Williams creek and other places in Huerfano park, Colorado, where about forty specimens were collected, and near the base of the cretaceous section at Coalville, Utah.

Genus PHARELLA Gray.

PHARELLA? PEALEI Meek.

Pl. XXV, Figs. 12 and 13.

Pharella? pealei Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 496;—White, 1880, *idem* for 1878, p. 21, Pl. 11, Figs. 6*a*, *b*.

Original description:

"Shell elongate-oblong, or subrhombic, the length being about twice and a half the height, rather compressed; anterior margin slightly sinuous just in advance of the beaks above, and somewhat narrowly rounded below this faint sinuosity; posterior margin truncated, with a convex outline, very obliquely backward and downward, from the posterior extremity of the hinge to the prominent and very narrowly rounded or angular posterior basal extremity; hinge-line proper apparently comparatively short, and not forming any angularity of outline at its connection with the sloping posterior dorsal margin; beaks rising a little above the hinge margin, but rather depressed and placed about one-fifth the entire length of the valves from the anterior margin; basal margin long, slightly sinuous along most of its length; posterior dorsal slopes rather prominently rounded from the beaks obliquely to the posterior basal extremity. Surface only showing obscure lines of growth.

"Length, 1.20 inches; height, 0.48 inch; convexity, 0.28 inch.

"Knowing nothing of the hinge of this shell, I only refer it provisionally to *Pharella*. It does not seem to have had the extremities gaping as in that genus; but the specimen has evidently been accidentally compressed, and this may have given the valves the appearance of being closed. In general appearance it resembles *Solen guerangeri* d'Orbigny, which seems to belong to the genus *Pharella*. Our shell, however, evidently differs from d'Orbigny's specifically, at least, in not having the posterior margins of its valves near so abruptly truncated, but rounding and sloping forward gradually into the dorsal outline above. Possibly I should call it *Modiola pealei*.

"*Locality and position.*—Missouri river, below Gallatin, Montana, Cretaceous."

PHOLADOMYIDÆ.

Genus PHOLADOMYA Sowerby.

PHOLADOMYA PAPYRACEA M. & H.

Pl. XXVI, Fig. 1.

Pholadomya papyracea Meek and Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 27; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 217, Pl. 5, Figs. 4*a* and *b*.

Revised description:

"Shell under medium size, very thin and fragile, transversely subovate in outline, with length about once and a half the height, rather compressed, the greatest convexity being in the anterior and umbonal regions; posteriorly cuneate and a little gaping; outline of base regularly semiovate, its greatest prominence being a little in advance of the middle; anterior side short and rounded; posterior longer and more narrowly rounded; hinge margin straight, not inflected so as to form a defined false area, but subcarinate all along; beaks depressed, small, and incurved, located near the anterior end of the valves, though not terminal. Surface of each valve ornamented by about ten to twelve small radiating costæ, which are crossed, and, as it were, cut into very small tubercles by numerous, very regular, sharply defined, and much more closely arranged concentric ribs and furrows, the markings being all well defined on the internal cast.

"Length about 1.16 inches; height, 0.76 inch; convexity, 0.55 inch.

"In a side view this species more nearly resembles *P. tenera* of Agassiz (particularly as illustrated by Fig. 16, Pl. 3*a*, of his Étud. Crit.) than any other form with which I have compared it. It is decidedly more compressed, however, as well as more depressed, and may also be at once distinguished from that species by having no traces of a false cardinal area, which is well defined in that species. The only good specimen of it that I have seen was found by Lieut. Mullan of the United States Topographical Engineers.

"*Locality and position.*—Chippewa point, near Fort Benton, on the upper Missouri, in the Fort Benton group of the Cretaceous series of the Northwest."

Some specimens recently collected from the same horizon in northern Montana by Mr. W. H. Weed are fully twice as large as the type.

PHOLADOMYA COLORADOENSIS n. sp.

Pl. XXVI, Fig. 2.

Shell transversely elongate oval, depressed; anterior end regularly rounded from the beak to the base; basal margin forming an irregular broadly rounded curve with the greatest convexity in the posterior third; posterior end abruptly narrowed and subangular; beaks rather broad, approximate, projecting considerably beyond the hinge line and situated about one-fifth the total length of the shell behind the anterior end. Surface marked by 25 to 28 narrow, angular, radiating costæ, some of which occasionally bifurcate. The interspaces are not quite equal, even on the middle portions of the valve, and they become much broader toward the anterior and posterior ends.

Length, 46^{mm}; height, 29^{mm}; convexity of a single valve, about 10^{mm}. Broken specimens in the collection show that the species sometimes reached dimensions one-half greater than those given.

This species seems to be closely related to *P. breweri* Gabb, from the Cretaceous of California, and it is also quite similar to *P. subventricosa* M. & H., from the Fox Hills beds at the mouth of Judith river. From the former it differs in the more elongate form, more contracted posterior end, and less regular costæ.

Pholadomya subventricosa is known only by a single distorted specimen, but it seems to be more ventricose, and the posterior end is broader and the beaks are nearer the anterior end than in our species.

Locality and position.—Williams creek, Huerfano county, Colorado, in the Pugnellus sandstone.

ANATINIDÆ.

Genus ANATINA Lamarck.

ANATINA LINEATA n. sp.

Pl. XXVI, Figs. 3 and 4.

Shell of medium size, transversely subelliptical or elongate ovate in outline, inequilateral; anterior end produced, broadly and regularly rounded; posterior end short, gaping, abruptly contracted, and more narrowly rounded; dorsal margin concave immediately behind the beaks and gently convex in front; basal margin forming a broad curve; beaks small, approximate, fissured, with an oblique internal rib behind the fissure. The valves are slightly flattened in the middle, so that the greatest convexity is in advance of that region. Surface marked by strong concentric undulations that become obsolete on the posterior third of the shell, and by more numerous fine concentric lines covering the whole valve. The best preserved impression of the surface shows also two to three faint radiating lines on the umbonal region.

Length of a large specimen (anterior portion restored from other examples), about 70^{mm}; height, 44^{mm}; convexity of both valves united 16^{mm}.

Anatina sulcatina Shumard ? as figured by Whiteaves[1] and by White[2], is very closely related to the form here described. Our species has somewhat more prominent beaks and it lacks the well-defined furrow that extends from the beak to the base in *A. sulcatina*.

[1] Mesozoic Fossils, vol. I, Pl. 17, Fig. 5.

[2] Bull. U. S. Geol. Sur. No. 51, Pl. 6, Fig. 1.

Locality and position.—In the Pugnellus sandstone on Williams creek and in Poison canyon, Huerfano county, Colorado. At Coalville, Utah, casts that are believed to belong to the same species were found in the sandstone of the "first ridge," and also at a much higher horizon in the "third ridge" of the same section.

Genus LIOPISTHA Meek.

LIOPISTHA (PSILOMYA) MEEKI White.

Pl. XXVI, Figs. 5-7.

Liopistha (Psilomya) Meeki White, 1874, Expl. and Sur. West 100th Merid., Prelim. Rept. Invert. Fossils, p. 26; 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 186, Pl. 18, Fig. 14*a-d*.

Revised description:

"Shell short, much inflated; umbones large, elevated; beaks small, strongly curved inward and downward, and very slightly turned forward; posterior portion moderately produced, somewhat compressed laterally; free margins forming a regular but unequally convex curve, the greatest convexity of which is in front and the least along the base; upper portion of the posterior border obliquely truncated, so that the greatest posterior extension of the shell is a little below the hinge extremity.

"Surface having a smooth aspect, but it is marked by fine concentric lines of growth. Under a lens, very fine, obscure, radiating striæ are seen upon the surface of a little more than the anterior half of the shell; and upon the remainder of the surface, except a small space adjoining the posterior cardinal border, there are small, somewhat distant, radiating striæ, easily seen by the unassisted eye. Upon these striæ, both the distinct and the obscure, the lens shows numerous minute punctures, placed at irregular intervals, which are the bases of minute, short, blunt spines, or which mark the places from which the spines have been removed.

"Length, 25^{mm}; height, from base to umbo, 20^{mm}; greatest thickness, both valves together, 16^{mm}.

"This shell seems to be more nearly related to *L. globulosa* (=*Poromya globulosa* Forbes) than to any other described species. Compared with that species, as figured and described by Stoliczka,[1] ours differs in being less globular, in having the umbones more elevated, and in the more distinct radiating striæ upon the posterior half of each valve."

Locality and position.—The types come from southeast of Paria, Utah. In the Upper Kanab valley, which is not far from the typical locality, it occurs about 350 feet above the base of the Cretaceous section, associated with characteristic species of the Colorado formation.

[1] Cretaceous Fauna of Southern India, vol. III, p. 47, Pl. III, Fig. 8, and Pl. XVI, Fig. 16.

Liopistha (Psilomya) concentrica n. sp.

Pl. xxvi, Figs. 8–10.

Shell of medium size, very thin, transversely ovate in outline, moderately convex; anterior and basal margins forming a continuous but unequally convex curve; posterior end subangular and compressed; dorsal margin behind the beak, straight, slightly descending, abruptly deflected so as to form a distinct false area which bears fine transverse striæ and is separated from the body of the shell by a narrow furrow running from the beak to the angular posterior end; beaks prominent, ventricose, incurved, and but slightly oblique, situated a little in advance of the middle. Surface marked by lines of growth and regular concentric undulations that are about 1^{mm} apart on the body of the shell, but are more closely arranged and more prominent near the beaks.

Length of one of the largest specimens, 27^{mm}; height, 19^{mm}; convexity of a single valve, 8^{mm}.

This species has very nearly the size and shape of *L. meeki.* It is slightly more elongate, however, and its surface ornamentation is entirely different. The Survey collections contain more than a dozen of each of these species, and the differences seem to be constant. The Utah species, *L. meeki*, never has the concentric undulations, and always shows more or less radiating striæ, while in *L. concentrica* the reverse of this is true.

Locality and position.—In the Pugnellus sandstone on Williams creek and in Poison canyon, Huerfano park, Colorado, and at about the same horizon on the Arkansas river, 20 miles above Pueblo, Colo.

Note.—Since the above description was written about 25 additional specimens of *Liopistha meeki* have been collected in southern Utah, and among them is one marked with distinct radiating striæ and with concentric undulations almost as strong as in *L. concentrica.* Possibly the latter should be regarded as only an extreme variety of *L. meeki*, though the two forms are easily distinguishable.

Liopistha (Psilomya) elongata n. sp.

Pl. xxvi, Figs. 11 and 12.

Shell rather large for this genus, inequilateral, transversely elongate, moderately convex in the umbonal region, and compressed posteriorly; dorsal margin behind the beak, straight, and inflected so as to form a narrow false area; anterior margin forming a regular curve from the beak to the ventral margin, which is but slightly curved and almost parallel with the dorsal margin; posterior end subtruncate above and narrowly rounded into the base below; beaks prominent, ventricose, incurved, and approximate, situated about half-way between the middle and the anterior end. Surface marked by lines of growth and obscure concentric undulations that are most prominent on the umbonal region, and are as distinct on the casts as on the surface.

Length, 37^{mm}; height, 27^{mm}; convexity of a single valve, 9^{mm}.

Externally this species has a close resemblance to certain forms of *Pleuromya*, and I was inclined to refer it to that genus, although it is not reported as occurring in beds later than the Lower Cretaceous. On further examination a part of the hinge of a left valve was exposed, revealing a prominent conical tooth under the beak. So far as it is known, therefore, the hinge is like that of *Liopistha*. The surface is not well enough preserved to show whether it was marked by the obscure radiating lines of granules or minute spines that usually appear on species of the Psilomya section of this genus, but this feature seems to be wanting in *Liopistha* (*Panopœa*) *frequens* Zittel, a species from the Gosau beds that is very closely related to ours. Another species, described above under the name *Liopistha* (*Psilomya*) *concentrica*, has very nearly the same surface ornamentation as *L. elongata*, but its form is more nearly like that of the typical species of the genus. It is worthy of remark that the three species herein described are the only American ones that have been referred to the subgenus *Psilomya*, and they all come from approximately the same horizon.

Locality and position.—Upper Kanab valley, Utah, from concretions in shale about 350 feet above the base of the Cretaceous section.

MACTRIDÆ.

Genus MACTRA Linnæus.

MACTRA (CYMBOPHORA?) UTAHENSIS Meek.

Plate XXVII, Figs. 16 and 17.

Mactra (*Cymphobora*) *utahensis* Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, Pt. 1, p. 155, Pl. 15, Figs. 9, 9*a*, 9*b*.

"Shell subovate, moderately convex; anterior margin rounded; posterior margin narrower, and rather abruptly rounded, or sometimes apparently slightly truncated, being most prominent below; basal margin forming a semielliptic or semiovate curve, being sometimes more prominent anteriorly; dorsal outline sloping from the beaks toward the extremities; beaks moderately prominent, very nearly central, and incurved with little obliquity; umbonal slopes merely rounded, and not terminating in a flexure of the posterior basal margin. Surface apparently merely marked with fine, obscure, irregular lines of growth. Hinge merely known to possess linear anterior and posterior lateral teeth. Ligament and internal characters unknown.

"Length, 1.35 inches; height, 0.90 inch; convexity, about 0.50 inch.

"The specimens of this shell in the collection agree so nearly with a form described by the writer in connection with Dr. Hayden, from the Upper Cretaceous beds on Deer Creek, near the North Platte, under the name *Tellina nitidula*, that I was at one time inclined to think they might belong to a variety of that species. Still, as they are merely casts, giving but a limited knowledge of the hinge, and showing nothing of the internal characters, it is much more probable that they are really very distinct. So far as regards their form and general appearance, they seem only to differ in having the anterior side rather more produced and sometimes wider.

"From this general resemblance, however, I have, in the absence of any knowledge of the nature of its cardinal teeth or pallial line, ventured to refer it provisionally to the same section of the *Mactra* group to which *Tellina nitidula* is now believed to belong, that is, to *Cymbophora* Gabb. I should have been inclined to refer it to *Macoma* or *Gastrana* were it not for the impressions of lateral teeth seen before and behind the beaks in the casts.

"*Locality and position.*—Whitish Cretaceous sandstone, East Canyon creek, Wasatch range, and near Coalville, Utah."

At Coalville this is one of the most abundant species in the strata below the principal coal bed, but they are all in the same state of preservation as the types. At first I was inclined to doubt whether the two forms represented by Meek's figures are really the same species, but after comparing a large series I am unable to find any constant differences by which they may be separated. Several specimens of the equilateral form show impressions of cardinal teeth like those of *Mactra*.

MACTRA EMMONSI Meek.

Pl. XXVII, Figs. 9–13.

Mactra ? emmonsi Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, Pt. 1, p. 153, Pl. 15, Fig. 8.

"Shell small, oval-subtrigonal, rather compressed, longer than high, nearly or quite equilateral, or with anterior side slightly longer than the other; basal margin forming a semielliptic curve; anterior margin narrowly rounded below the middle; posterior margin somewhat broader, most prominent and abruptly rounded or obtusely subangular below, and very faintly subtruncated obliquely above; dorsal margin sloping before and behind the beaks, the anterior slope being greater, with a concave outline; beaks nearly central, or sometimes placed a little behind the middle, rather depressed, and incurved with very slight obliquity; posterior umbonal slope very obscurely angular from the beaks to the posterior basal extremity. Surface only marked by fine obscure lines of growth. (Hinge and other internal characters unknown.)

"Length, 0.45 inch; height, 0.30 inch; convexity, 0.17 inch. Some specimens of apparently the same species are nearly double the size of that from which the above measurements were taken, and some of the smaller ones are proportionally a little shorter."

The figured type is a small sandstone cast somewhat distorted by pressure, and with the beak partially concealed in the matrix, so that it was drawn less prominent and more obtuse than it really is. It was collected in the Cretaceous sandstone on East Canyon creek, Utah, where it is associated with *Cardium pauperculum* and other characteristic species of the Colorado fauna. Some much larger casts from about the same horizon, the first ridge in the Coalville section, are believed to belong to the same species, because of their close agreement in form, when allowance is made for the slight distortion of the type. One of these larger specimens is figured.

In the Pugnellus sandstone of Huerfano park, Colorado, one of the more abundant species is a small *Mactra* that in size and form is very like the above-mentioned Coalville specimens, and I think it best to describe and figure it under the same name, although one can never be certain that a well preserved shell, showing the surface characters, belongs to the same species with an imperfect internal cast from a distant locality.

The description of the form as above given serves very well for the Colorado examples, excepting that the most of them are proportionally more convex and many are not quite so elongate anteriorly. There is a large distinct lunule, lanceolate in form, bordered by an impressed line that extends from the beak to the extreme anterior end. Behind the angulation of the posterior umbonal slope there are one or two other faint radiating lines, the posterior of which forms the boundary of the escutcheon. Both the lunule and the escutcheon are marked by regular, distinct concentric lines. The remainder of the surface bears only lines of growth that are very faint and closely arranged, excepting toward the ventral border of adult specimens, where they become nearly equal in size to those on the lunule.

The hinge structure, so far as seen, is that of a *Mactra;* there is a cartilage pit, in front of which is an $\wedge$-shaped tooth, and the lateral teeth are well developed. The pallial sinus is short and rounded.

This species has some resemblance to small examples of *Mactra warrenana*, which occurs in the upper portion of the Montana formation, but *M. emmonsi* is a more depressed form with a smoother surface and slight differences in outline, which are regarded of specific importance, especially when considered in connection with the difference in size and in stratigraphic position.

Mactra huerfanensis n. sp.

Pl. XXVII, Figs. 14 and 15.

Shell thin, depressed, subelliptical, nearly equilateral; anterior border regularly and rather narrowly rounded; posterior border forming a slightly convex regular slope from the beak to the subangular posterior end; base forming a broad regular curve; beaks small, projecting slightly beyond the cardinal border. Surface smooth, marked only by faint lines of growth.

This species varies considerably in length and in convexity. The specimens selected for figuring, representing the extremes of variation, having the following dimensions, respectively: Length, 30 and 38mm; height, 21 and 22mm; convexity (of single valve), 5 and 4mm.

The left valve has a medium-sized cartilage pit with a Λ-shaped cardinal tooth in front of it. Some of the casts show impressions of small lateral teeth. The anterior muscular impression is ovate or subcircular, the posterior, elongate ovate. Pallial sinus rather broad, rounded at the extremity, and horizontal. The structure of the hinge is determined from internal casts that do not show all the features clearly, so that it is impossible to say whether the species is a *Mactra* or some other allied genus.

I was at first inclined to identify these fossils with *Tellina? isonema* which they closely resemble in general form. They differ from that species, however, in that their surface is much smoother, lacking the regular concentric lines and also the angular posterior umbonal slope.

Locality and position.—In the Pugnellus sandstone at many localities in Huerfano park, Colorado.

MYIDÆ.

Genus CORBULA Bruguiére.

CORBULA SUBTRIGONALIS M. & H.

Pl. XXVII, Figs. 7 and 8.

Corbula subtrigonalis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., p. 116.
Corbula perundata Meek and Hayden, ibid.
Corbicula crassatelliformis Meek, 1871, Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 315.
Corbula tropidophora Meek, 1873, idem for 1872, p. 514.
Corbula subtrigonalis White, 1879, idem for 1877, p. 170; 1880, idem for 1878, p. 80, Pl. 25, Figs. 6a–f; 1883, 3d Ann. Rept. U. S. Geol. Sur., p. 442, Pl. 19, Figs. 10–13.
Compare *Corbula perangulata* Whiteaves, 1885, Cont. to Can. Palæont., vol. I, p. 9, Pl. 1, Fig. 5a, b, Pl. 2, Fig. 1.

Shell large, transversely elongate-triangular; moderately convex, subequivalve, the right valve being slightly longer and more convex than the other; anterior end short, obliquely subtruncate above, regularly rounded below to join the ventral margin, which forms a regular, gently convex curve; posterior end narrow, greatly produced, subangular at the extremity; posterior dorsal margin straight or very slightly convex, forming approximately a right angle with the truncate anterior end; beaks prominent, incurved; posterior umbonal slope very prominent and angular in the left valve, more rounded in the right. A broad area immediately in front of the umbonal ridge is flattened, while the portion of the shell between it and the dorsal margin is abruptly deflected. Surface ornamented by fine lines of growth and a few larger concentric ridges.

Length of a large specimen, 33mm; height, 21mm; convexity of a single left valve, 7mm.

The specimens here described were collected from coal-bearing sandstone of the Colorado formation at Bear River city, Wyoming (No. 12 of Meek's Sulphur creek section), where they are associated in the same layer with *Inoceramus labiatus*, *Cardium pauperculum*, *Pugnellus fusiformis*, etc. After comparing them with the types of all the forms that are now regarded as varieties of *Corbula subtrigonalis* I am unable to find any reason for their separation, excepting that some of them are larger than any other known specimens of *C. subtrigonalis*, and they come from a much lower horizon. The types all came from strata that have been referred to the Laramie, *C. subtrigonalis* and *C. perundata* from the mouth of Judith river, *C. tropidophora* and *Corbicula? crassatelliformis* from the Bitter creek series of southern Wyoming. It should be stated that some examples in the Bear River city collections agree perfectly with the varieties described as *C. perundata* and *C. crassatelliformis.* Whiteaves reports the occurrence of the species in the Belly River series, which is supposed to hold the position between the Colorado and Montana formations, and I have found it at Coalville, Utah, in the "third ridge," above the Carleton coal bed, which is referred to the Montana formation. The species therefore seems to range through nearly all of the Upper Cretaceous, from the Colorado to the Laramie inclusive, and from purely marine to brackish water beds. The well-known fact that recent marine representatives of the genus are not essentially different from those inhabiting the almost fresh waters of estuaries and the mouths of rivers makes it less surprising that in the course of time a species should pass from one of these kinds of habitat to the other without material change.

CORBULA NEMATOPHORA Meek.

Pl. XXVII, Figs. 3 and 4.

Corbula nematophora Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 496; White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 188, Pl. 17, Fig. 7; 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 290, Pl. 3, Figs. 4*a–d*.

Original description:

"Shell of about medium size, ovate-subtrigonal, nearly equivalve and moderately convex, with height equaling two-thirds the length; anterior outline rounded; base semiovate; posterior extremity somewhat produced and subangular or minutely truncated in outline below; dorsal outline sloping from the beaks, the anterior slope being more abrupt and slightly concave in outline above, and the posterior longer and nearly straight, with a greater obliquity; posterior umbonal slopes more or less angular in each valve from the beak to the posterior basal extremity; beaks rather prominent and placed about one-third the length of the valves from the front. Surface ornamented by small, regular, concentric ridges, or strong lines and furrows, both of which are more distinct on the right valve than on the left, where they are sometimes obsolete.

"Length of largest specimen seen, 0.50 inch; height, 0.32 inch; convexity, 0.25 inch."

Prof. Meek noted the close resemblance of this species to certain Laramie forms that are now regarded as belonging to *Corbula subtrigonalis*, and it may be that they are identical. It often happens that very closely related forms of this genus are found at greatly separated horizons, and for this reason, though a great many fossil species have been named, they can seldom be used with any certainty in correlating strata.

Locality and position.—The types came from coal-bearing Cretaceous beds near Cedar City, Utah, apparently equivalent with the lower part of the Coalville section. The species is common beneath the main coal bed at Coalville, Utah, and in the "third ridge" of the same section I have collected specimens that seem to belong to it.

CORBULA KANABENSIS n. sp.

Pl. XXVII, Figs. 5 and 6.

Shell small, ventricose, subequivalve, equilateral, transversely ovate in outline; front end broadly rounded, forming a regular curve from the beak to the base; posterior end abruptly contracted and angular; beaks large, prominent, approximate; posterior umbonal slope subcarinate; basal margin usually thickened, and inflected so as to form a flattened band. Surface bearing fine regular concentric lines.

Length of a medium-sized specimen, 10^{mm}; height, 7^{mm}; convexity of both valves united, 5^{mm}.

Corbula traski, from the Chico group of California as figured by Gabb[1] and by Whiteaves,[2] is very much like this species, and direct comparison of specimens may show that they are identical, but judging from the figures and description *C. traski* is more inequivalve and less regularly convex, and it lacks the angular umbonal slope and the thickening and deflection of the ventral border.

Locality and position.—About 350 feet above the base of the Cretaceous section in Upper Kanab valley, southern Utah.

PHOLADIDÆ.

Genus PARAPHOLAS Conrad.

PARAPHOLAS SPHENOIDEUS White.

Pl. XXVII, Figs. 1 and 2.

Turnus sphenoideus White, 1876, Geol. Uinta Mts., p. 117.
Parapholas sphenoideus White, 1879, Ann. Rept. U. S. Geol. Sur. for 1877, p. 300, Pl. 5, Figs. 1*a–d*.

Revised description:

"Shell elongate, cuneate, inflated in front, narrowed and laterally compressed behind; beaks anterior, incurved, adjacent; dorsal margins

[1] Palæont., California, vol. 1, Pl. 22, Fig. 121.
[2] Mesozoic Foss., vol. 1, Pl. 17, Fig. 3.

of the valves straight and sloping from the beaks to the posterior end, capped or connected by a slender styliform, plain accessory plate; posterior extremity small, truncated, or narrowly rounded; basal margins nearly straight, connected by a ventral accessory plate similar to the dorsal one, except that it is shorter, broadest behind, but coming to a slender point in front about midlength of the shell, longitudinally divided by a linear groove; front regularly rounded, both vertically and laterally; anterior gape consisting of a narrow, vertical slit, which occupies the middle of a somewhat prominent projection at the antero-basal portion of the shell, which projection has the shape of a Norman shield, as seen by front view when both valves are in their natural position, and which seems to have been occupied by a much wider gape in the younger than in the adult condition of the shell; both umbonal grooves distinct, both upon the outer surface and upon that of the stony cast; anterior grooves broader and deeper than the other, but both are slender; besides the two umbonal grooves there is another somewhat broader groove or furrow, extending with a broad, downward curve from the posterior side of the beak to the posterior end of the shell. This groove, like the others, is distinctly traceable upon the outer surface, but is more distinctly seen upon the stony cast.

"A broad, subcircular, cake-like umbonal accessory valve covers the beaks and the space between them, the valve being divided by a suture into two nearly semicircular pieces so neatly that it is hardly perceptible until the valves are slightly displaced. The margins of the principal valves between the beaks and the Norman shield-shaped projection are narrowly but abruptly everted, which, with the beaks above and the borders of the projection below, bound a distinctly hollowed space on each side and below each beak. Besides the grooves before mentioned, the surface is marked by fine concentric, distinctly raised lines on each side of the shell, but they are less distinct upon the snrface of the Norman shield-shaped projection than elsewhere. Between the posterior grooves or furrow before mentioned as ending at the posterior margin of the shell and the dorsal margin, the surface is occupied by strong, irregular scales and laminæ that were successively left as the shell increased in size.

"Length, 13^{mm}; greatest height, 7^{mm}; breadth at front, 6^{mm}."

For extended comments on the generic relationship of this species, see Dr. White's remarks in the second work above referred to.

Comparison of this species with *Parapholas californica*, the type of the genus, leaves little room for doubt that they are congeneric, but it seems to me that it is still an open question whether *Parapholas* is really distinct from *Martesia*.

Locality and position.—Upper Kanab valley, Utah, and near the base of the Coalville section. Specimens from the latter place are mentioned by Meek[1] as "*Martesia* (undetermined sp.)."

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[1]Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 476.

PARAPHOLAS? sp.

A bit of fossil wood collected in the Pugnellus sandstone of Poison canyon, Colorado, contained several short tubes of a boring mollusk that may belong to this genus. The large end of the tube is rounded and it tapers rapidly toward the posterior end. It seems to be a much shorter species than *Parapholas sphenoideus*.

GASTROPODA.

NERITIDÆ.

Genus NERITINA Lamarck.

NERITINA PISUM Meek.

Pl. XXVIII, Figs. 1–3.

Neritina (*Neritella*) *pisum* and *N. pisiformis* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 500.
Neritina pisum White, 1879, idem for 1877, p. 308, Pl. 7, Figs. 11*a–c*.
Neritina pisiformis White, 1880, idem for 1878, p. 26, Pl. 12, Figs. 9*a–c*.

The original description of *Neritina pisum* is as follows:

"Shell globose; spire much depressed; volutions about three, rapidly increasing in size, so that the last or body turn (which is a little depressed above) composes nearly the entire shell; inner lip broad, flattened, and smooth; aperture small and semicircular; surface nearly or quite smooth.

"Height, 0.22 inch; breadth, 0.26 inch."

On the same page the following description of *Neritina pisiformis* is given:

"Shell small, subglobose, or obliquely rhombic, the height being slightly less than the oblique breadth; spire rather prominent for a species of this genus; volutions three to three and a half; convex; last one large, and forming most of the bulk of the shell; aperture subovate, considerably contracted by the flattened, moderately wide inner lip, which is nearly straight on its inner margin, and provided there with four small denticles, the upper one of which is largest. Surface smooth.

"Height, 0.30 inch; greatest oblique breadth, 0.32 inch.

"This little shell agrees so nearly in size and form with the described species (*N. pisum*) that they may be readily confounded, as they are found with the aperture filled with rock. A fortunate fracture of one of the specimens exposed the inner edge of its flattened columnella, however, and thus enabled me to see that it is denticulated, and in this respect differs from *Neritina pisum*, which seems to be entirely without teeth. Further comparisons also show the two shells to differ in form, that under consideration having a more prominent spire and a more globose outline, being less oblique."

On attempting to separate collections from the typical locality into two species as above described, it was soon evident that they could not be separated by form alone because they vary in that respect, showing every gradation between the extremes represented by the types. The type of *N. pisum* was then studied more closely, and the rock was removed from the aperture, revealing the fact that the inner lip is denticulate as in *N. pisiformis*. Consequently the latter name must be regarded as a synonym of *N. pisum*.

Locality and position.—Near the base of the Cretaceous section at Coalville, Utah.

NERITINA INCOMPTA White.

Pl. XXVIII, Figs. 4 and 5.

Neritina incompta White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 308, Pl. 7, Figs. *a–c*.

Original description:

"Shell transversely elongate when adult; spire depressed, abruptly convex, small, but rising perceptibly above the body-volution; volutions three and a half or four, increasing rapidly in size, the last one comprising much the greater part of the shell, regularly convex or with a faint appearance of flattening upon the distal side of the last one; suture moderately distinct; aperture rather large, its outer border regularly rounded, proximal, and distal margins slightly convex and subparallel; outer lip thin-edged, inner lip moderately long, plain, slightly concave upon its face, not very broad, sloping inward. Surface marked by ordinary lines of growth.

"Length, in direction of the axis, 12^{mm}; breadth, across the aperture and body-volution, 17^{mm}.

"This species resembles *N. bannisteri* Meek from the brackish-water layers of the same formation at Coalville, Utah; but it differs in the greater, although slight, elevation of the apex, the nearly straight, instead of curved, border of the inner lip, and its nonpolished surface."

Locality and position.—Valley of Sulphur creek, near Hilliard station, Wyoming, in strata that are now believed to belong to the Colorado formation.

NERITINA (VELATELLA) PATELLIFORMIS Meek.

Pl. XXVIII, Figs. 6–10.

Neritina (*Dostia?*) *patelliformis* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 498.

? *Neritina* (*Velatella*) *carditoides* White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 189, Pl. 18, Fig. 7*a–c*.

Neritina (*Velatella*) *patelliformis* White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 309, Pl. 7, Figs. 7*a–d*.

Neritina (*Velatella*) *patelliformis* var. *weberensis* White, 1879, ibid. Pl. 7, Figs. 8*a* and *b*.

Original description.

"Shell small, thick, oval, or subelliptic; nucleus nearly posterior and generally more or less elevated above the posterior margin, but always lower than the middle portion of the dorsal region in front of it, directed obliquely backward, and in well-preserved specimens minutely subspiral at the immediate, more or less oblique apex; inner lip very broad, or having the form of a thick, smooth, convex septum that extends forward more than half the length of the shell; outer lip thickened, obtuse and smooth within; open part of the aperture small and transversely semicircular. Surface with moderately distinct lines of growth.

"Length of one of the largest specimens found, 0.62 inch; breadth, 0.50 inch; height or convexity, 0.33 inch."

The variety *weberensis* White, which was found in the same layer with the typical form, was described as follows:

"Shell small, depressed, almost regularly elliptical in outline, nearly regularly convex above, and nearly flat or longitudinally slightly concave beneath; beak very small, apparently making about one volution, turned a little to the dextral side of the shell, resting upon the thickened posterior margin, but not projecting beyond it, the posterior margin being slightly reflexed so as to obscure the incurved apex; inner lip broad, smooth, flat, or concave longitudinally, and slightly convex laterally, apparently occupying more than half the under surface of the shell; outer lip moderately thin, smooth, or at least not crenulate. Surface marked by ordinary lines and undulations of growth, and upon the middle portion of the anterior half by five or six narrow, slightly raised, obscure, radiating ribs, with spaces between them a little wider than the ribs. In some cases there are also other obscure radiating lines upon the anterior flanks of the shell.

"Length, 11^{mm}; breadth, 8^{mm}; height, 5^{mm}. Some examples in the collection are larger, but none of them quite equal in size the larger examples of the typical forms of the species.

"This variety, although perhaps connecting the typical forms with *N.* (*V.*) *carditoides* Meek, differs from it in the number and character of its costæ, the proportions of the shell, and its smaller size. At one time I thought, as did also Mr. Meek, that this variety might prove to be specifically distinct from the typical forms of *N.* (*V.*) *patelliformis*, but study of collections since made at the typical locality shows that intermediate forms exist, associated with this variety and the typical forms in the same layer."

It should be added that the inner lip of this species is slightly denticulate on the margin.

The name *Velatella* was proposed by Meek as a subgenus of *Neritina* to include this and a few other Cretaceous species. It was adopted by White, who gave a diagnosis of it in the Ann. Rept. U. S. Geol. Sur. of the Territories for 1878, p. 27. It seems to me to be scarcely distinct from *Dostia*, from which it differs "in its more nearly perfect bilateral symmetry and its minute apex."

Locality and position.—Abundant in certain layers near the base of the Cretaceous section at Coalville, Utah, and in equivalent beds at Bear River city, Wyoming. *Neritina carditoides*, which is a closely related but probably distinct species, occurs at a much higher horizon in the "third ridge" of the same section.

TURRITELLIDÆ.

Genus TURRITELLA Lamarck.

TURRITELLA WHITEI n. sp.

Pl. XXVIII, Figs. 12–16.

Turritella uvasana White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 195, Pl. 18, Figs. 11*a* and *b*.
Not *Turritella uvasana* Conrad, 1856, Pacific Railroad Repts. vol. V., p. 321.

This species was first obtained from Cretaceous strata southeast of Paria, Utah, and was doubtfully referred to *Turritella uvasana*, a species of the Tejon formation of California.

Dr. White describes the Utah specimens as follows:

"Shell of ordinary size, elongate, slender; sides straight; volutions numerous, apparently reaching eighteen or twenty when full-grown; the sides of the volutions nearly straight or only slightly convex; suture broad, deeply impressed.

"Surface marked by numerous revolving raised lines, six or eight of which are moderately large, the smaller ones alternating with them. The larger lines are minutely nodose upon the larger volutions, and upon the last one they are even subspinulose.

"All the specimens of this species in the collection are more or less broken, but judging from the apical angle indicated by their sides, the largest must have been about 5½ centimeters long, and its last whorl about 13 millimeters in diameter."

Since the above description was published, Mr. C. D. Walcott has collected a number of good specimens at Upper Kanab, Utah, and the writer has more recently obtained a great many from the Pugnellus sandstone of Huerfano park, Colorado. The study of this additional and better material has proved that it differs from Conrad's species in several particulars. The revolving lines of *Turritella uvasana* are not nodose, the apical angle is less than in our species, and the whorls are broader, so that there is a less number of volutions in a given length of specimens of the same size, and it is probable that the total number of volutions is less in the California species. Some young specimens of *T. whitei* (or tips of old ones) from Upper Kanab have about twenty volutions in a length of a little over half an inch, and the diameter of the last whorl is only 3 millimeters, or about the same as the upper end of the specimen represented by Fig. 12 on Pl. XXVIII. An individual of that size would, therefore, have about thirty volutions when complete.

These differences are sufficient basis for the separation of the two forms, and the additional fact that one of them occurs near the base of the Upper Cretaceous, while the other is found at the very top of the Cretaceous—or in the Eocene—makes their separation still more reasonable.

It should be stated that the specimens from Colorado do not quite agree in ornamentation with those from Utah. The revolving lines are somewhat broader and fewer in number, usually not more than five or six prominent ones, and the intermediate fine thread-like lines are often obsolete. Perhaps such differences are of specific importance, but it seems to me more probable that they are only local variations of one species. If it should ever be found desirable to separate them the Utah form must be regarded as the type of *Turritella whitei.*

At a locality about 12 miles east of Walsenburg a number of specimens of the Colorado variety were found in a peculiar state of preservation that gives them a very different aspect. The shell is entirely replaced by calcite and the surface is eroded until there is hardly a trace of the natural ornamentation remaining. The planing down of the rounded whorls has left irregular zigzag lines that are, in some cases at least, coincident with the angles of the calcite crystals. One of these is figured.

Locality and position.—About 350 feet above the base of the Cretaceous section in Upper Kanab valley, Utah; in the Pugnellus sandstone of Huerfano park, Colorado, and at about the same or a little lower horizon in the Benton shales on the Arkansas river above Pueblo, at Rattlesnake butte, and other places in southern Colorado.

TURRITELLA MICRONEMA Meek.

Pl. XXIX, Fig. 3.

Turritella (Aclis?) micronema Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 504; White, 1879, idem for 1877, p. 316, Pl. 9, Fig. 8*a*.

Original description:

"Shell small, terete or elongate-conical; volutions about nine, nearly flat, sometimes moderately convex, increasing gradually in size, last one rounded or obscurely subangular in the middle; suture linear to moderately distinct; aperture rhombic-ovate, angular above. Surface ornamented by fine, regular, rather crowded revolving lines, six or eight of which may be counted on each volution of the spire.

"Length of the largest specimen seen, 0.50 inch; breadth, 0.18 inch; angle of spire, about 19°, with slightly convex slopes. [Specimens since found at the original locality, and in the same layers, indicate a size nearly twice as great as this.]

"This may not be a *Turritella*, the specimen not being in a condition to show the texture of the shell or to give a clear idea of its aperture and lip. It would be a rather small species for that genus, and if it possessed the delicacy of surface seen in those genera, it might perhaps with more propriety be referred to *Aclis* or *Menestho*. The fractured lip in some of the specimens has somewhat the appearance of a slight angularity or very small notch at the base of the aperture, but this may be due to the manner in which it is broken; if not, it would seem to present affinities with the genus *Mesalia*. It will be readily distinguished from the species I described under the name *T. spironema* by its less attenuated form and finer and less distinct revolving lines. It is also not nearly so attenuated toward the upper part of the spire as that species.

"*Locality and position.*—Coalville, Utah, from the Cretaceous below the heavy bed of coal mined at that place."

Genus GLAUCONIA Giebel.

GLAUCONIA COALVILLENSIS Meek (sp.).

Pl. XXVIII, Fig. 11; Pl. XXIX, Figs. 1 and 2.

Turritella coalvillensis Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 502; White, 1879, idem for 1877, p. 315, Pl. 9, Fig. 4*a*.

Cassiope whitfieldi White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 196, Pl. 18, Fig. 1*a*.

Original description of *Cassiope whitfieldi:*

"Shell moderately large, elongate-conical, umbilicate; volutions apparently about twelve, prominent and prominently angular below the middle of the visible portion, slightly concave from the prominent revolving angle to the suture below, also very slightly and somewhat irregularly concave from that angle to the suture above. A little below the suture there is a rather small, shallow furrow, with its borders above and below raised into more or less distinct revolving ridges. Upon the under side of the last volution, which is rather strongly convex, there are three small revolving ridges, one of them bounding the umbilicus; the other two are placed near each other above the middle of the space, and are continuous to the apex of the shell. It is between the two last-named ridges that the hinder edge of each succeeding volution joins the preceding one. Umbilicus moderately large and deep; aperture subovate in outline; outer lip sinuate, having a broad, shallow notch above its middle, projecting somewhat anteriorly, and rounded abruptly into the umbilicus.

"Surface marked by more or less strong undulating lines of growth apparently without small revolving lines.

"Diameter of the last volution of our largest example, nearly 4½ centimeters; the full height of the same, when entire, must have been not far from 11 centimeters."

Turritella coalvillensis was originally described from fragments that are more or less eroded and do not show the umbilicus. When better preserved specimens were obtained from southern Utah they were described as a new species and referred to *Cassiope*, which according to the manuals of Zittell and Fischer is a synonym of *Glauconia*.

In the more recent collections from Coalville there are several examples that unquestionably belong to Meek's species and yet they possess the umbilicus and other characteristic features of *Cassiope whitfieldi*.

The surface ornamentation varies considerably in different individuals. In some examples each whorl of the spire bears five well marked revolving ridges, two of which are adjoining the suture above and below, respectively, while the other three are close together in the middle of the whorl and the lowest of them is the largest, giving to the whorl its angular appearance. In other specimens, especially very large ones, one or both of the ridges immediately above the angle is obsolete.

Turritella martinezensis Gabb, from the Cretaceous of California, resembles this species quite closely both in form and ornamention, but it is not umbilicate.

Locality and position.—Near the base of the Cretaceous section at Coalville, Utah, and at various localities in southern Utah.

XENOPHORIDÆ.

Genus XENOPHORA Fischer von Waldheim.

Xenophora simpsoni n. sp.

Pl. xxix, Figs. 4–6.

Shell small, trochiform, consisting of four or five volutions; spire moderately elevated with straight sides; periphery of last volution narrow, angular and somewhat produced; base nearly flat, with a rather small but distinct umbilicus. The aperture is very oblique, irregularly oval in outline, and with the inner lip slightly thickened. Surface of the spire marked by numerous faint, irregular pits and depressions that seem to have been caused by the adhesion of small pebbles and bits of shell in the manner that is characteristic of this genus. These irregularities of the surface are shown on internal casts almost as distinctly as on the shell itself. The surface also shows lines of growth that are especially prominent and strongly curved on the base of the shell.

Height of one of the largest specimens, 10^{mm}; greatest breadth, 16^{mm}.

There is no other described species in the American Cretaceous with which this need be compared, though comparisons with recent species show that it certainly belongs to *Xenophora*. There are 21 specimens in the collection, all more or less imperfect, but taken together they show all the characters of the species.

The name is given in honor of Mr. Charles T. Simpson, of the U. S. National Museum.

Locality and position.—In the Pugnellus sandstone near Malachite post-office, and in Poison canyon, Huerfano park, Colorado; at the same or a somewhat lower horizon on the Arkansas river, 20 miles above Pueblo, Colorado.

NATICIDÆ.

Genus LUNATIA Gray.

LUNATIA CONCINNA Hall & Meek (sp.).

Pl. XXIX, Figs. 9 and 10.

Natica concinna Hall & Meek, 1856, Mem. Am. Acad. Arts and Sci., n. s. vol. V, p. 384, Pl. 3, Figs. 2*a–d*.

Natica moreauensis Meek & Hayden, 1856, Proc. Acad. Nat. Sci., Phila., p. 64.

Lunatia concinna Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p, 314, Pl. 32, Figs. 1*a–c*; Whitfield, 1880, Geol. Bl. Hills of Dak., p. 430, Pl. 12, Fig. 13.

Compare *Natica obliquata* Hall & Meek, 1856, op. cit., p. 384, Pl. 3, Figs. 1 *a* and *b*; and *N. rectilabrum* Conrad, Jour. Acad. Nat. Sci., Phila., 2d ser., vol. IV, p. 344, Pl. 58, Fig. 28.

Prof. Meek's revised description is as follows:

"Shell obliquely rhombic-subovate, or subglobose; spire moderate; volutions three and a half to four, convex, and separated by a deep suture, last one comparatively large; surface marked by fine, rather obscure, lines of growth, crossed by nearly obsolete, minutely flexuous, revolving striæ, only seen on well-preserved specimens; aperture subovate, being straighter on the inner than the outer side; umbilicus, small and sometimes showing a slight tendency to develop a small revolving ridge within; inner lip a little thickened and slightly reflected upon the body volution above the umbilicus.

"Length of a mature rather gibbous specimen, 0.90 inch; breadth of same, 0.76 inch.

"This shell varies somewhat in form, some individuals being proportinally a little shorter, and having the body volution more ventricose than others. For a long time it was believed to be distinct from *N. concinna*, and consequently the name *N. moreauensis* was proposed for it. Since seeing a good series of specimens, however, showing the form and general appearance of the shell at various stages of growth, I am led to believe that it is not specifically distinct from the type of *N. concinna*, which is now believed to be a young individual. At any rate, small specimens before me of the same size seem to agree almost exactly with the type of *N. concinna*, while I am at a loss to separate these specifically from the larger individuals, such as those for which the name *N. moreauensis* was proposed."

The author then proceeds to compare this with the closely related species *Natica obliquata* and *N. rectilabrum*. According to Mr. Gabb all the names given above, and *N. acutispira* Shumard, are synonyms of *Lunatia obliquata*. This conclusion is quite probable, but I am unable to confirm it with the material at hand.

The collections from Upper Kanab valley, Utah, contain 9 specimens, two of which are figured, that are not distinguishable from rather small examples of this species. The inner lip is perhaps slightly straighter, the callous deposit smaller and the outer lip is somewhat less oblique, but in form and surface markings they agree almost exactly. The principal fact that causes me to hesitate to assign them to the described species is that they come from a lower horizon and nearly all of their associates are different. The types and all the specimens hitherto reported, with one exception, came from the upper portions of the Montana formation, and from its equivalents in the southernstates. In the Geology of the Black Hills of Dakota, Mr. Whitfield states that one cast not distinguishable from this species came from a much lower horizon, probably the Benton shales.

Locality and position.—About 350 feet above the base of the Cretaceous section in Upper Kanab valley, Utah.

Genus GYRODES Conrad.

GYRODES DEPRESSA Meek.

Pl. XXIX, Figs. 11–14.

Gyrodes depressa Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV., Pt. 1, p. 159, Pl. 15, Figs. 1 and 1 *a*.

Shell depressed subglobose, consisting of three or four rapidly increasing whorls, the last of which is very large; spire varying from depressed to moderately elevated and prominent; whorls in some examples distinctly truncate above, in others only slightly flattened or simply rounded to the distinct, impressed suture, subangular or very narrowly rounded below around the borders of the umbilicus, which is broad and deep, but narrows rapidly within. Aperture ear-shaped, subangular above and broadly rounded below, oblique to the axis of the shell; outer lip forming an irregular curve; inner lip nearly straight and with the upper half reflexed and somewhat thickened. Surface marked by strong lines of growth.

Height of an average specimen, about 22^{mm}; the greatest breadth, 32^{mm}. In some of the more elevated examples the height and breadth are nearly equal.

This description is drawn from a large suite of well-preserved specimens obtained in Huerfano park, Colorado, that have been compared with the types and with other examples from the typical locality. The types are sandstone casts, more or less distorted by pressure, so that the spire is unnaturally low. In the original description the suture is said to be "channeled in such a manner as to be flattened within, owing to the presence of a revolving furrow just above it," but this feature is accidental, the flattened channel simply representing the thickness of the shell between the whorls. I have no doubt that the Colorado shells belong to Meek's species, especially since many of the associated forms are identical in the two regions.

The extreme forms represented by Figs. 11 and 14 seem sufficiently different to be regarded as distinct species, but there are many intermediate forms and every character by which they might be separated is variable, consequently I shall include them all under the one name for the present. The most nearly related species with which I am acquainted is *Gyrodes petrosa* Morton (sp.), from the Ripley formation of the Atlantic and Gulf border regions.

Locality and position.—In the lower portion of the Cretaceous section at Coalville, Utah, ranging upward to the top of the "second ridge;" abundant in the Pugnellus sandstone at many localities in Huerfano park, Colorado.

GYRODES CONRADI Meek.

Pl. XXIX, Figs. 7 and 8.

Gyrodes conradi Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 310, Figs. 33–36 in text.

Original description:

"Shell obliquely depressed-subglobose, the height being about seven-eighths the breadth; volutions four to five, increasing rapidly in size, the last one forming about nine-tenths of the entire bulk, rounded on the outer side, somewhat produced and acutely carinated around the middle below, and, like those of the spire, with the truncation of the upper edge moderately broad and a little concave; spire much depressed; umbilicus very broad and somewhat funnel-shaped, with its marginal angle prominent, acute, and regularly and rather distinctly crenate, while some distance within there is a second less prominent, linear, revolving ridge; aperture sub-rhombic and about twice as high as wide, distinctly angular at the termination of the revolving carina of the under side of the body-volution below, and obtusely angular above; outer lip very oblique, being produced above, and thence nearly straight, and extending obliquely backward and downward to the basal angle, where it connects with the lower extremity of the thin inner lip by a small, sharp sinus, or emargination; surface nearly smooth, or having obscure lines of growth, that become stronger and show a tendency to gather into little wrinkles on the upper truncated part of the volutions, while on well-preserved specimens the faintest possible traces of fine revolving striæ may be seen by the aid of a magnifier.

"Height, 0.91 inch; breadth, about 1.10 inches; height of aperture, 0.86 inch; breadth of same, 0.43 inch."

Some larger specimens from Huerfano park, Colorado, are proportionally somewhat more elevated and have a narrower umbilicus than the type, with which they agree in all other respects.

This species is very closely related to *Gyrodes pansus* Stoliczka, from the Cretaceous of southern India, and it may also be compared with *G. crenata* Conrad, from the Ripley formation.

Locality and position.—The type was found on Cheyenne river, South Dakota, in strata supposed to belong to the Fort Benton shales. The additional examples above mentioned came from the Pugnellus sandstone on Williams creek and Poison canyon, Huerfano park, Colorado.

Genus AMAUROPSIS Mörch.

AMAUROPSIS BULBIFORMIS Sowerby (sp.).

Pl. XXX, Figs. 2–4.

Natica bulbiformis Sowerby, 1832, Trans. Geol. Soc. Lond., 2d ser., vol. III, p. 418, Pl. 38, Fig. 13; d'Orb., Pal., Franç., Terr. Crét., Gastéropodes, p. 162, Pl. 174, Fig. 3; Goldfuss, Petrefacta Germ., p. 112, Pl. 199, Figs. 16 and 17; Zekeli, Die Gastropoden der Gosaugebilde, p. 45, Pl. 8, Fig. 2.

Ampullina bulbiformis Stoliczka, Sitzungsber. k. Akad. d. Wissenschaften, Wien, Bd. 52, p. 146; Pal. Indica, Cretaceous Fauna of Southern India, vol. II, p. 300, Pl. 21, Figs. 11–15.

Compare *Amauropsis alveata* (Con.) Gabb, Pal. California, vol. I, p. 110, Pl. 19, Fig. 59.

Shell large, elongate-ovate, not umbilicate, consisting of seven or eight rapidly increasing, moderately convex, shouldered whorls; spire elevated and prominent, the apical angle varying from about 50° to 65°; sutures deeply channeled; aperture elongate-ovate, contracted behind where it is separated from the body of the shell by the channeling of the suture, somewhat produced and subangular in front; outer lip thin and sharp; inner lip nearly straight, moderately thick, anteriorly flattened, and reflected so as to form a sharp projecting ridge. Surface marked by lines of growth and by numerous revolving lines of minute punctations that are always visible on well preserved specimens, and on a few examples are situated in well-defined revolving furrows, giving the shell in these rare cases a distinctly striate appearance.

Length of an average specimen, 77^{mm}; breadth, 47^{mm}. The length of the largest specimen in the collection is 92^{mm}.

I have seen no good European examples of this species with which to make direct comparisons, but, judging from the published figures and the comments of the authors who have described it, it is quite variable in form, several of the published figures differing more from Sowerby's original drawing than our specimens do. In those in which the aperture is represented as complete it is more broadly and regularly rounded than in the shells before me. This and other very slight differences that might be pointed out do not seem to me sufficient basis for proposing a new name. The species is already known to have had a wide geographic range in Cretaceous time, as it occurs in the Turonian of France, in the Gosau beds of Austria, and in the Cretaceous of southern India, where it is said to range through the entire Cretaceous series developed there. I suspect that some of the California fossils referred by Gabb to *Amauropsis alveata* really belong to this species, although he states that they are umbilicated.

I follow Zittel in referring this species to *Amauropsis*.

Locality and position.—Common in the Pugnellus sandstone at several localities in Huerfano park; rare in the upper part of the Benton shales on the Arkansas river above Pueblo, Colorado.

AMAUROPSIS? UTAHENSIS White (sp.).

Pl. xxx, Fig. 1.

Lunatia utahensis White, 1876, Geol. Uinta Mts., p. 122.
Euspira coalvillensis White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 310, Pl. 4, Figs. 2*a* and *b*.

Revised description:

"Shell subglobose; spire small, conical, acute, but not much extended; volutions about eight when the apex is entire, last one inflated, and, when adult, extended a little in front, and also posteriorly, near the border of the aperture; aperture obliquely ovate-semilunar, somewhat abruptly rounded anteriorly; callus of the inner lip apparently not much thickened, but thicker anteriorly than posteriorly; columnella rimate or almost solid, and nearly covered by the callus of the inner lip, which seems not to be so closely appressed against it as it is against the body-volution farther back. Surface marked by the ordinary lines of growth. The figures on plate 4 are restorations of this species, all the numerous examples in the collections being crushed except one or two sandstone casts. The examples being somewhat numerous, afford a view of all the features shown by the figures.

"Length, from the apex to the anterior end of the aperture, about 4^{cm}; breadth, across the aperture and body-volution, about $3\frac{1}{2}^{cm}$."

The material on which this species was based is very imperfect and unsatisfactory, though it seems to justify the restoration given in the figure. In the National Museum collection there is one specimen, from another locality, of the same general form, that has a broad, open, *Gyrodes*-like umbilicus, but it seems hardly possible that it can belong to this species, or even to the same subgenus.

In the second publication of the species the specific name was inadvertently changed from *utahensis* to *coalvillensis* and the original name was restored by the same author.[1]

According to Zittel[2] *Euspira* can not be retained even as a subgeneric name, and forms without an umbilicus resembling this and the species described above are by him referred to *Amauropsis*, though it seems to me that the species now under consideration might be referred with equal propriety to *Ampullina* or to *Cernina*.

Locality and position.—Near the base of the Cretaceous section at Coalville, Utah.

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[1] Ann. Rept. U. S. Geol. Sur. Ter. for 1878, p. 29.

[2] Handbuch der Palæontologie, II, p. 221.

Genus SIGARETUS Lamarck.

SIGARETUS (EUNATICINA?) TEXTILIS n. sp.

Pl. XXX, Figs. 5 and 6.

Shell thin, broadly ovate, consisting of three or three and a half rapidly increasing volutions, the last one forming the greater part of the entire bulk; suture linear, impressed; aperture large, rhombic ovate, narrow and produced behind, broad and sinuous in front, the greatest breadth being in front of the middle; outer lip thin and sharp, irregularly convex in outline; inner lip somewhat thickened and reflected, almost covering the narrow umbilical chink; columella arched. The inner lip is also concave in the middle, so that it and the narrow umbilicus are concealed when the aperture is filled with rock.

Surface marked by distinct revolving filiform lines that are not quite a millimeter apart on the body whorl, and by crowded, wavy transverse lines that are just visible to the unaided eye. On several of the specimens the revolving sculpture is very faint on an area of 2 or 3^{mm} wide bordering the outer lip, and the lines of growth are there more distinct.

Length of the largest type, 15^{mm}; breadth, 12^{mm}.

The generic relations of this species are rather obscure, and the specimens in hand are not very well preserved. Mr. Charles T. Simpson, of the department of mollusks, U. S. National Museum, through whose courtesy I was enabled to make comparisons with recent species, decides that it is most nearly related to *Sigaretus* and to the subgenus *Eunaticina* of Fischer (=*Naticina* Gray).

Naticina obliqua Gabb, from the Tejon formation of California, is the only other American species that has been referred to the Cretaceous, and it is plainly different from ours.

Locality and position.—Upper Kanab valley, Utah, about 300 feet above the base of the Cretaceous section.

RISSOIDÆ.

Genus MESOSTOMA Deshayes.

MESOSTOMA OCCIDENTALIS n. sp.

Pl. XXX, Figs. 7 and 8.

Shell scalariform, with about eight or nine convex whorls; sutures deeply impressed. Surface marked by numerous moderately strong transverse costæ, that pass entirely across the whorl and are about as broad as the interspaces, and by more closely arranged, fine, revolving lines. On each of the larger whorls there are about twenty of the transverse costæ and about twelve or fifteen revolving lines.

The aperture is obliquely ovate in outline, slightly narrowed behind and a little produced or sub-canaliculate in front. Outer lip thin and sharp; inner lip somewhat reflexed and thickened below; peritreme not continuous, columnella somewhat arcuate.

Length of one of the types with the apex restored, about 13^{mm}; greatest diameter, about 5^{mm}. Some fragments of the same species evidently belong to shells with about double these dimensions.

With the imperfect material with which the paleontologist must usually deal, it is very difficult to assign such forms as this to the genus to which it belongs. Its general form and the character of the ornamentation are duplicated in *Cerithium*, *Scalaria*, and *Rissoa*, or at least in species that have been referred to those genera. The fact that in our species the peritreme is not continuous prevents its reference to either *Scalaria* or *Rissoa*. It seems to be very nearly related to some of the Cretaceous species of *Mesostoma* figured by Holzapfel,[1] and I have therefore placed it provisionally in that genus rather than in *Cerithium*. No described species from the American Cretaceous known to me is nearly related to this one, though *Cerithium lallierianum* var. *suciense* Whiteaves, seems to belong to the same general type.

Locality and position.—In the Pugnellus sandstone, at several localities in Huerfano park, and in the upper part of the Benton shales on the Arkansas river above Pueblo, Colorado.

PYRAMIDELLIDÆ.

Genus EULIMELLA Forbes.

EULIMELLA? FUNICULA Meek.

Pl. XXX, Fig. 9.

Eulima funicula Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 506.
Eulimella? funicula White, 1876, U. S. Geog. and Geol. Sur., West 100th Meridian, Vol. IV, p. 197, Pl. 18, Fig. 6; 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 316, Pl. 9, Fig. 10*a*.

Original description:

"Shell subterete or elongate-conical; spire regularly tapering from the middle of the body volution to the apex, or with very slightly convex slopes; volutions about twelve, flattened; last turn not much enlarged, subangular around the middle; suture merely linear; aperture ovate or rhombic-subovate; inner lip slightly thickened and reflected. Surface smooth.

"Length, 0.65 inch; breadth, 0.20 inch; divergence of slopes of spire about 19°.

"This shell has much the appearance of a slender *Nisso*, but it certainly wants the umbilicus seen in that genus, its axis not being in the slightest degree perforated. It is even like some recent species of *Euli-*

[1] Die Mollusken der Aachener Kreide, Palæontographica, Bd. 34, p. 129 et seq.

mella, and may possibly have to take the name *Eulimella funicula*, when its generic characters can be more clearly determined from the examination of good specimens. The best examples I have seen do not show the extreme apex of the spire, or very clearly the form of the aperture. So far as can be determined, however, its columnella does not seem to present the straightness seen in *Eulimella*. I know of no closely allied Cretaceous species.

"*Locality and position.*—Cretaceous at Coalville, Utah."

Some specimens from the north fork of Virgin river were described by Dr. C. A. White, who afterward added the following note on the species:

"The examples described and illustrated by me (loc. cit.) were published before I had seen either Mr. Meek's types or his drawings, having access only to his published descriptions. Subsequently comparison raises a doubt as to their specific identity, but they are evidently congeneric. My examples were more robust than Mr. Meek's, with a wider apical angle. It is possible that neither of these forms should be referred to *Eulimella*, but they certainly agree more nearly with the characteristics of that genus than with any other, so far as they are yet known."

Genus CHEMNITZIA d'Orbigny.

CHEMNITZIA? COALVILLENSIS Meek.

Pl. XXX, Figs. 10 and 11.

Turbonilla (*Chemnitzia?*) *coalvillensis* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 505; White, 1879, idem for 1877, p. 305, Pl. 9, Figs. 5*a* and *b*.

Original description:

"Shell elongate-conical; volutions ten or eleven, moderately convex; last one not much produced below, rounded, or sometimes obscurely subangular around the middle; suture well defined; aperture rhombic-suboval, being angular above and apparently a little so below; inner lip slightly thickened, rather deeply arched, a little reflected, and closely appressed below; outer lip thin. Surface ornamented by rather strong, simple, regular, nearly or quite straight vertical ridges, crossed by regularly disposed revolving lines (about ten or eleven of the ridges and five or six of the revolving lines being seen on each volution of the spire), while only the revolving lines are continued below the middle of the body volution.

"Length of a large specimen, 1 inch; breadth, 0.40 inch; angle of spire, from 20° to 25°.

"None of the specimens of this species yet seen are quite perfectly preserved at the base of the aperture. Some of them look as if there had been a slight angularity there, while others, differing in no other respect, present appearances that leave room for doubt on this point. In some of its characters this shell reminds one of the fresh-water *Go-*

niobasis, to which I was at one time much inclined to refer it, and I am hardly quite sure yet that it may not have to take the name *Goniobasis coalvillensis*. Many authors refer very similar shells to *Chemnitzia*, but it has not so large and produced a body volution and aperture as the forms to which Mr. Conrad and Dr. Stoliczka propose to apply that name. If found in any of the Paleozoic rocks, most geologists would refer it to *Loxonema* of Phillips. Whether or not the nucleus or apex of its spire was covered as in the typical species of *Turbonilla*, I have been unable to determine. It is a far larger shell, however, than the species upon which that genus was founded.

"Specifically, this shell seems to be related to *Turbonilla spillmani* Conrad (Jour. Acad. Nat. Sci., vol. IV, new series, Pl. 46, Fig. 28), but its vertical folds or costæ are straighter, less crowded, and less numerous, while its revolving lines are smaller and more numerous. Its aperture also certainly differs in being decidedly more angular above, and probably somewhat so below. It may likewise be compared with *Scalaria mathewsonii* Gabb, from Cretaceous rocks of California, from which it differs in having less convex volutions, or less rounded aperture, less crowded vertical ridges, and more distinct and coarse revolving lines.

"*Locality and position.*—Coalville, Utah; from below the lowest heavy bed of coal at that locality. Cretaceous."

The figures of this species hitherto published do not give a correct idea of it, because the specimen drawn had lost nearly all of the shell and consequently the transverse costæ are less prominent and more broadly rounded than they should be. The examples figured on Pl. XXX are from the typical locality and certainly belong to Meek's species. They show the character of the ornamentation and the extremes of variation in form, but they do not give any additional information concerning the generic relationship of the shell.

Some fragmentary specimens that apparently belong to the same species were collected from shales in the "third ridge" of the Coalville section, about 1,500 feet above the bed in which the types were found.

CHEMNITZIA? sp.

Turbonilla (*Chemnitzia*) *melanopsis* (Con.?) White, 1876, U. S. Geog. and Geol. Sur. West 100th Merid., vol. IV, p. 197, Pl. 18, Fig. 10*a*.

Not *Turbonilla* (*Chemnitzia*) *melanopsis* Conrad, 1860, Jour. Acad. Nat. Sci., Phila., 2nd ser. vol. IV, p. 287, Pl. 46, Fig. 35.

The fragments figured by Dr. White and doubtfully referred to Conrad's species came from southern Utah. Other similar specimens have since been obtained from the coal-bearing series near the base of the upper Cretaceous in the same region, where it is associated with *Glauconia coalvillensis*, *Barbatia micronema*, and *Corbula nematophora*. They are too imperfect for specific description, but they are certainly distinct from *Turbonilla melanopsis*. The form is apparently rather short and robust, and it is marked by strong transverse costæ. It resembles the *Goniobasis cleburni* White of the Bear River formation, excepting that it is not quite so slender.

APORRHAIDÆ.

Genus APORRHAIS Dillwyn.

APORRHAIS (GONIOCHEILA) CASTORENSIS Whitfield.

Pl. XXXI, Fig. 1.

Aporrhais (Goniocheila) castorensis Whitfield, 1877, Prelim. Rept. Paleont. Black Hills, p. 38; 1880, Geol. Black Hills of Dakota, p. 427, Pl. 12, Fig. 1.

Original description:

"Shell small, with a moderately elevated spire, composed of about four flattened or very slightly ventricose volutions, which are crossed by fine, flexuous, vertical folds, strongly directed forward in their course across the whorl, and also marked by fine, thread-like, revolving lines; suture distinct; apical angle about 40°, but slightly variable on different individuals. Body volution proportionately large and very strongly angular, or even carinate, along the middle, flattened or slightly concave on the upper surface, and rapidly contracted below to the short, pointed, rostral beak. A second rather indistinct carination marks the surface a little below the first, but seldom or never extends to the margin of the lip. Outer lip expanded, strongly carinate on the back, and projecting in the middle to form a short, obtuse, slightly recurved digitation, and posteriorly extending along the spire to the base of the second volution above.

"This species somewhat resembles *A. biangulata* M. & H.,[1] but differs in the subdued character of the lower carination and in the strongly uniangular form of the body volution. Among a number of specimens none show the posterior canal extending above the point described, nor any evidence of a second digitation to the lip. The surface markings are quite superficial, but few specimens showing them, appearing quite smooth from slight exfoliation.

"We are extremely adverse to describing new species of this group of shells, as from their extreme liability to variation with different degrees of development they are easily mistaken, and we have feared that this might prove, on the examination of a larger and better collection of specimens, to be only a form of *A. biangulata* M. and H., above referred to, but the single strong carination and the fact that it comes from a lower geological horizon and distant locality have induced us to separate it under a new name.

"*Formation and locality.*—In the ferruginous sandy limestone on the east fork of Beaver creek, Black hills. Associated with fossils of the Fort Benton group."

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[1] Paleontology of the United States Geological Survey of the Territories, p. 322, Pl. 19, Fig. 6.

APORRHAIS (PERISSOPTERA?) PROLABIATA White (sp.)

Pl. XXXI, Fig. 2.

Anchura prolabiata White, 1876, Geol. Uinta Mts., p. 121.
Anchura (*Drepanocheilus*) *prolabiata* White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 313, Pl. 7, Fig. 2*a*.
Compare *Anchura? fusiformis* White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 190, Pl. 18, Fig. 4*a*.

The following is Dr. White's description, with a few changes and corrections made necessary by the better material now before me:

Shell rather above medium size, subfusiform, spire elongated and tapering to a point, with nearly straight sides; volutions nine or ten, convex, the last one proportionally a little more enlarged than the others, the distal margin of each narrowly appressed against the proximal side of the next preceding one at the suture; wing large, broad, its outer border, nearly straight or slightly convex, its anterior extremity abruptly rounded to the broadly concave front margin; posteriorly the wing is divided by a deep rounded sinus into two portions, the posterior of which is narrow and directed backward and a little outward in a slender pointed process, while the anterior portion is larger and subquadrate, with the outer angles slightly produced. Anterior canal and beak short; no posterior canal, though the outer lip is slightly produced backward and attached to the penultimate volution; inner lip and adjacent parts of the shell glazed, but without a distinctly marked callus.

Transverse costæ slightly curved, scarcely half as wide as the interspaces, usually well marked on the whole spire, and gradually increasing in prominence on each succeeding whorl until on the back of the body volution they become narrow elevated ridges that extend from the suture to about the middle of the whorl, but on a few specimens, such as the original type, the transverse ornamentation is less prominent throughout and almost obsolete on the body whorl, and it is always more or less indistinct for some distance around the inner lip. In addition to these regular costæ the spire sometimes bears a number of heavy varices that are not quite parallel with them. The entire surface is covered with crowded revolving raised lines that are barely visible without the aid of a lens. There is no carina on the body volution, but the posterior process of the wing is subcarinate, especially toward the extremity.

Length of the largest specimen, 47^{mm}; breadth, across the wing and body volution, 34^{mm}; diameter of the body volution, 18^{mm}.

No closely related species has been described from the American Cretaceous, though *Rostellaria rostrata* Morton, a Ripley species, should probably be referred to the same section. In the Cretaceous of Europe there are many similar forms, such as *Aporrhais parkinsoni*, *A. reussi*, *A. schlotheimi*, etc., ranging from the Gault to the lower Senonian, inclusive.

Some of the shells described by Dr. C. A. White as *Anchura? fusiformis* Meek, are certainly young individuals of *Anchura prolabiata*, but the figured specimen may represent a distinct species. The form of the wing seems to be different from that of *A. prolabiata* at any stage of its growth, but as none of the surface features are preserved it is impossible to determine its true relations. Prof. Meek stated that it does not belong to his species.[1] These specimens came from several localities in New Mexico and their associates at some of them at least belong to the Colorado formation. This species, together with the European species above mentioned, forms a natural group that differs considerably from typical species of *Anchura* in general aspect, and especially in the form of the wing. The subgenus (of *Aporrhais*) *Perissoptera* proposed by Mr. Tate[2] in 1865 was evidently intended to include this group. Unfortunately I have been unable to obtain the original paper, in which the subgenus was described, and consequently I do not know what species was taken as the type. According to Mr. Gardner[3] it is equivalent to his section I of *Aporrhais*, and includes *A. parkinsoni* and related forms, and also the recent *A. occidentalis*. The latter species, which was the type of Gabb's subgenus *Arrhoges*, has many features in common with the Cretaceous forms, the principal difference being that it has a distinct thickened inner lip, but whether it is placed in the same section with the fossil forms or not I think that Tate's name should probably be applied to the latter, as he was writing on "the so-called Rostellariæ of the Cretaceous." More recently these forms have been referred to *Lispodesthes*, which I regard as an entirely distinct genus.[4]

Locality and position.—Sink spring and Upper Kanab valley, Utah, occurring about 350 feet above the base of the Cretaceous section at the latter locality.

Genus ANCHURA Conrad.

ANCHURA (DREPANOCHEILUS) RUIDA White.

Pl. XXXI, Figs. 3 and 4.

Anchura ruida White, 1876, Geol. Uinta Mts., p. 120.

Anchura (*Drepanocheilus*) *ruida* White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 312, Pl. 7, Figs. 4*a* and *b*.

Revised description:

"Shell rather small; spire moderatelv elongate; volutions about seven, convex; suture impressed; wing moderately large, contorted, bearing at its extero-posterior corner a strong falciform process, the direction of which is nearly parallel with the axis of the shell; the outer

[1] U. S. Geol. Expl. 40th Parallel, vol. IV, p. 161.

[2] Quoted by Gabb: Am. Jour. Conch., vol. IV, 1868, p. 148.

[3] Gardner, J. Starkie, on Cretaceous Aporrhaidæ: Geological Magazine, Dec. II, vol. II, 1875, p. 394.

[4] See p. 146.

border of this process is slightly convex and continuous with the outer border of the body of the wing; the extero-anterior border of the wing abruptly rounded, from which to the very short beak the border is sinuous, almost sigmoid; posterior border of the wing deeply concave, its proximal half being slightly reflexed outward, as if for the passage of soft parts corresponding to those that in allied genera occupy a posterior canal, as the curved sinus adjacent to the columella doubtless gave passage to soft parts corresponding to those that in *Anchura* proper occupied the anterior canal or channel of the beak; inner lip provided with a distinct and moderately broad callus, which, in some cases at least, extends beyond the distal end of the aperture across the next volution, as seen by dorsal aspect of the shell; columella very slightly produced in front, and its apex flexed a little toward the dextral side of the shell. Volutions of the spire marked by many longitudinally oblique folds, which extend to the suture on the proximal side of the volutions, but not much beyond the middle on the distal side, and do not appear at all on either the body-volution or wing. The whole surface marked by fine revolving striæ, which are more distinct upon the last volution than elsewhere; last volution and wing also marked by a moderately strong carina, which terminates at the point of the falciform process.

"Length, 16^{mm}; breadth across the body-volution, including the wing, 12^{mm}.

"This species agrees well with the subgeneric diagnosis of Meek for *Drepanocheilus*, and in many respects it resembles *A.* (*D.*) *americana* Evans and Shumard sp., but it differs from that shell in its large anterior sinus, the deep sinuosity of the anterior border of the wing, and the reflexion of a portion of the posterior margin of the wing."

Locality and position.—Upper Kanab valley, Utah, from same horizon as the preceding species.

STROMBIDÆ.

Genus LISPODESTHES White.

This name was proposed[1] to include two species, *Lispodesthes nuptialis* and *L. lingulifera*, now regarded as one.

It was characterized as follows:

"Shell fusiform; anterior canal straight or slightly curved, and more or less produced; posterior canal extending nearly or quite the whole length of the spire, from near the apex of which it may be a little deflected; aperture winged; wing rather large, bearing two processes; the posterior process spine-like or falciform; the anterior process either in the form of a lobe or tongue-shaped; inner lip and spire covered with callus."

To this description it should be added that in the adult the wing is

[1] U. S. Geog. and Geol. Sur. West 100th Merid., vol. IV, p. 191

greatly thickened and bordered externally by a raised rim; the anterior canal is bent inward (from the observer in the dorsal view); and in the known forms there is no transverse sculpture on the volutions of the spire. In fact, it agrees with *Pugnellus* in every particular excepting that it has a long posterior canal.

In Zittel's Handbuch der Paleontologie, *Lispodesthes* is adopted as a subgenus under *Aporrhais*, but he includes in it *Aporrhais reussi* and other related forms of the type of *Aporrhais* (*Perissoptera ?*) *prolabiata*, above described, which, as it seems to me, is entirely distinct. Holzapfel,[1] following Zittel, has used the name only for such forms as I now refer to *Perissoptera*. In outline there is some resemblance between species of *Perissoptera* and *Lispodesthes nuptialis*, but the differences in all other characters seem to me of much greater than specific importance.

I would place *Lispodesthes* in the Strombidæ next to *Pugnellus*.

LISPODESTHES NUPTIALIS White.

Pl. XXXI, Figs. 5 and 6.

Anchura nuptialis White, 1874, Expl. Sur. West 100th Meridian, Prelim. Rept. Invert. Foss., p. 24.

Lispodesthes nuptialis White, 1876, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 192, Pl. 18, Figs. 3*a* and *b*.

Lispodesthes lingulifera White, 1876, ibid., Pl. 18, Figs. 2*a* and *b*.

Revised description:

"Shell small; body subfusiform; wing moderately large; spire somewhat prominent, acute, but so thickly encrusted with callus that the volutions are only obscurely shown, except where the callus is removed by exfoliation; revolving angle absent or obsolete upon the volutions of the spire, even when bared by exfoliation of the callus, but it is somewhat distinct upon the body-volution, being continued out upon the falciform process of the wing. This posterior falciform process diverges widely from the axis of the shell, but by recurving it extends nearly as far backward as the apex of the spire; anterior process of the wing somewhat thickened, its breadth throughout about equal to that of the falciform process at the base, its length and breadth about equal, its outer end obliquely rounded; space between the two processes very narrow; from the base of the anterior process the border of the wing extends forward with a concave curve to the base of, and ends at, the long, slender anterior canal; posterior border of the wing concave and continuous with that of the falciform process on the one hand and with the callus-border of the posterior canal on the other.

"Length, from the apex of the spire to the end of the anterior canal, 20^{mm}; breadth, measuring across from the base of the processes of the

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[1] Mollusken der Aachener Kreide, p. 120, Pl. XII, Figs. 11–13.

wing to the opposite side, 9mm; spire, falciform process, and anterior canal each about 7mm."

In the type specimen the wing is very thick and bordered externally by a raised rim and the anterior canal is somewhat curved inward. In these features, as well as the thick callus enveloping the spire, it resembles *Pugnellus.*

The types of *Lispodesthes lingulifera* were obtained at another locality though apparently from about the same horizon as the one above described. They are smaller specimens with thinner shells and wings of slightly different shape, but these differences are only such as might be seen at various stages in the growth of a single individual and are therefore not regarded as of specific importance. The author of the species concurs in this opinion.

It has already been shown in the note on the genus *Lispodesthes* that this typical species is not closely related to such forms as *Aporrhais parkinsoni*, *A. schlotheimi*, etc., that have been referred to this genus by Zittel and Holzapfel. The only species known to me that seems to be congeneric with this one is *Anchura? newberryi* Meek [1]. The description and figure of this species, given by Whitfield in the Geology of the Black hills of Dakota, show that it belongs to the same section with *L. nuptialis.*

Locality and position.—Fifty miles north of Camp Apache, 5 miles west of Mineral Springs, Arizona; east of Mount Taylor, 1 mile south of Pajuate, New Mexico. At the former locality it is associated with *Camptonectes platessa* and at the latter with *Pinna petrina*, both of which occur elsewhere in the Colorado formation.

Genus PUGNELLUS Conrad.

PUGNELLUS FUSIFORMIS Meek (sp.).

Pl. XXXI, Figs. 7–11.

Anchura? fusiformis Meek, 1877, U. S. Geol. Expl. 40th Parallel, vol. IV, Pt. 1, p. 160, Pl. 15, Figs 2 and 2*a*.

Not *Anchura? fusiformis* (Meek) White, U. S. Geog. & Geol. Sur. West 100th Meridian, vol. IV, p. 190, Pl. 18, Fig. 4*a*.

Lispodesthes? obscurata White, 1880, Ann. Rept. U. S. Geol. Sur. Terr. for 1878, p. 30, Pl. 11, Figs. 7*a* and *b*.

Shell, exclusive of the outer lip, fusiform, consisting of six or seven volutions, of which the last forms about five-sixths of the total length; the whorls of the spire are sometimes subangular above the middle, and the body-whorl is ventricose in the same region; suture distinct in young shells, but almost entirely covered in the adult by a very heavy spiral callus, which extends backward from the inner lip over the

[1] Macomb's Exped. from Santa Fé to junction of Grand and Green rivers, p. 129.

apex of the spire; aperture narrow, oblong; outer lip in the adult greatly thickened and expanded, bordered externally by a heavy ridge. The posterior expansion of the outer lip is broad falciform, slightly narrowed at the base, somewhat twisted so that it is not quite in the same plane as the rest of the margin, directed backward and outward, and terminating in a blunt point. About midway between this falciform process and the anterior end of the canal there is a smaller subquadrate projection, directed downward and forward, in front of which there is a deep, narrow sinus, followed by a third projecting lobe that is broadly rounded and separated from the anterior end of the canal by a well-defined notch. The tip of the canal is slightly bent inward. The shell is very thin on the dorsum, which is the only portion not covered in the adult by a heavy callus. Surface smooth, excepting on the upper portion of the body-whorl, where it is marked by more or less prominent curved transverse costæ that are sometimes shortened into nodes. From the front end of the last costa a rather prominent subangular ridge, corresponding to the angulation of the earlier whorls, passes out on the outer lip and forms the upper (posterior) border of the falciform process. In the earlier stages of its growth the shell has a much more simple form.

Length of a large specimen, 41^{mm}; breadth, including the expanded outer lip, 39^{mm}; diameter of body-whorl, exclusive of lip, 16^{mm}.

This description is drawn from a large collection of well preserved specimens from Huerfano park, Colorado. At several localities the species is very abundant in a bed of sandstone, which I have, for that reason, called the Pugnellus sandstone, as a convenient local designation.

The original types of Meek's species are imperfect sandstone casts from the neighborhood of Coalville, Utah, while White's types, also imperfect and showing different features, came from the Arkansas river above Pueblo, Colorado. Better collections recently made at both these localities prove that they all belong to the species that is so abundant in Huerfano park, and that it has all the characteristic features of *Pugnellus*.

The most nearly related form is *Pugnellus manubriatus* Gabb, from the Chico series of California, but the resemblance is not so close as to require minute comparisons.

Locality and position.—At the localities mentioned in Colorado the species is confined to the upper part of the Fort Benton, being most abundant in the thin bed of Pugnellus sandstone, just beneath the Niobrara limestone, and very rare in the upper part of the underlying shales. At Coalville, Utah, it occurs in the sandstone of the "second ridge," where it is associated with many of the same species that are found with it in Colorado. It has also been found at the same horizon at Bear River city, Wyoming.

TRITONIIDÆ.

Genus TRITONIUM Link.

TRITONIUM KANABENSE n. sp.

Pl. XXXI, Fig. 12.

Shell small, slender, fusiform, with six or seven rounded whorls, of which the last is somewhat inflated and below abruptly contracted into the short canal. Surface ornamented by very prominent narrowly rounded transverse costæ, of which there are about ten on the last whorl, crossed by strong elevated revolving lines, alternating with faint lines on the later whorls. There are also a few strong varices on the spire, representing the outer lip at various stages of growth.

The canal is short and somewhat bent and the aperture is ovate in outline. The outer lip is strongly dentate within and the inner lip has a thin callus.

Length of the type specimen, which is incomplete at both extremities, 21^{mm}; greatest breadth, 10^{mm}.

Locality and position.—About 350 feet above the base of the Cretaceous section at Upper Kanab, Utah. Collected by Mr. C. D. Walcott.

FUSIDÆ.

Genus FUSUS Lamarck.

FUSUS SHUMARDI H. & M.

Pl. XXXI, Fig. 13.

Fusus shumardi Hall and Meek, 1856, Mem. Am. Acad. Arts. and Sci., vol. v, 2d ser., p. 391, Pl. 3, Fig. 6; Whitfield, 1880, Geol. Black Hills of Dakota, p. 424, Pl. 12, Figs. 7 and 8.

Whitfield's description is as follows:

"Shell small, with a moderately elevated spire and rather short rostral beak; volutions about six, strongly ventricose, and marked by comparatively strong, slightly oblique, vertical costæ or folds, which are directed forward on the lower part of the upper volutions and again recurved below, as seen on the body whorl, and also by finer striæ of growth between the folds. The folds are crossed by numerous elevated revolving lines, with wider interspaces; suture well marked and distinct; aperture obliquely ovate, obtusely pointed above, and continued below into the short, narrow, rostral canal; columellar lip slightly thickened, but without visible folds or plaits.

"The specimen used is imperfect at both extremities and much of the surface shell removed; enough remains, however, to furnish the specific characters. The species may possibly belong to Mr. Meek's genus

Trachytriton; but although the vertical folds are distinctly marked where the shell is entirely removed, there is no evidence of revolving lines on the spaces between them, as required in the diagnosis of that genus.

"*Formation and locality.*—In a ferruginous sandy limestone on the east fork of Beaver creek, Black hills, associated with fossils referred to the Fort Benton group."

This species seems to have been abandoned by Prof. Meek, as he does not include it in his final work on the "Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country," and he there speaks of it as a possible synonym of *Trachytriton vinculum.* The original type was found in the Fort Pierre group at the Great Bend of the Missouri. It is somewhat doubtful whether the specimen above described belongs to the same species. (See remarks on *Pleurotoma hitzi*, p. 161.)

Fusus gabbi Meek.

Pl. xxxi, Fig. 14.

Fusus (*Neptunea*) *gabbi* Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 504; White, 1879, idem for 1877, p. 317, Pl. 9, Fig. 9*a*.

Original description:

"Shell rather small, fusiform; spire moderately prominent, conical; volutions seven or eight, convex; last one somewhat ventricose in the middle, and rather suddenly contracted below into the narrow, slightly twisted, more or less bent, and apparently moderately produced canal; suture well defined; aperture rhombic-subovate, and rather suddenly narrowed into the canal below. Surface ornamented with equal, distinct, regularly disposed varices or vertical folds, about eight of which may be counted on the penultimate volution, and less on the body-whorl, where some of them become obsolete; crossing these are also seen fine revolving lines, and a little below the suture, apparently a shallow revolving furrow that gives it a slightly banded appearance.

"Length, including canal, about 0.87 inch; breadth, 0.40 inch; slopes of spire straight, and diverging at an angle of about 50°.

"The specimens of this species contained in the collection are quite imperfect, being mainly casts retaining more or less of the shell. From such material it is, of course, impossible to determine with much confidence the generic affinities of shells. I have, therefore, provisionally referred it to the genus *Fusus*, putting in parenthesis the name *Neptunea* with a mark of doubt, to indicate that I suspect it may belong to that group, with the limits assigned it by some conchologists. It seems, however, quite as probable to belong to *Tritonidea*, as understood by some.

"*Locality and position.*—Coalville, Utah; from the Cretaceous beds below the lower heavy bed of coal mined at that place."

FUSUS (NEPTUNEA?) VENENATUS n. sp.

Pl. XXXII, Figs. 1 and 2.

Shell fusiform, rather large; spire conical, equaling or exceeding the aperture and canal in length; volutions about six, convex, obliquely flattened above; last whorl abruptly contracted into the canal, which is not complete in any of the specimens, but was evidently rather short and bent to the left (in aperture view).

Surface with numerous thread-like revolving lines and a row of prominent rounded nodes, of which there are about twelve on each volution. In the shells with more elongate spires like the largest one figured, this row of nodes is near the middle of the whorls of the spire, while in those that are more depressed it is near the suture. The nodes are not conspicuous on the earlier whorls. Aperture, exclusive of canal, oval; inner lip with a moderately thick callus; outer lip unknown.

Length of largest specimen, exclusive of canal, 72^{mm}; breadth, 43^{mm}.

The collections from Huerfano park contain a large number of fragmentary specimens that I have placed in this species. They vary considerably in form, the extreme being shown by the two specimens figured. These two would hardly be regarded as belonging to the same species if it were not for the fact that other examples seem to be exactly intermediate between them.

In size and general appearance this species has some resemblance to *Fusus* (*Serrifusus*) *dakotensis* M. & H., but the volutions are not at all carinate, as in that species, and the form of the aperture is different.

Locality and position.—In the Pugnellus sandstone on Williams creek, in Poison canyon, and other localities in Huerfano park, Colorado.

Genus TRITONIDEA Swainson.

TRITONIDEA? HUERFANENSIS n. sp.

Pl. XXXI, Fig. 15.

Shell rather small, short fusiform, spire elevated, about equal in length to the aperture and canal; whorls six, ventricose, abruptly contracted just below the suture so that they have a shouldered appearance, with prominent rounded nodes on the shoulder of the body-whorl. On the spire these nodes are elongated into transverse costæ that completely cross the exposed portion of the whorl. Surface also marked by numerous flat revolving lines that are broader than the spaces between them. Aperture not seen.

Length of the type specimen, 23^{mm}; breadth, 14^{mm}.

In general appearance this species is not very different from some of the smaller individuals of *Fusus* (*Neptunea?*) *venenatus* with which it is associated. It differs, however, in the shouldered character of the whorls as well as in all the details of surface ornamentation.

Locality and position.—Poison canyon, Huerfano county, Colorado, in the Pugnellus sandstone.

Genus FASCIOLARIA Lamarck.

FASCIOLARIA? WALCOTTI n. sp.

Pl. XXXII, Fig. 5.

Shell small, slender fusiform, consisting of eight or nine convex whorls; spire elevated, about equal in length to the last volution; last whorl merging into the rather short and slightly curved canal. Surface marked by numerous sinuous transverse costæ and finer, closely arranged, revolving lines. On the penultimate whorl there are about thirty of the costæ and about twenty revolving lines.

Length, 29^{mm}; breadth, 10^{mm}.

The single type specimen is beautifully preserved, but as it is imbedded in a hard matrix from which it can not be removed without endangering it, I have not been able to see the character of the aperture nor to determine whether there are any folds on the columella. It seems, however, to be closely related to *Fasciolaria (Mesorhytis) gracilenta* Meek, from which it differs in its shorter canal, more numerous transverse costæ, and more delicate sculpture.

Locality and position.—Collected by Mr. C. D. Walcott about 350 feet above the base of the Cretaceous section at Upper Kanab, southern Utah.

FASCIOLARIA? (CRYPTORHYTIS) UTAHENSIS Meek (sp.)

Pl. XXXII, Figs. 3 and 4.

Fusus (Neptunea) utahensis Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 505.

Fusus? utahensis White, 1880, idem for 1878, p. 34, Pl. 12, Fig. 2*a*.

Original description:

"Shell of moderate size, short fusiform; spire rather depressed, conical; volutions about four; those of the spire a little convex; last one large and ventricose, rounded or very slightly flattened around the middle and contracted rather rapidly below into a narrow canal that is longer than the spire, and more or less bent to the left; aperture rhombic, angular above and narrowed and prolonged into the canal below. Surface, as determined from a cast in sandstone, with obscure vertical ridges, about twelve of which may be counted on the penultimate volution, while on the last, or body-whorl, they become nearly or quite obsolete. (Revolving lines probably also marked the surface of the shell, though no traces of anything of the kind are seen on the cast, excepting a shallow furrow above the suture on the volutions of the spire.)

"Length, including canal, about 1.90 inches; breadth, 0.91 inch; angle of spire, about 67°."

In the collections from Huerfano park, Colorado, there are a number of specimens that are believed to belong to this species although in the type and other examples from Coalville, Utah, only the general form and a part of the surface features are preserved. The Colorado specimens show the following additional characters: The surface ornamentation consists of lines of growth and rather distant rounded transverse costæ which never entirely cross the whorls of the spire and in many individuals are shortened into obtuse nodes, or become obsolete, especially on the last whorl. In some cases these nodes are almost concealed by the succeeding whorl thus leaving the spire nearly smooth and giving an undulated outline to the sutures which are not very distinctly impressed and are sometimes glazed over by a deposit of callus. Some examples also show faint revolving lines. The outer lip is simple and sharp, and the inner lip has a thin deposit of callus which seems to have spread over the spire in the adult. The columella bears below the middle one very prominent fold that is hardly visible in the aperture view of a perfect specimen. The angle of the spire varies considerably as is shown by the figures, and the number of volutions is six or seven instead of four.

I am very much in doubt as to the generic relations of this species, and the material at hand is not sufficient to show all of its characters fully. It seems, however, to be allied to *Fasciolaria ?* (*Cryptorhytis*) *flexicostata* M. & H. It is one of those early generalized forms that seem to stand between the Fasciolariidæ and the Volutidæ though this species is more closely related to the latter family.

Locality and position.—In the "second ridge" at Coalville, Utah, and with similar associates in the Pugnellus sandstone, Poison canyon, Huerfano park, Colorado.

Genus PYROPSIS Conrad.

PYROPSIS COLORADOENSIS n. sp.

Pl. XXXII, Figs. 6–8.

Shell of rather large size, pyriform, consisting of four or five rapidly increasing volutions; spire in some specimens much depressed, in others rather prominent; suture distinct, bordered below by a revolving ridge that gives it a channeled appearance; whorls bicarinate around the middle, the upper carina the stronger, obliquely flattened above and rather abruptly contracted below into the canal, which is moderately long and slightly curved. On the whorls of the spire only the upper slope above the greater carina is exposed. In addition to the carinæ, that are prominent and more or less nodose on the body whorl, the surface ornamentation consists of numerous strong, granular revolving lines, usually alternating with finer ones and crossed by distinct lines of growth. Aperture elongate ovate, suddenly narrowed and slightly produced above to form a short posterior canal and more gradually contracted below into the rather broad anterior canal.

Outer lip thin and slightly dentate within; inner lip comparatively thin, forming a broad thin glaze on the body whorl above, but thickening and narrowing below until it is free from the columella, leaving a distinct and deep umbilicus. There is a single oblique fold on the columella.

Length of one of the types, 77^{mm}; greatest breadth, 49^{mm}.

Compared with *Pyropsis bairdi* M. & H., which seems to be the most closely related described form, this species has a shorter and broader anterior canal, a larger umbilicus, only two carinæ on the body whorl instead of three, and stronger revolving sculpture. Besides, our species has the short posterior canal and the dentate outer lip, both of which are entirely lacking in *P. bairdi*. In some respects it approaches *Rapa cancellata* Sowerby, from the Cretaceous of southern India.

Locality and position.—In the Pugnellus sandstone on Williams creek and in Poison canyon, Huerfano park, Colorado. Some very imperfect casts from about the same horizon at Coalville, Utah, probably belong to this species.

VOLUTIDÆ.

Genus ROSTELLITES Conrad.

This genus was proposed in 1855 with *Rostellites texana* (= *Volutilithes navarroensis* Shumard) as the type. In 1876 Gabb gave the name *Volutoderma* to the group to which this species belongs. In his recent discussion of the Volutidæ Dr. W. H. Dall[1] has more fully characterized the genus and restored Conrad's earlier name. His description is as follows: "The genus *Rostellites* is characterized by a usually thick shell with a tendency to cancellated sculpture of distant narrow ridges, more or less nodose at the intersections; by an acute apex and trochoid, minute nucleus; by a tendency to a notch or sulcus in the outer lip near the suture; and by the presence of several well-differentiated plaits on the pillar. A few species are thin and the form is extremely variable. The surface is not glazed, the pillar is nearly straight, and the incremental lines are conspicuous."

Dr. Dall has kindly examined the three species described below and he regards all of them as members of this genus. *Rostellites gracilis* differs from the type of the genus in that the revolving sculpture is obsolete and the spire is glazed, at least in some examples, but these features are not considered of generic importance.

[1] Trans. Wagner Free Inst. of Sci., vol. 3, 1890, pp. 71, 72.

ROSTELLITES DALLI n. sp.

Pl. XXXIII, Figs. 11–13.

Shell of medium size, slender fusiform; spire elevated but not quite equal to the aperture in length; volutions about seven, convex, with a narrow constriction below the suture; body whorl large and in some specimens rather ventricose. Surface ornamented by distinct revolving lines and prominent rounded, transverse costæ, the latter dying out above the middle of the body whorl. On the last volution there are ten transverse costæ and about twenty revolving lines. Aperture long and narrow, with a slight notch at the posterior end as indicated by the lines of growth; outer lip lirate within; inner lip with a thin deposit of callus. Pillar nearly straight, with three distinct oblique folds near the middle, the anterior fold being the stronger. The folds are scarcely visible in the aperture view of an unbroken specimen.

Length of a medium sized specimen, about 80 ^{mm}; greatest breadth, 25 ^{mm}. Other specimens are considerably broader in proportion to their length.

The apex is not preserved in any of the specimens so that the character of the nucleus has not been determined.

This species seems to be congeneric with *Rostellites texanus* Conrad, which is the type of the genus to which Gabb subsequently gave the name *Volutoderma*. Specificially it is closely related to *Voluta* (*Rostellites*) *elongata* d'Orb., which occurs in the Turonian of France, the Gosau beds of Austria, and the Arrialoor and Trichinopoly groups of southern India.

Internal casts are not easily distinguished from the following species with which it is associated, but the surface ornamentation is very different.

Localities and position.—In the Pugnellus sandstone at many localities in Huerfano park, and at a slightly lower horizon on the Arkansas river, 20 miles above Pueblo, Colorado.

ROSTELLITES AMBIGUA n. sp.

Pl. XXXIII, Figs. 8–10.

Shell of rather large size, spindle shaped; spire elevated and rather slender, somewhat more than half the length of the aperture; whorls about seven in number, moderately convex, the last one very large; suture distinct, more or less channeled. Below the rounded border of the suture the whorl is slightly constricted or flattened. Surface ornamented by numerous closely arranged revolving lines and by larger curved transverse costæ that are less conspicuous on the body whorl than on the spire, and that have a tendency to form nodes just below the suture.

The aperture is narrow, prolonged into the rather short canal, and with a short posterior notch. Outer lip thin, obscurely lirate within, and slightly reflexed; inner lip with a very thin callus. The pillar is slightly arched with two distinct folds, the anterior of which is the stronger, and faint indications of two others behind them.

Length of an average specimen, 77^{mm}; greatest breadth, 24^{mm}. Other specimens show that the species attained a considerably greater size and sometimes had a more robust form.

One imperfect specimen of which a figure is given (Pl. XXXIII, Fig. 10) differs somewhat in the character of the ornamentation, the transverse costæ being shortened into rounded nodes. Possibly it belongs to a different species; but the other specimens that certainly belong together show considerable variation in this character.

Forms similar to this have been referred to *Fasciolaria* by Stoliczka and others, but they seem to belong to the Volutidæ. It is true, however, that in the Cretaceous the lines can not be sharply drawn between the Volutidæ and the Fasciolariidæ; and we find different authors assigning such forms in some cases to *Fasciolaria* and in others to *Volutilithes* and other volutoid genera. Some forms of *Piestochilus* which was proposed as a subgenus under *Fasciolaria* by Meek are not very different in general aspect from this species.

Locality and position.—Abundant in the Pugnellus sandstone on Williams creek and in Poison canyon; it also occurs at other places in Huerfano park, and at about the same horizon at Rattlesnake butte, 18 miles east of Walsenburg and on the Arkansas river, 20 miles above Pueblo, Colorado.

ROSTELLITES GRACILIS n. sp.

Pl. XXXIV, Figs. 1–3.

Shell large, slender, fusiform, consisting of about seven volutions, the last of which comprises about three-fourths of the total length of the shell; whorls convex and rounded in the middle, constricted posteriorly, the body whorl gradually narrowed into the moderately long canal; suture linear, appressed, in some examples apparently glazed by a thin deposit of callus. Surface marked by rather distinct lines of growth and by curved transverse costæ that cross only the convex portion of the whorl leaving the posterior constricted portion smooth. The costæ are most prominent on the upper part of the spire, gradually becoming more distant and less conspicuous and disappearing entirely on the last whorl or sometimes earlier. One specimen also shows traces of numerous very fine revolving lines on the earlier whorls.

Aperture long and narrow, posteriorly acute and slightly emarginate; outer lip thin, sharp, and smooth within; inner lip with a thin deposit of callus that seems sometimes to spread over the spire in a thinner glaze. Pillar nearly straight with three very strong, subequal, oblique plaits near the middle.

Length of a medium-sized specimen, 110^{mm}; greatest breadth, 28^{mm}. The largest of the figured specimens, which lacks the apex of the spire and the entire canal, measures, without restoration, 109mm in length and 49mm in breadth. This large specimen differs somewhat in form from the others and it is the one that shows fine revolving striæ on the earlier whorls of the spire. If better collections should prove that two species are represented the name here proposed should be used for forms like that represented by Figs. 1 and 2 of Pl. XXXIV.

I do not know any described species nearly related to this one and its generic affinities are not very clear. In general form and in the character of the plaits of the columella it is quite like *Rostellites*. In other respects it suggests *Volutomorpha*, and perhaps it should be regarded as intermediate between these two groups.

Locality and position.—In the Pugnellus sandstone near Malachite and in Poison canyon, Huerfano park, Colorado. About a dozen more or less fragmentary specimens were obtained.

CANCELLARIIDÆ.

Genus CANCELLARIA Lamarck.

CANCELLARIA MALACHITENSIS n. sp.

Pl. XXXIII, Figs. 6 and 7.

Shell small, short fusiform, comparatively thick; spire moderately elevated, conical, consisting of three or four whorls; body whorl very large, rounded, produced below into a short, broad canal. Surface beautifully cancellated by strong revolving and transverse lines. On the body volution there are about fifteen of the revolving lines of which two or three nearest the suture are considerably larger than the others and separated by broader furrows. On the spire only four revolving lines are visible.

The aperture is not complete in any of the specimens, but it is evidently narrow ovate in outline, and the columella bears three strong plaits, of which the first and second are very close together, and the posterior one is more remote and the strongest.

Length of one of the larger specimens, 18mm; breadth, 9mm.

Locality and position.—In the Pugnellus sandstone near Malachite, Huerfano park, Colorado; represented by three specimens.

Genus ADMETOPSIS Meek.

ADMETOPSIS RHOMBOIDES Meek.

Pl. XXXIII, Fig. 3.

Admete? rhomboides Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 501.
Admete? gregaria Meek, 1873, ibid.
Admetopsis rhomboides White, 1879, idem for 1877, p. 317, Pl. IX, Figs. 6*a* and *b*.

Original description:

"Shell rather small, rhombic-suboval, or short subfusiform, the length being slightly more than twice the breadth at the widest part, which is near the middle; spire rather depressed-conical, subturreted; volutions five or six, convex; last one forming about three-fourths the entire bulk of the shell, and more than half of its length, widest near its upper part, and abruptly narrowed below so as to present an obliquely obovate form; suture rather deep from the convexity of the volutions; aperture narrow, subangular above and narrowed below to a small notch at the base of the truncated columella, which is provided with two small obscure plaits or folds, the lower of which is formed by the twisted margin of the truncated inner lip, while the other is placed a little farther up; outer lip sharp, with its margin slightly retreating above, and more prominent below, or near the middle. Surface ornamented by distinct vertical folds, that are usually well developed on the volutions of the spire, and around the upper part of the body whorl, but become obsolete below; moderately distinct revolving lines also mark the lower part of the body volution, but these appear to become obsolete on its upper part, and on those of the spire, as specimens are usually found.

"Length, 0.37 inch; breadth, 0.21 inch; angle of spire about 58°."

The three forms to which Prof. Meek gave the names *Admete? rhomboides*, *A.? gregaria* and *A.? subfusiformis*, at the same time suggesting *Admetopsis* as a generic designation for them, are very abundant in certain layers near the base of the Cretaceous section at Coalville, Utah, where the types were obtained. The surface markings of these fossils are seldom well preserved and most of the examples are more or less crushed and distorted. Prof. Meek states that the ornamentation is similar and variable in all the species, and his chief reason for separating them seems to have been that some individuals are much more slender than others. Dr. White remarks concerning them (loc. cit.) that "after examining many examples I am much inclined to think that they represent not more than two species at most." It seems to me probable that there is only one variable species, but for the present and until better collections shall fully decide the question, I shall refer the short ventricose specimens to *Admetopsis rhomboides*, and the slender elongate ones to *A. subfusiformis*, treating *A. gregaria* as a synonym of the former as Dr. White has already done.

ADMETOPSIS SUBFUSIFORMIS Meek.

Pl. XXXIII, Figs. 1 and 2.

Admete ? subfusiformis Meek, 1873, Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 502.
Admetopsis subfusiformis White, 1879, idem for 1877, p. 318, Pl. IX, Fig. 7.
?Admetopsis gregaria White, ibid., Pl. III, Fig. 5*a*, and U. S. Geog. and Geol. Sur. West of 100th Merid., vol. IV, p. 198, Pl. XVIII, Figs. 5*a*, *b*.

Original description:

"Shell subfusiform, with the length nearly three times the breadth; spire elongated, conical, turreted; volutions seven or eight, convex;

last turn more than half the entire length; suture well defined in consequence of the convexity of the whorls; aperture narrow, equaling about two-fifths the entire length of the shell, angular behind and narrowing below to a small, sharply defined notch at the base of the truncated columella, which seems to bear two small folds near its lower part, one being formed by the twisted and truncated lower margin; inner lip a little thickened; surface ornamented by distinct, regular vertical folds that are nearly or quite obsolete on the body-volution below its upper part, and regular revolving lines quite well defined on the body-turn, especially its lower part, and appear to be obsolete on those of the spire; lines of growth moderately distinct.

"Length, 0.50 inch; breadth, 0.20 inch; angle of spire, about 30°.

"This species differs even more strongly from the last [*A. gregaria*] than that form does from the species *rhomboides*, having a much more elevated spire and a proportionally smaller body-volution and aperture. In ornamentation, however, the three forms are much alike. The species here under consideration shows a somewhat more thickened inner lip than I have yet seen in either of the others."

The fossils from southern Utah that have been referred to *Admetopsis gregaria* (see last two references above) seem to belong here, if the more slender elongate form can be regarded as a specific character.

Locality and position.—Near the base of the Cretaceous section at Coalville, Utah, and at several localities in southern Utah.

ADMETOPSIS HUMEROSA n. sp.

Pl. XXXIII, Figs. 4 and 5.

Shell small, slender, fusiform; whorls about eight, the earlier ones rounded and marked by numerous distinct transverse costæ, the last two or three distinctly shouldered and smooth. The transverse ornamentation is proportionately strongest near the apex of the spire, and is gradually reduced as the whorls become shouldered or channeled, until it disappears entirely on the body whorl, and usually on the preceding one. Some specimens show very faint revolving lines.

Aperture showing the characteristic features of the genus as in the other described species. Inner lip considerably thickened; outer lip not complete in any of the specimens.

Length of an average specimen, 15^{mm}; breadth, 8^{mm}.

This species may be easily distinguished by the shouldered character and smooth aspect of the larger whorls.

Locality and position.—Near Iron city, southwestern Utah, where it is associated with *Glauconia coalvillensis*, *Barbatia micronema*, *Corbula nematophora*, and other species of the Colorado formation. About 40 specimens were collected.

PLEUROTOMIDÆ.

Genus PLEUROTOMA Lamarck.

PLEUROTOMA? HITZI Meek.

Pl. XXXIV, Fig. 4.

Turris (*Surcula*)? *hitzi* Meek, U. S. Geol. Sur. Terr., vol. IX, p. 386, Fig. 50 in text.
Compare *Fusus shumardi* (H. &. M.) Whitfield, 1880, Geol. Black Hills of Dakota, p. 424, Pl. 12, Figs. 7 and 8.

"Shell elongate-conical (or fusiform), thin; spire much produced and turreted; volutions about seven, distinctly convex, or subangular around the middle, and flattened or concave with an outward slope above the angle, and convex below; last one not larger than the regular enlargement of the others from the apex, each provided with about thirteen prominences or little obscure vertical folds, which on the angle of the last turn assume rather more the character of obscure nodes; entire surface marked by raised, revolving lines; aperture trigonoid-oval, being biangular above and abruptly contracted below; beak, if any existed, unknown.

"Length (exclusive of the beak), about 2 inches; breadth, 0.90 inch; slopes of spire somewhat convex, and diverging at an angle of about 36°."

The only example of this species known to me is the imperfect type specimen, which does not show either the generic or the specific characters very well.

The small fossil described by Whitfield (loc. cit.) and referred by him to *Fusus shumardi* has fully as close resemblance to the earlier whorls of this species as it has to *Fusus shumardi*, and the fact that it comes from the Fort Benton group, the same horizon from which *Turris hitzi* was obtained, while *Fusus shumardi* came from a higher horizon, makes its identification with the former species more probable.

Locality and position.—On the Missouri river opposite Fort Shea, where it is associated with fossils of the Colorado formation.

ACTÆONIDÆ.

Genus ACTÆON Montfort.

ACTÆON PROPINQUUS n. sp.

Pl. XXXIV, Figs. 5–8.

Shell small, slender ovate, with six convex volutions; spire moderately elevated, acute; suture impressed or slightly channeled. Surface marked by fine, punctate, revolving lines, of which there are about six visible on each whorl of the spire and about twenty on the body whorl. The aperture is narrow, acute behind and narrowly rounded in front. There is one prominent fold on the columella.

Length of the larger specimen, 10 mm; breadth, 5mm.

This species is closely related to *Actæon subellipticus* M. & H., which occurs in the Fort Pierre shales of Dakota. It has a larger number of whorls and fewer revolving striæ, the form of the aperture is slightly different, and the body volution is more ventricose.

Locality and position.—In the Pugnellus sandstone, Poison canyon, Huerfano park, Colorado, represented by three specimens.

BULLIDÆ.

Genus HAMINEA Leach.

HAMINEA TRUNCATA n. sp.

Pl. XXXIV, Figs. 9–11.

Shell rather large, thin, subcylindrical; whorls two and a half or three, the last one very large and gradually expanding to the anterior end, where it is squarely truncate; spire depressed, not projecting above the last whorl; sutures channeled. Surface smooth and polished, with faint wrinkles and lines of growth and very obscure traces of revolving striæ. Possibly the thin outer layer of shell bearing the revolving striæ has been exfoliated. The aperture is subtriangular, being narrow and acute behind and very broad in front. The outer lip is free from the preceding whorl for some distance, leaving a moderately deep narrow slit, below which it is almost straight to the front, where it is abruptly rounded into the straight anterior border.

Length of the largest specimen, 23mm; greatest breadth, 18mm.

The depressed spire, the smooth surface, and the square-cut anterior end are the distinctive features of this species by which it may be separated from all the described Cretaceous forms known to me, though a number of recent species resemble it more closely in these respects.

Locality and position.—In the Pugnellus sandstone, Poison canyon, Huerfano park, Colorado. Represented by three specimens.

AURICULIDÆ.

Genus MELAMPUS Montfort.

MELAMPUS? ———?

Melampus? ———? White, 1880, Ann. Rept. U. S. Geol. Sur. Terr. for 1878, p. 25, Pl. 19, Fig. 6*a*; 1883, 3d Ann. Rept. U. S. Geol. Sur., p. 444, Pl. 5, Fig. 17.

This species, which has never been described or named on account of lack of sufficient material, was found in the lowest fossiliferous beds of the Cretaceous section at Coalville, Utah. Only one specimen has yet been found.

LIMNÆIDÆ.

Genus PHYSA Draparnaud.

PHYSA sp.?

Physa ———? White, 1879, Ann. Rept. U. S. Geol. Sur. Terr. for 1877, p. 307, Pl. 7, Fig. 13*a*; 1883, 3d Ann. Rept. U. S. Geol. Sur., p. 444, Pl. 4, Fig. 5.

A single specimen of *Physa*, too imperfect for specific description, was found by Dr. C. A. White in the "second ridge" at Coalville, Utah, where it was associated with many marine species of the Colorado formation. It is the only example of the genus that has been found in that formation.

CEPHALOPODA.

NAUTILOIDEA.

NAUTILIDÆ.

Genus NAUTILUS Breynius.

NAUTILUS ELEGANS Sowerby.

Pl. XXXV, Fig. 1.

Nautilus elegans Sowerby, 1816, Min. Conch., vol. II, p. 33, Pl. 116; Sharpe, 1853, Monog. Chalk Cephal. of England, p. 12, Pl. 3, and many other European authors.

Nautilus elegans var. *nebrascensis* Meek and Hayden, 1862, Proc. Acad. Nat. Sci., Phila., p. 25.

Nautilus elegans Meek, 1876, U. S. Geol. Sur. Terr., Vol. IX, p. 499, Pl. 8, Figs. 2, *a*, *b*, *c*.

Compare *Nautilus texanus* Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 590.

Meek's description is as follows:

"Shell subglobose, broadly rounded over the periphery and on each side of the umbilicus, which is closed in young and medium-sized specimens, but becomes a little open in the adults; volutions increasing rapidly in size, considerably wider transversely than in the dorso-ventral direction, all of those within entirely embraced and hidden by the last one; aperture transversely reniform-sublunate, being profoundly sinuous on the inner side for the reception of the inner turns; margins of the septa arching forward a little near the umbilicus, slightly waved backward on the sides, then again curving very slightly forward as they approach the periphery, in crossing which they bend again almost imperceptibly backward; siphuncle placed a little outside of the middle of the septa; surface of the outer volution ornamented by regular flattened, transverse costæ (about five times as broad as the narrow, shallow grooves between) and moderately distinct lines of growth, which, like the costæ, in crossing the periphery, arch gracefully and deeply backward, parallel to the deep peripheral sinus of the margin of the lip.

"Length or greatest diameter, about 3.90 inches; height, 2.82 inches; breadth at aperture, 3.40 inches."

Locality and position.—Chippewa point on the upper Missouri river, in Fort Benton shales.

AMMONOIDEA.

LYTOCERATIDÆ.

Genus HELICOCERAS d' Orbigny.

HELICOCERAS PARIENSE White.

Pl. XXXV, Figs. 2–4.

Helicoceras pariense White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 203, Pl. 19, Figs. 2*a–d*.

Compare *Ancyloceras annulatus* Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 595.

Original description:

"Shell dextral; spire much depressed; whorls distinct, subcircular or very broadly oval in transverse section, increasing somewhat rapidly in size; surface marked by comparatively strong, rather abruptly rounded annulations, which cross the whorls obliquely; annulations only slightly prominent upon the inner side of the whorls, but more prominent upon the upper and under sides; upon the outer side of the whorl each annulation bears a pair of prominent nodes, one on each side of the siphuncle, forming two dorsal rows of nodes along the whole length of the shell, the portion of the annulation between each pair of nodes being straightened and slightly flattened upon the back. The annulations are apparently always simple, never coalescing, and never failing to completely encircle the volution. The nodes are moderately prominent upon exfoliated specimens, and where the test is preserved they are seen to be subspinous or sharply nodose.

"Septa moderately distant, sometimes embracing two annulations, but toward the aperture only one. Lobes all smaller than the saddles, the size in each transverse series gradually diminishing from the dorsal to the ventral one; the smallest saddle, the ventral, not being larger than the largest lobe, the dorsal; lobes all bifurcate, except the ventral, the inferior lateral lobe being but slightly so; the anterior portion of the space between the branches of the dorsal lobe occupied by two backward projecting points; the ventral lobe is simple, small, narrow, and serrate upon both sides. The saddles of the different longitudinal series all similar in shape, diminishing gradually in size from the dorsal to the ventral series; all broader than long, except the ventral one, the length and breadth of which are about equal; each partially parted at the middle; edges of all the lobes and saddles serrated or toothed.

The longest fragment in the collection measures about 7^{cm}. At the larger end of this the long diameter is 15^{mm} and the short diameter 14^{mm}; at the smaller end the long diameter is 8½^{mm}.

"This species is similar in aspect to *H. Mortoni* Hall and Meek, but differs from it in diminishing in caliber much more rapidly toward the apex, in the presence of a double series of nodes along the dorsum of the volutions, and in the proportions and details of its lobes and saddles.

"*Position and locality.*—Cretaceous strata; southeast of Paria, Utah."

In the collection from Upper Kanab, Utah, there are many fragments of this species, some of which show the form of the spiral at least in the earlier stages. One of these showing one and a half volutions is figured. The form is not constant, however, as one specimen is more closely coiled than this one, while others form a more open spiral and show a tendency to become straight at an early stage. The spire is only very slightly elevated, so that in side view the apex is almost concealed by the succeeding larger whorl.

The nodes on the periphery vary considerably in different examples. In some cases they are not developed on the earlier whorls, while other fragments of the same size bear two rows of sharp spines.

Excepting in its more depressed spire this species is very much like *Helicoceras annulatum* d'Orb., which is the type of the genus. Similar forms have frequently been referred to *Crioceras*, *Hamites*, *Ancyloceras*, and other so-called genera that are based entirely on slight differences in form.

The species described by Shumard without figures under the name *Ancyloceras annulatus* seems to be closely related to this Utah form and may be identical with it.

HELICOCERAS? CORRUGATUM n. sp.

Pl. XXXV, Fig. 5.

Shell dextral, forming a very low, broad, open spiral; whorls with an ovate cross section, increasing rapidly in size, apparently not in contact. Surface marked by small, regular, rather closely arranged costæ that pass obliquely entirely around the whorl. The costæ are narrowly rounded, not quite as broad as the interspaces and without nodes or spines.

Full form of the shell and details of the septa not known.

The type specimen, which is about half of one volution, measures 105^{mm} in length, with sections 10 by 12^{mm} at the smaller end and 18 by 23^{mm} at the larger end.

If the earlier whorls continue the low spiral indicated by the form of this fragment and by the oblique direction of its costæ it must have been almost as much depressed as *Helicoceras pariense*, though in such evolute forms it is never safe to restore the entire shell from a single fragment.

Specifically this shell is easily distinguished from *H. pariense* by its more numerous and smaller costæ without nodes, and by its larger size.

Locality and position.—From the lower part of the Niobrara limestone on Turkey creek, Huerfano park, Colorado, where it is associated with *Buchiceras swallovi*, *Baculites gracilis*? and *Inoceramus fragilis.*

Genus BACULITES Lamarck.

BACULITES GRACILIS Shumard?

Pl. XXXVI, Figs. 1–3.

Baculites gracilis Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 596.
Baculites ovatus (Say) White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 199, Pl. 19, Figs. 4*b* and *c*.

Shell small, very slender; transverse section varying from broad ovate to subelliptical; surface sometimes nearly smooth, but usually with numerous distinct rounded costæ or undulations that are strongest on the siphonal side from which they curve backward parallel with the lines of growth, gradually becoming fainter and disappearing before reaching the opposite side. In addition to the costæ there are broad, rather obscure constrictions at intervals of about half an inch that completely encircle the shell. They are also more distinct on the siphonal side and are parallel with the lines of growth, passing nearly straight across the siphonal and antisiphonal sides and curved sharply backward on the flank.

Septum with six lobes and six saddles, all of the latter, excepting the antisiphonal one, symmetrically but not deeply divided; lobes much more slender than the saddles.

Length of the longest fragment in the collection, 106^{mm}, diameters of the extremities, 10^{mm} by $7\frac{1}{2}^{mm}$ and 5^{mm} by 4^{mm}, respectively.

This species differs from *Baculites ovatus* in its smaller size and more slender form, in the character of the surface ornamentation, and the details of the septa. The latter have the same general character in the two species, but on comparing specimens of the same size it is seen that in *B. gracilis* the septa are more distant and not so deeply incised and the lobes are narrower in proportion to breadth of the saddles.

The fossils above described include the specimens from southeast of Paria, Utah, that were doubtfully referred to *B. ovatus* by Dr. White (loc. cit.), a larger collection from Upper Kanab, Utah, where it is associated with many species of the Colorado formation about 350 feet above the base of the Cretaceous section, and several examples from the Niobrara limestone on Turkey creek, Huerfano park, Colorado.

Shumard's types were found on Shawnee creek, Grayson county, Texas, in strata that are believed to be approximately the equivalent of the Colorado formation. The species was not figured and I have never seen any Texas examples of it. Consequently the identification of the western specimens is somewhat doubtful, though they agree fairly well with the original description. Shumard states that the septum of his species has only four lobes, but it is evident from the detailed description that he counted the lateral lobes on only one side, so that there are really six.

In form and surface ornamentation this species resembles *Baculites baculoides* d'Orb., but the periodic constrictions on that species are narrower and more distinct and the septa are much more complex.

BACULITES ASPER Morton?

Pl. XXXVI, Figs. 4 and 5.

Baculites asper Morton, 1834, Synopsis Org. Rem. Cret. Gr., p. 43, Pl. 1, Figs. 12 and 13, Pl. 13, Fig. 2.

In the collection from Cinnabar mountain, Montana, there is a number of fragments of a small *Baculites* that are provisionally referred to this species. They were first mentioned by Prof. F. B. Meek.[1] They are associated with fossils of the Colorado formation. Recently Mr. W. H. Weed has collected specimens of the same form on Mission creek, northern Montana, associated with *Pholadomya papyracea* and *Inoceramus undabundus*, both of which are Colorado fossils.

The form is slender, very gradually tapering, rather narrow ovate in cross section, and bearing on each side a row of distant more or less prominent tubercles. The tubercles are usually rounded, but sometimes they are slightly elongated, taking a crescentic form.

The diameters of the largest specimen are 14^{mm} and 11^{mm}. Nearly all of the fragments are more compressed than this one.

The septa are not deeply divided, and are characterized by the great breadth of the saddles as compared with the lobes, but they are not well enough preserved to show all the details.

Mr. Gabb considered this species identical with *B. anceps* Lamarck,[2] but most other authors have regarded them as distinct. The type of *B. asper* came from Cahawba, Alabama, but its exact stratigraphic range in that region is not yet known. A form that is certainly identical with the one from Montana occurs in the Austin limestone of Texas and was referred to Morton's species by Dr. Roemer.[3] The material now at my disposal does not permit me to determine whether the same form occurs at a higher horizon or not. The one in the Montana and Ripley formations that is usually referred to *B. anceps* seems to me certainly distinct from this one, and the fragments that Prof. Meek doubtfully referred to *B. asper*[4] are probably also different.

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[1] Ann. Rept. U. S. Geol. Sur. Terr. for 1872, p. 475.

[2] Proc. Acad. Nat. Sci. Phila., 1861, p. 395.

[3] Kreideb. v. Texas, p. 36.

[4] U. S. Geol, Sur. Terr., Vol. IX, p. 404, Pl. 39, Fig. 10.

Baculites incurvatus Dujardin as figured by Schlüter[1] is a closely related form, that occurs in the "Emscher Mergel" of Germany. Several of its associates are considered identical with forms that are found in the Austin limestone and in the upper part of the Colorado formation.

AMALTHEIDÆ.

Genus BUCHICERAS Hyatt.

BUCHICERAS SWALLOVI Shumard (sp.).

Pl. XXXVII, Fig. 1; Pl. XXXVIII, Figs. 1–3.

Ammonites swallovi Shumard, 1860, Trans. St. Louis Acad. Sci., vol. I, p. 591.

Buchiceras swallovi White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 202, Pl. XX, Figs. 1*a*, *b*, *c*.

Compare *Placenticeras* (*perizianum* ? var.) *liardense* Whiteaves, 1889, Cont. to Can. Paleont., vol. I, pt. 2, p. 158, Pl. XX, Figs. 1 and 2.

Dr. White's description of the Utah fossils referred to this species is as follows:

"Shell moderately large, flattened-discoid; sides greatly convex; dorsum [abdomen] narrowly flattened, the flattened space bordered on each side by a row of more or less distinct nodes; volutions three or four, partially embracing; umbilicus broad, its outline not clearly defined; deep for so discoid a shell, although it has a shallow aspect because of its breadth and want of definite outline, and exhibiting a large part of each of the inner volutions; aperture subovate in outline, its longest diameter directed from the center of the shell, narrowest at the outer end, where it is truncated by the flattening of the dorsum [abdomen]; sides of the volutions marked by prominent, somewhat flexuous, rounded costæ, extending from the inner to the outer edge; the space between each two of these principal costæ is occupied by one or two short ones which do not reach the umbilicus, but they end at the dorsum [abdomen] like the others; upon each costa, near its dorsal [abdominal] end, there is an obtuse node, which, together with the dorsal [abdominal] nodes before mentioned, constitute a double row of nodes at each side of the dorsum [abdomen]. Saddles all broader, and simpler in outline than the lobes, none of the former being really digitate, and those near the ventral side of the volutions are nearly as simple in outline as they are in *Ceratites*.

"This shell presents some differences from the description by Dr. Shumard of *A. swallovi*, the principal of which is the absence of the nodes at the umbilical side of the volutions and of the distinct transverse ribs of the dorsum [abdomen] mentioned by him; but these are not regarded as essential specific characters.

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[1] Palæontographica, Vol. XXIV, Pl. 39, Figs. 6 and 7.

"Full diameter of the shell, about 18cm; transverse diameter of the aperture, nearly 5½cm; long diameter of the same, about 8½cm.

"Prof. Hyatt writes me, after an examination of the specimen figured on Pl. xx, that he regards it as a species of his genus *Buchiceras*, but that, 'it differs from *B. syriacum*, the type of the genus, in having larger lobes and cells more Ammonite-like.'

"*Position and locality.*—Strata of the Cretaceous period; Glendale, Long valley, Utah."

The types of the species came from "4½ miles north of Sherman, and bluffs of Red river in Fannin and Lamar counties, Texas." I have found a few fragments of it in the Niobrara limestone on Turkey creek, Huerfano park, Colorado. Mr. Walcott collected a number of specimens at Upper Kanab, Utah, about 350 feet above the base of the Cretaceous section. These show a considerable variation and some of them have nodes around the umbilicus and the costæ cross the abdomen, as in Shumard's type. Direct comparison of the Utah fossils with specimens from Texas shows that they are unquestionably identical. Other specimens that are smoother and have a narrower umbilicus, look exactly like the figure of *Placenticeras* (*perizianum* ? var.) *liardense* Whiteaves, which occurs in the "Earlier Cretaceous" of British Columbia.

Genus PLACENTICERAS Meek.

PLACENTICERAS PLACENTA Dekay (sp.)?

Pl. XXXIX, Figs. 1–3.

Ammonites placenta Dekay, 1828, Ann. N. Y. Lyceum Nat. Hist., vol. II, p. 278, Pl. 5, Fig. 2, and of various authors.

Ammonites (*Placenticeras*) *placenta* Meek, 1870, Proc. Am. Philos. Soc., vol. XI, p. 429, and Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 297.

Placenticeras placenta Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 465.

Meek's description is as follows:

"Shell lenticular in form, attaining a large size; umbilicus small; volutions deeply embracing, compressed laterally, with sides converging from near the umbilicus to the periphery, which is very narrowly truncated and flattened or a little concave, with its smooth margins becoming more obtuse with age; aperture narrowly sagittate; surface generally smooth or only showing very obscure traces of curved, transversely-elongated prominences on each side, with sometimes a row of very small indistinct nodes around the umbilicus; in young, exfoliated shells also usually showing small, faintly defined, divaricating corrugations, directed backward around the outer half of each side.

"Large examples attain 2 feet or more in their greatest diameter. Young specimens, 3.70 inches in breadth, show a thickness of about 0.90 inch, while large individuals are proportionally thicker, and on the periphery become more obtuse.

"Septa with 12 lateral lobes and as many sinuses on each side, in large examples crowded and very complex." [The detailed description of the septa is omitted, as it is more clearly expressed by the figure.]

The species has hitherto been regarded as characteristic of the Montana formation and its equivalents, and I have been in doubt whether the specimens from the earlier beds should be referred to the same species, but the scanty material at hand does not show enough difference to permit of separation. Whether they are placed in a different species or not, I have no doubt that they were the direct ancestors of the form that is so abundant and well developed in the overlying formation.

The collection under examination consists of single fragments from Huerfano park and Rattlesnake butte, Colorado, and Coalville, Utah, and several more or less fragmentary specimens from Upper Kanab valley, Utah. None of these indicate a size of more than 8 or 10 inches in diameter. The only differences that have been observed between these and typical examples of the species is that the septa are somewhat less complicated and less crowded, and the periphery seems to have become rounded in somewhat smaller specimens, but the species is known to vary in these respects. A specimen from Ellis county, Texas, where it is associated with *Buchiceras swallovi*, probably in the Eagle Ford shales, is still more closely like the typical form.

In the collection from Upper Kanab some examples are smooth, while others, such as the small specimens figured, show a tendency to become nodose, like the variety *intercalare.* The septum figured was visible only to the edge of the umbilicus, so that several of the small inner lobes and sinuses are not shown.

Genus PRIONOCYCLUS Meek.

This generic name was first suggested by Prof. Meek [1] in 1871, but he then gave no diagnosis, and he did not again use the name in his writings until 1876, when he published [2] a description of the genus and of the two subgenera, *Prionocyclus* (typical) and *Prionotropis*, with *P. wyomingensis* as the type of the former, and *P. woolgari* of the latter. In the same work the genus *Mortoniceras* was proposed with *Ammonites vespertinus* (=*A. texanus*) as the type. Meanwhile Neumayr had proposed [3] the name *Schloenbachia* for the "very natural group of the Cristati," in which he evidently included forms that are referable to *Prionocyclus* and *Mortoniceras*, if not to *Prionotropis*, and in Zittel's Handbuch der Paleontologie these three names are treated as synonyms of *Schloenbachia.* They certainly have some features in common, the septa, especially, being similar in all our American species.

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[1] Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 298.

[2] U. S. Geol. Sur. Terr., vol. IX, pp. 452, 453.

[3] Deutsch. geol. Gesellsch., Zeitschr., Bd. XXVII, 1875, p. 887.

Some representatives of *Prionocyclus* and *Prionotropis*, including the types, were submitted to Prof. Alpheus Hyatt, and after examining them he states that they are generically distinct and that he also regards both as separate from *Schloenbachia* properly restricted. I shall therefore use Prof. Meek's names.

As to the genus *Mortoniceras*, the specimens from the Colorado formation are hardly sufficient for generic determination and the original description will be simply copied under the old names.

Prionocyclus wyomingensis Meek.

Pl. xl, Figs. 1–4.

Ammonites serratocarinatus Meek, 1871, Proc. Am. Philos. Soc., vol. xi, p. 429.
Ammonites (*Pleuroceras?*) *serratocarinatus* Meek, 1871, Ann. Rept. U. S. Geol. Sur. Terr. for 1870, p. 298.
Prionocyclus wyomingensis Meek, 1876, U. S. Geol. Sur. Terr., vol. ix, p. 452; White, 1880, Ann. Rept. U. S. Geol. Sur. Terr. for 1878, p. 35, Pl. 15, Figs. 1*a*–*e*; Whitfield, 1880, Geol. Black Hills of Dak., p. 440, Pl. 14, Figs. 1–3.
Not *Ammonites serratocarinatus* Stoliczka, 1865, Cret. Cephalopoda of Southern India, p. 57, Pl. 32, Fig. 3.

Original description:

"Shell attaining a rather large size; discoid, with periphery provided with a very narrow, prominent, serrated mesial keel, including the siphuncle. Volutions increasing rather gradually in size, somewhat compressed laterally, and a little excavated without being distinctly channeled on each side of the ventral keel; inner ones but slightly embraced by each succeeding turn, and consequently well exposed in the wide umbilicus. Surface ornamented with numerous unequal costæ, some of the larger of which bear a small, somewhat elongated node near the umbilicus, and two closely approximated small nodes around the ventro-lateral margins, where they all curve very strongly forward as they pass upon the periphery; spaces between each two of the large nodose costæ occupied by from one to about three smaller ones. Septa unknown."

The costæ are very irregular and vary considerably in strength on different individuals, but they retain the same character through all the stages of growth, excepting that the smaller intermediate ones almost disappear from the last whorl of very large specimens. Frequently two costæ spring from a single node near the umbilicus and sometimes are again united in the node near the periphery, but in other cases they continue separate until they disappear near the keel. Very few specimens show more than one row of nodes near the periphery, and these are never developed into spines. The serrations of the keel are small and somewhat more numerous than the costæ.

The septum, as shown in the figure, has the same general character as that of *Prionotropis woolgari*, the principal difference being in the greater breadth of the first lateral lobe.

The breadth of the whorls is about two-thirds of the height in young specimens; in larger ones it is proportionally somewhat greater.

The species sometimes reached a size not less than 25^{cm} in diameter. The outer whorl of a specimen that is 125^{mm} in diameter measures 38^{mm} in width by 48 in height.

Ammonites germari Reuss, which occurs in the Turonian of Germany, seems to be a closely-related species.

Locality and position.—The types came from the valley of the Medicine Bow river, Wyoming; Whitfield's specimens were found "in siliceo-calcareous layers of Division No. 2, Cretaceous, on the east fork of Beaver creek, near Camp Jenney, Black hills." It is common but usually not well preserved in a layer of calcareous sandstone immediately beneath the Niobrara limestone in Huerfano park and other places in southern Colorado and along the eastern base of the Front range, and it occurs in eastern Utah.

PRIONOCYCLUS MACOMBI Meek.

Pl. XLI, Figs. 1–5.

Prionocyclus? macombi Meek, 1876, Macomb's Exploring Exped. from Santa Fé, N. M., to the Junction of Grand & Green Rivers, Geol. Rept., p. 132, Pl. 2, Figs. 3*a–d*.

Original description:

"Shell discoidal; umbilicus shallow; somewhat less than the diameter of the last whorl from the ventral to the peripheral side, and showing all the inner turns; volutions increasing gradually in size, very slightly embracing, compressed so as to be nearly flat on the sides, but rounding into the umbilicus; periphery rather narrow, nearly flat, and provided with a small mesial carina, which is very slightly waved in outline; lateral margins of the periphery each having a row of small compressed nodes, arranged one at the termination of each of the costæ, with their long diameters nearly parallel to the peripheral keel; sides of each turn ornamented by from thirty-six to forty rather obscure, slightly flexuous costæ, only every second, third, or fourth one of which extends across to the umbilical margin, where they are usually a little swollen.

"The septa are generally a little crowded in adult shells, and divided into two very unequal principal lobes on each side. Siphonal lobe slightly longer than wide, and ornamented by three branches on each side, the two terminal of which are a little larger and much less spreading than the lateral pair, and each ornamented by some five or six sharp digitations along the margins and at the extremity, while the first pair of principal lateral branches above the terminal ones are of nearly the same form as the latter, but more spreading, and the third pair are smaller and merely provided with a few digitations; first lateral sinus (dorsal saddle of old nomenclature) as long as the siphonal lobe, but much wider, and deeply divided into two unequal parts, of which the one on the siphonal side is larger than the other, each of these principal divisions being ornamented by some four or five short, irregular branchlets, with obtusely digitate margins; first lateral lobe longer and slightly wider than the siphonal, and provided with some seven or eight short, rather unequal, merely digitate, and palmately spreading terminal and lateral branchlets; second lateral sinus narrower, but as long as the first on the outer or siphonal side, and much shorter on the umbilical, having two short, unequal, digitate, terminal branches at the end, and some three or four short, irregular divisions along the oblique margin of the umbilical side; second lateral lobe small, or scarcely more than twice as large as the auxiliary lobe of the siphonal sinus, and somewhat irregularly bifid, the divisions being short, and, like the lateral margins, more or less digitate.

"Greatest diameter of a specimen retaining only a small portion of the non-septate outer whorl, 4.40 inches; greatest convexity of same, 0.95 inch; breadth of umbilicus, 1.35 inches; breadth of the last whorl from the siphonal to the umbilical side, 1.80 inches."

The description of the septum above given was made out from a weathered specimen that did not show all the details clearly. The one I have figured is drawn from a smaller specimen, and it is therefore not quite so deeply divided as the one originally figured. There are also slight differences in the forms of the second lateral lobe and the second saddle, but these are in part due to errors in restoring the septum of the type. It will be seen by the figure now given that the septum is very similar to those of the other species of *Prionocyclus* above described.

In the young stages of this species the costæ are simple, linear, closely arranged, and strongly curved forward. The keel is then minutely crenate, with one crenation for each costa. After the third volution some of the costæ are more strongly developed and bear nodes or small spines at their outer ends while the intermediate ones become obsolete. The crenations of the keel still continue numerous and small.

One of the specimens figured (Fig. 2) has unusually strong spines around the periphery and the larger costæ are farther apart than in the other specimens of the same size.

This species is more closely related to *Prionocyclus wyomingensis* than to any other described American species. It can be easily distinguished by its more compressed form, by the greater regularity of the costæ, and by the much greater difference between its young and adult stages.

Locality and position.—The types came from "Banks of Canadian; lower part of Middle Cretaceous of New Mexican section." I have collected it near Mancos, southwestern Colorado, about 400 feet above the base of the Colorado Cretaceous shales, where it is associated with *Ostrea lugubris* and *Inoceramus dimidius*.

Genus PRIONOTROPIS Meek.

PRIONOTROPIS WOOLGARI Mantell (sp.).

Pl. XLII, Figs. 1–4.

Ammonites woolgari Mantell, 1822, Geol. of Sussex, p. 197, Pl. 22, Figs. 6 and 7; Sowerby, 1829, Min. Conch., VI, p. 25, Pl. 587, Fig. 1; Sharpe, 1853, Fossil Remains Moll. Chalk of England, p. 27, Pl. 2, Figs. 1 and 2, and various other European authors; Meek and Hayden, 1861, Proc. Acad. Nat. Sci. Phila., p. 421.

Prionocyclus (*Prionotropis*) *woolgari* Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 455, Pl. 7, Figs. 1*a–h* and Pl. 6, Fig. 2.

Not *Ammonites woolgari* d'Orb. Paleont. Franç. Terr. Crét., vol. I, Pl. 108, Figs. 1–3.

Ammonites percarinatus, Hall and Meek, 1856, Mem. Am. Acad. Arts and Sci., 2d ser., vol. V, p. 396, Pl. 4, Fig. 2.

Compare *A. bravaisianus* and *A. carolinus* d'Orb., op. cit., Pl. 91.

Meek's description is as follows:

"Shell attaining a medium size, more or less compressed-discoidal, the outer turn being proportionally more convex (including nodes) than those within; umbilicus about equaling the greatest dorso-ventral diameter of the last turn; each volution embracing about one-fifth of the next within, and having its umbilical margin slightly indented by the uncovered nodes forming the inner of the two outer rows on the succeeding volution within. Young examples, half an inch to one inch in diameter, with costæ linear, closely arranged, of nearly uniform size, and manifesting scarcely any tendency to develop nodes, but already showing the forward curve of their outer ends well defined, while the peripheral keel is low, narrow, and simple, and the furrow on each side shallow. At a somewhat larger size, costæ usually more or less unequal in size, the larger ones now beginning to develop the two nodes at their outer curved ends, and to become a little more prominent and compressed at their inner extremities, while the rather more prominent keel begins to develop its crenate outline, and the nodes nearest it to assume their compressed form and parallel arrangement. On attaining to 2½ to 3 inches in diameter, costæ, nodes, and keel becoming more prominent, the latter being strongly compressed and deeply and largely scalloped, with divisions rounded in outline; while at this stage of growth, the periphery, as seen in profile, would seem to be very deeply sulcated on each side of the keel, but this is due to the prominence of the row of nodes on either side of the same. Costæ, when the shell has attained a diameter of 4 inches, much depressed in the middle, with the nodes at their inner ends thicker and more obtuse, and those nearest the keel more depressed or nearly obsolete, while those of the third series, near by, become much enlarged and produced obliquely outward as short, thick, spine-like projections. Soon the outer compressed nodes disappear, and the keel is only represented by distinctly separated, low, elongated nodes; and when the shell has attained a diameter of 7 inches, the costæ are more distant, greatly elevated, compressed, and almost wing-like, but still retain a large, prominent, subtrigonal node or projection at their outer ends, and again become, as it were, pinched up at their inner extremities, which do not quite reach the umbilical margin.

"Septa moderately close together; siphonal lobe longer than wide, with three or four short branches on each side, the two terminal of which are largest, more or less nearly parallel, and merely serrated; first lateral sinus broader than the siphonal lobe, more or less deeply divided into two subequal branches with short, irregular branchlets and digitations; first lateral lobe somewhat longer that the siphonal and tripartite, with short, irregular branchlets and digitations occasionally in small specimens, with the middle terminal branch proportionally broad and so deeply sinuous at the end as to impart more nearly the appearance of a bipartite arrangement of the whole; second lateral sinus nearly resembling one of the divisions of the first, and in the adult with merely a number of marginal digitations; second lateral lobe little more than one-third as long, and from one-third to one-half as wide as the first, generally tripartite at the end, but sometimes, in large specimens, bipartite on one side of the shell (see Fig. 1*h* of our Pl. 7), the divisions being very short and simple, or serrated; third lateral sinus very small and merely bilobate, or in large specimens digitate along the margins; third lateral lobe hardly half as long as the second, and in small specimens (it has not been seen in the large ones) merely tridentate at the end.

"Largest specimen seen (with a part of the nonseptate portion wanting), 7 inches in its greatest diameter; convexity, measuring between the costæ at the larger broken end of the last turn, 1.60 inches; convexity of the same, measuring so as to include the greatly expanded costæ, 3.25 inches."

This species was fully illustrated by Prof. Meek (loc. cit.) and copies of several of his figures showing some of the stages of development are here given. So far as can be determined from the figures and descriptions of Mantell's types there is no reason for separating the American from the English forms, but those figured under the same name by d'Orbigny are entirely different, and it seems to me that the forms referred to *Ammonites woolgari* by Schlüter [1] probably also belong to another species. *Ammonites bravaisianus* and *A. carolinus* are probably immature specimens of *P. woolgari*, as Prof. Meek suggested. At least they can be exactly duplicated by young individuals of the American species. If these really are distinct from Mantell's species I think that our species is also different, but this can not be decided until the young stages of the English form are more fully known, and all the evidence now available supports the opinion that they are identical.

There has been some confusion in regard to the generic relationships of this species. Meek [2] made it the type of *Prionotropis*, which he

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[1] Schlüter, C., Cephalop. d. oberen deutsch, Kreide, Palæontographica, vol. XXI, Pls. 9 and 12.
[2] Op. cit., p. 453.

regarded as a subgenus of *Prionocyclus*. When Neumayr described the genus *Acanthoceras*, he cited *A. woolgari*[1] as an example of that genus, but in the same paper he referred *A. bravaisianus*, which may be the young of the same species to *Schloenbachia*, a genus that as originally defined included *Prionocyclus* and *Mortoniceras*. In Zittel's Handbuch der Paleontologie the same inconsistency is repeated, as *A. woolgari* is listed under *Acanthoceras*, while both *Prionotropis* and *Prionocyclus* are treated as synonyms of *Schloenbachia*. On this point in a personal letter to the writer, Prof. Alpheus Hyatt says: "The type of this genus [*Acanthoceras*] was in my opinion the *Amm. angulicostatus* d'Orb. If this be granted, *Prionotropis* must be considered as the type of another genus, since no one having the latest views with regard to the Ammonitinæ would be apt to place it in the same group with *Acanth. angulicostatum* unless unacquainted with the history of the development of the individual in both of these types." Prof. Hyatt regards *Prionotropis* as generically distinct from *Schloenbachia* and *Prionocyclus* also, although it seems to me to have much closer affinities with the latter genus than with *Acanthoceras*.

Locality and position.—Southeast base of the Black hills, South Dakota, and on the Missouri river 5 miles below the mouth of Vermilion river in the Fort Benton shales. It is also reported from the same horizon in northeastern Nebraska, in New Mexico, and 8 miles north of Fort Lyon, Colorado, and from the Eagle Ford shales in Texas.

In Europe the species seems to be confined to the Turonian.

PRIONOTROPIS HYATTI n sp.

Pl. XLII, Figs. 5–8.

Compare *Ammonites meekianus* Shumard, 1860. Trans. St. Louis Acad. of Sci., vol. I, p. 592, and *Ammonites graysonensis* Shumard, ibid., p. 593.

Shell of rather small size, compressed discoidal, consisting of five or six whorls; volutions gradually increasing in size, embracing the earlier ones but very slightly so that the umbilicus is broad, though different specimens vary somewhat in this respect. In very young examples the height of the whorls is greater than the breadth, the keel is small, and more or less crenate, and the costæ are simple, linear, and strongly curved forward at the outer ends, without any nodes at first. Usually every third or fourth costa is stronger than the others. Some specimens three-fourths of an inch in diameter are scarcely distinguishable from the young of *Prionotropis woolgari* excepting that usually the costæ are slightly more unequal. As the shell continues to grow the inequality of the costæ becomes more marked and each of the larger ones develops two nodes near the outer end where it curves forward, and on some of them there is also an elongated node near the umbilicus.

[1] Deutsch. Geol. Gesell. Zeitschr., vol. XXVII, 1875, p. 929.

At first the two outer nodes are equal, one being just on the angle between the side and the abdomen and the other about halfway between it and the keel, but at a later stage the nodes nearest the keel become obsolete, while the others rapidly increase in size, and some of them are developed into prominent sharp spines that are directed obliquely outward and backward. On the outer whorl of the larger example the costæ becomes distant, apparently by the suppression of the intermediate smaller ones.

While these changes in the surface ornamentation are developing, the form of the volution is also considerably altered. The abdomen becomes flattened on each side of the narrow, prominent keel, the sides become less convex, and the breadth of the whorl is finally almost equal to the height, so that its cross section is subquadrate.

The keel in all the larger specimens is usually more or less serrate, the serration equaling the costæ, though sometimes it is only slightly sinuous and it is never completely divided into nodes as it is in *Prionotropis woolgari.* Septa very much like those of *Prionotropis woolgari*, as is shown by the figures.

None of the specimens show the complete living chamber, but the well-developed spines and other features of the surface ornamentation seem to be adult characteristics, and it is therefore probable that the species never attained a very large size. The largest one before me measures 47^{mm} in diameter; the outer whorl is 16^{mm} in height, exclusive of the keel, and 15^{mm} in breadth. Some of the spines on specimens of this size are 6^{mm} or 7^{mm} long. Some fragments apparently of this species belonged to larger individuals.

The development of this species is very much like that of *P. woolgari*, but at the same time it shows many of the features of *Prionocyclus wyomingensis.*

Ammonites meekianus was described from fragments of the outer volution of a specimen that seems to have had about the same form as our species, but it was much larger than any of the examples I have seen. The description of the septum shows that it had the same general form as in *P. hyatti*, but the abdominal lobe is said to be broader than the first lateral, while the opposite is true in ours. The species has never been figured, and there are no specimens of it in the National collection.

I have not seen *Amm. graysonensis*, but judging from the description and a figure of one of the types it might be founded on the young of either this species or *P. woolgari.* The types of these two species came from near Sherman, Texas, in beds probably equivalent with the Fort Benton.

Locality and position.—Abundant in the Pugnellus sandstone at many localities in Huerfano park, Colorado, where the types were obtained. A few specimens were found associated with the same fauna in the "first and second ridges" of the section at Coalville, Utah.

PRIONOTROPIS? LŒVIANUS White (sp.).

Pl. XLIII, Figs. 3 and 4.

Ammonites lœvianus White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 201, Pl. 19, Figs. 1*a* and *b*.

Original description:

"Shell moderately large, robust; volutions four or more, increasing rapidly in size, especially the outer one, so that the umbilicus is rather deep but yet showing all the volutions, each volution embracing between one-quarter and one-third of the width of each preceding one; transverse section of outer volution, between the nodes, oval-subquadrate; surface, upon each side, marked by a row of moderately elevated, transversely elongate nodes, situated about one-third of the distance from the umbilicus to the dorsum [abdomen]; and also by a row of very prominent nodes on each side of the dorsum [abdomen]. Each of these rows consists of the same number of nodes. The dorsal [abdominal] nodes diverge strongly, but are wholly embraced by each succeeding volution, and do not therefore appear in the umbilicus. Between these two rows of dorsal [abdominal] nodes, the dorsum [abdomen] is slightly convex, and the outer surface of the shell appears to have been marked by a small median carina. Between these nodes and the umbilicus the sides of the volution are broadly convex.

"A greater transverse elongation of the lateral nodes than exists on our example would make each continuous with its corresponding dorsal node, which would give to each lateral pair of nodes the character of a rib. It is not improbable that this modification may be found to exist in some examples of the species.

"Septa complex; dorsal [abdominal] lobe and part of dorsal [abdominal] saddle unknown; superior lateral lobe moderately large, but not bifid; inferior lateral lobe small, narrow, not bifid; accessory lobes and saddles more or less deeply notched or dentate.

"Diameter of the only example in the collections, the larger part of the outer chamber being broken away, 14 centimeters.

"Specific name given in honor of Dr. Oscar Lœw.

"*Position and locality.*—Strata of the Cretaceous period; Ojo de los Cuervas, New Mexico."

The type specimen is the only one known that can be positively referred to this species. It is considerably weather-worn on the abdomen, so that the abdominal lobe of the septum is destroyed, and it is impossible to say whether the shell had a keel or not. The character of the ornamentation and of the septum, so far as it is preserved, suggests relationship with *Prionotropis woolgari* and it is provisionally referred to the same genus. It is considerably more involute than the species just mentioned.

Ammonites nodosoides, as figured by Schlüter,[1] resembles this species

[1] Palæontographica, vol. XXI, p. 19, Pl. 8.

closely. Both it and *Ammonites woolgari* have been referred to *Acanthoceras* by some authors, while other species that seem to me related to it, such as *Amm. michelinianus* and *Amm. regularis* have been assigned to *Hoplites*.

P. lævianus is included in the fauna of the Colorado formation because no *Ammonites* of the same type are known in higher strata and because fragments that are believed to belong to this species have been found in the Fort Benton shales of Colorado.

Genus MORTONICERAS Meek.

MORTONICERAS SHOSHONENSE Meek.

Pl. XLIII, Figs. 1 and 2.

Mortoniceras shoshonense Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 449, Pl. 6, Figs. 3*a*, *c* and 6*b*.

"Shell compressed-discoidal, with umbilicus apparently nearly or quite twice as wide as the outer whorl; volutions very narrow, with dorso-ventral and transverse diameters equal, and section subquadrangular, those within scarcely one-sixth embraced by the succeeding turn; costæ each mainly represented by two nodes, the inner of which is low, compressed, and elongated so as to extend from near the umbilical margin about halfway across the sides, while the outer near the peripheral margin are more prominent, rounded, and directed laterally; keel less prominent than the row of compressed nodes on each side about halfway between it and the rounded nodes along the margins of the periphery; compressed nodes on the periphery of each inner turn covered by the succeeding volution, the inner margin of which is indented by the rounded lateral nodes of that next within.

"Septa moderately approximate; siphonal lobe oblong, about once and a half as long as wide, with small, short, nearly parallel, serrated terminal branches, and three or four very short, digitate, and simple branchlets and points on each side; first lateral sinus wider than the siphonal lobe (which it equals in length), unequally bipartite at the anterior end, both divisions being digitate, and the larger one on the siphonal side deeply bifid; first lateral lobe somewhat longer, but narrower than the siphonal, and having its terminal division deeply bifid, and its lateral margins bearing a few very nearly simple branchlets; second lateral sinus scarcely more than half as wide as the first, and much shorter on the umbilical side, unequally bifid or trifid at the end, with more or less sinuous margins; second lateral lobe only about half as long and wide as the first, and trilobate, with the small middle division emarginate at the end; third lateral sinus a little shorter and narrower, and irregularly tridentate at the end; antisiphonal lobe about as long as the first lateral, but narrower, with a few short, nearly simple, lateral divisions, and a tridentate posterior extremity.

"Having only a fragment of this species, no measurements of the size and proportions of the shell can be given. As this fragment shows the form and ornamentation, however, of the volutions, and very clearly all of the details of the septa, there will probably be no difficulty in identifying it. At one time I was rather inclined to regard it as a variety of *M. vespertinum* Morton; but as the costæ in that species seem to be very constant in the possession of four nodes each, while on the form here described each rib is represented by two nodes, and these of different forms, I can not believe it the same species.

"*Locality and position.*—Head of Wind river valley, Wyoming; from the Fort Benton group of the upper Missouri river Cretaceous series."

It is not improbable that this species, and possibly *M. vermilionense* also, is identical with *Amm. vespertinus* Morton (=*Amm. texanus* Roem.), as Meek suggested, but until other collections are made from the upper Missouri localities I prefer to leave them under separate names, giving copies of Meek's descriptions.

MORTONICERAS VERMILIONENSE M. & H.

Pl. XLIV, Fig. 1.

Ammonites vermilionensis Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., p. 77.
Mortoniceras vermilionense Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 450, Pl. 7, Fig. 2*a*, *b*.

"Shell compressed-discoid, with its shallow umbilicus about one-fifth wider than the last turn; volutions increasing gradually in size, with convexity about three-fourths the dorso-ventral diameter, each turn less than one-fifth embraced by the succeeding outer one; costæ simple and closely arranged in the very young shell, but gradually becoming larger, more distant, and a little thickened at their inner and outer extremities, which latter are slightly curved forward, in examples an inch or so in diameter; peripheral keel moderately prominent, with the depression on each side shallow.

"Septa not crowded; siphonal lobe oblong, about one-fourth longer than wide, with two short, narrow, equal or subequal, nearly simple lateral branches, the two terminal of which are diverging and moderately distant; first lateral sinus as long and nearly twice as wide as the siphonal lobe, and deeply divided into two nearly or quite equal parts, with merely sinuous and obtuse digitate margins; first lateral lobe slightly longer than the siphonal, and of about the same breadth, with some five or six spreading, unequal digitations at the posterior end, the middle two of which sometimes become more prominent, so as to give a slightly bifid appearance to the extremity; second lateral sinus short, or scarcely more than half as long on the inner side as the first, subquadrate in form, with shallow marginal sinuosities; the mesial very shallow indentation, causing a faint tendency to a bilobate outline at the anterior extremity; second lobe very small, or even less than the auxiliary lobe of the first lateral sinus, about twice as long as wide, narrower, and truncated at its posterior end, with a very few shallow sinuosities along its lateral margins; third lateral sinus hardly half as long or wide as the second, and merely faintly bilobate at the end; third lateral lobe a little oblique, simple, and smaller than one of the principal terminal digitations of the first lateral lobe.

"Greatest diameter, 1.10 inches; convexity, about 0.26 inch.

"The little specimen from which the foregoing description was made out is doubtless a young shell. If not, it would not properly go into the group *Mortoniceras*, as its costæ and periphery are without nodes; the former being also more curved forward at their outer ends than is usual in the typical species of the same. Its costæ, however, on the outer volution show rather a distinct thickening at both extremities, and it is very probable that in larger adult individuals distinct nodes are developed. The lobes and sinuses of the septa would doubtless at that size be found more deeply divided and branched.

"It is on the supposition that this shell is a young example, in which the usual characters of the group *Mortoniceras* have not been fully developed, that I here refer it to that group. It might even be a young of the last, or of *M. vespertinum*.

"It is evidently not a young specimen of *Prionotropis woolgari*, as its costæ are broader and decidedly straighter than those of that species of the same size, and show no traces of the double node usually seen at their outer ends, even in smaller examples of the same; while its keel is also without the obscure crenulations of that shell, and the volutions less compressed. It is true that the crenulations of the keel in specimens of *P. woolgari* of this size are not well developed; but traces of them can usually be seen near the larger extremity of the outer turn at that stage of growth.

"*Locality and position.*—Mouth of Vermilion river, Nebraska, on the Missouri; where it was found in the Fort Benton group of the upper Missouri Cretaceous series."

STEPHANOCERATIDÆ.

Genus ACANTHOCERAS Neumayr.

ACANTHOCERAS ? KANABENSE n. sp.

Pl. XXXVI, Figs. 6–8.

Shell discoidal with convex, slightly embracing whorls whose breadth is greater than the height; umbilicus about equal to the shorter diameter of the outer whorl; abdomen broad and gently convex with three rows of closely arranged rounded nodes, one on the median line and the others on either side half way between it and the peripheral margin. On the outer whorls the nodes of the median row tend to unite into a low keel. Sides of the whorl somewhat flattened; costæ on the earlier whorls numerous, angular, unequal in size and strongly curved forward in passing from the umbilicus to their termination at the outer rows of the abdominal nodes. On about the second whorl a few nodes begin to develop near the umbilical margin and a larger number of stronger ones form a row near the peripheral margin. Occasionally two costæ unite at one of these outer nodes and again divide on leaving it. As the shell grows the smaller costæ disappear and the larger ones become rounded and less prominent until on the outer whorl of specimens an inch and a half in diameter each is represented by two large round nodes. At this stage there are about twice as many nodes in each row of the abdomen as there are in the row near the peripheral margin, so that all the suppressed costæ are apparently still represented by nodes on the abdomen.

Septa not very complex; the lobes all bipartite and the saddles more or less distinctly tripartite at their extremities. Abdominal lobe large and rather slender, being nearly twice as long as broad; first lateral saddle about the size of the abdominal lobe; superior lateral lobe much broader than the first lateral saddle, deeply bifid; inferior lateral lobe and saddle with the forms of those just described but much smaller. There are one or two very small auxiliary lobes and saddles.

The type specimens are three young shells and two fragmentary older ones, all of which are septate throughout. The largest specimen gives the following measurements: Diameter, 49^{mm}; height of outer volution, 16^{mm}; breadth of same, 26^{mm}.

This species seems to fall into the genus *Acanthoceras*, as defined in Zittel's Handbuch der Paleontologie, though that genus is made to include a number of groups that are apparently not very closely related. *Acanthoceras angulicostatum*, which may be regarded as the type of the genus, is certainly very different from our form. The latter seems to be related to *Amm. coleroonensis* Stoliczka.[1] The suture is of the same character and the form as shown in the small specimen (Fig. 4 of same plate) is quite similar, though there is no abdominal keel and the costæ pass entirely across the abdomen.

Locality and position.—Upper Kanab, Utah, about 350 feet above the base of the Cretaceous section. Another specimen collected from the Austin limestone near New Braunfels, Texas, belongs to the same or a closely related species.

Genus SCAPHITES Parkinson.

SCAPHITES LARVÆFORMIS Meek and Hayden.

Pl. XLIV, Fig. 2.

Scaphites larvæformis Meek and Hayden, 1856, Proc. Acad. Nat. Sci. Phila., p. 58; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 418, Pl. VI, Figs. 6*a*, *b*, *c*.

Revised description:

"Shell small, transversely subovate, compressed, evenly rounded on the periphery; volutions slender, nearly round, the inner or coiled ones forming only a very small part of the entire shell, and so closely involuted as to leave only a very small umbilical pit; extended body-portion

[1] Fossil Cephalopoda of Southern India, Pl. XXXVII.

rather long, slender, and straight to the recurvature, thence continued backward until it comes nearly in contact with coiled inner volutions; aperture apparently circular; surface ornamented by small costæ, which pass from the inner side of the volutions to about half way across their lateral surfaces, where they swell into small, obscure, transversely elongated nodes, and then branch each into two or three smaller linear ribs, all of which pass straight over the periphery.

"Length, 0.87 inch; height, 0.63 inch; convexity, 0.33 inch.

"The septa of this species are comparatively rather simple, being each provided with but two principal lateral lobes on each side, none of which are deeply divided. The siphonal lobe is longer than wide, and has two very small, short, nearly parallel, obscurely bifid terminal divisions, with a more oblique, somewhat similar branch on each of the sides above. The first lateral sinus is wider than the siphonal lobe, and nearly as long, with its extremity deeply divided by a slender, obscurely trifid, auxiliary lobe, into two very unequal, more or less sinuous, and obtusely digitate branches. First lateral lobe about half as wide as the siphonal, but somewhat shorter, and bearing two very small terminal divisions similar to those of the siphonal lobe. Second lateral sinus not larger than the outer division of the first, and merely obscurely divided into very short, simple, obtusely rounded terminal subdivisions. Second lateral lobe very small and obscurely trifid at the end. Whether this last is what is usually called a ventral lobe, or whether there is another still smaller one beyond it, the specimen is scarcely in a condition to show.

"At one time I was inclined to think a very small species described by Dr. Shumard from the Cretaceous rocks of Texas, under the name *Scaphites vermiculus*, might be identical with this; but a sketch of that species sent to me some years back by Dr. Shumard shows it to be entirely distinct, being even a more slender, differently marked shell, with a proportionally much larger umbilicus and a longer deflected body-portion; that is to say, it presents the characters of the distinct section *Macroscaphites*.

"This species is perhaps more nearly allied to *S. Hugardianus* d'Orbigny,[1] than to any other foreign form, but yet differs too much to require a critical comparison or detailed statement of differences.

"*Locality and position.*—Eastern base of the Black hills; from the Fort Benton group of the upper Missouri Cretaceous series."

SCAPHITES VERMIFORMIS Meek and Hayden.

Pl. XLIV, Fig. 3.

Scaphites vermiformis Meek and Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 22; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 423, Pl. 6, Figs. 4*a*, *b*.

Revised description:

"Shell under medium size, ovate subdiscoidal in form; umbilicus very small; inner regularly coiled volutions closely involute, deeply

[1] Pal. Fr., 1, Terr. Crét., 525.

embracing and composing a rather large portion of the entire shell; deflected part very short, so as only to be slightly disconnected from the inner turns at the aperture, which is a little contracted and quadrato-subcircular in outline, with a slightly sinuous inner margin; surface ornamented by numerous straight costæ, which are rather small and nearly regular on the inner volutions, but become more distant and larger, as well as much more prominent, on the inner half of each side of the body-portion, where they each support a prominent node at the outer end, so arranged that those on opposite sides generally alternate; costæ all passing nearly straight across the periphery, on which they are of nearly uniform size, with the exception of their regular enlargement with the whorls.

"The nodes mentioned above are directed out at right angles to the sides of the shell, and, like the costæ, become again smaller toward the aperture. Most of the large costæ bifurcate at the nodes on the body-part of the shell, but their number is also increased by the intercalation of others between. Where they thus branch at the nodes on one side, the two divisions crossing over the periphery from the point of bifurcation never both connect at a node on the opposite side, but in most cases one, and sometimes each division, terminates between two of the nodes on the other side.

"The septate portion of the only specimen of this species in the collection being highly crystalline, the structure of its septa can not be very clearly traced out. The siphonal lobe, however, can be seen to be a little longer than wide, with a rather narrow body, provided with three branches on each side, the upper pair of which are small and nearly simple; while the next pair are longer and each bifid, and the terminal pair (which are larger than the second) are each ornamented by three small, pointed branchlets, or digitations, on the outer side. The first lateral lobe is somewhat irregularly tripartite; the lateral divisions being bifid and sharply digitate, while the terminal, which is not exactly central, is longer than the others and has about five pointed digitations, or sharp, nearly or quite simple, branchlets. The first lateral sinus can be seen to be deeply divided at the extremity into two nearly equal branches. The second lateral sinus can also be so far traced as to show that it is not more than about one-third as large as the first, nearly as long as wide, and regularly tripartite; and this is as far as the structure of the septa can be made out from the specimen.

"Length, 2.10 inches; height, 1.76 inches; greatest convexity, measuring to the extremities of the nodes on opposite sides, 1.25 inches; same between the nodes, 1 inch.

"This species is somewhat related to *S. hippocrepis* Dekay, sp. (= *Ammonites hippocrepis* Dekay[1]), but differs in having its body-part less extended, and in being higher in proportion to its length. Its nodes are also larger and much more prominent; but the most marked

[1] Ann. N. Y. Lyceum, Nat. Hist., II, Pl. V, Fig. 5.

differences between these two forms are in their septa, the siphonal lobe of the form under consideration being proportionally much narrower, and provided with three, instead of only two, branches on each side, while its first lateral lobe is tripartite (an unusual feature in the genus) instead of bifid. It is also related to *S. Texanus* Roemer,[1] though its septa differ as widely from those of that species as from those of *S. hippocrepis*.

"*Locality and position.*—Chippewa point, near Fort Benton, on the upper Missouri; from the Fort Benton group of the upper Missouri Cretaceous series. Specimen discovered by Lieut. John Mullan, of the United States Topographical Engineers."

SCAPHITES WARRENI Meek and Hayden.

Pl. XLIV, Figs. 4–7.

Scaphites warreni Meek and Hayden, 1860, Proc. Acad. Nat. Sci. Phila., p. 177; White, 1876, U. S. Geog. and Geol. Sur. West 100th Meridian, vol. IV, p. 200, Pl. 19, Fig. 3a; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 420, Pl. 6, Fig. 5; Whitfield, 1880, Geol. Black Hills of Dak., p. 444, Pl. 13, Figs. 1–4.
Scaphites warreni, var. *wyomingensis* Meek, 1876, ibid., p. 421, Fig. 61–63 in text.
Scaphites wyomingensis Whitfield, 1880, ibid., p. 446, Pl. 13, Figs. 5–7.
Compare *Scaphites æqualis* Sowerby.

Meek's description of the type is as follows:

"Shell small, transversely subovate, moderately compressed; inner volutions nearly circular, closely involute, and composing a comparatively rather large part of the entire bulk; deflected body-portion short and (perhaps accidentally) rather more compressed proportionally than the inner turns; surface costate, and without proper nodes; costæ small on the inner volutions, where they do not differ materially in size, but on the body-part about every fourth or fifth one becomes more prominent than the others, and extends entirely across from the inner side to and over the periphery, in passing upon which they bifurcate, or give off lateral branches, so that the whole, with some intercalated ones, assume there a uniform size; aperture and septa unknown.

"Length, 1.45 inches; height, about 1.22 inches; convexity, about 0.57 inch."

The type is an imperfect specimen that does not show the entire form nor the septa. Afterward other examples were found that showed these details and that differed slightly from the type in form and surface ornamentation, so that they could not be positively identified with it, and Mr. Meek therefore called them *Scaphites warreni*, var. *wyomingensis*.

Mr. Whitfield regarded this variety as a distinct species, assigning to it the smaller specimens with more compressed volutions. In discussing its relations with *S. warreni* he says: "The principal differ-

[1] Kreid. von Texas, tab. 1, Fig. 4.

ences, therefore, between the two shells, and those which we deem of specific importance, are the greater length of the deflected part, the laterally compressed form of the volution, and the different direction of the costæ on the straight part of the shell. The two forms are associated at the same localities, and even occur in the same hand specimen of rock, but we think there is no difficulty in distinguishing them."

The septa of the two forms are essentially the same, the only difference being that those of the small specimens assigned to *S. wyomingensis* are slightly less complex. In all of them the septa are much more simple than in most species of the genus. The differences do not seem to me great enough nor constant enough to warrant the reference of these forms to distinct species, especially when we remember that they are associated in the same stratum. Other species of *Scaphites*, such as *S. nodosus*, certainly show greater variations. For comparison, copies are given of Meek's figure of the type of *S. warreni* and of Whitfield's figures of *S. warreni* and *S. wyomingensis*. After careful comparison of this species with *Scaphites æqualis* Sowerby, of the European Cenomanian, Prof. Meek regarded them as very closely allied.

Locality and position.—The type came from the southern base of the Black hills of Dakota, where it was found in the Fort Benton shales. It has been collected from the some horizon at many localities in Wyoming, Dakota, Colorado, New Mexico, and Utah.

SCAPHITES VENTRICOSUS Meek & Hayden.

Pl. XLIV, Figs. 8–10; Pl. XLV, Fig. 1.

Scaphites ventricosus Meek & Hayden, 1862, Proc. Acad. Nat. Sci. Phila., p. 22; Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 425, Pl. 6, Figs. 7 *a, b* and 8 *a, b*.

Revised description:

"Shell attaining a medium or larger size, oval, ventricose, broadly rounded over the periphery; inner turns closely involute, deeply embracing, and composing a large portion of the entire bulk; deflected portion very short; umbilicus very small and deep; aperture transversely sublunate or reniform, but deeply sinuous, and but slightly disconnected from the inner turns on the inner side; surface ornamented with costæ that pass nearly straight over the periphery, where they are of uniform size, excepting their gradual enlargement with the volutions, while on the sides of the last or outer volution, about every fifth or sixth one is larger and more prominent than the intermediate ones, which latter do not extend inward to the umbilical margin.

"The septa, as made out from the specimen represented by our figures 8*a*, *b* (believed to be the inner volutions of this species, as represented by figures 7*a*, *b*) are provided with deeply divided lobes and sinuses. Siphonal lobe longer than wide, and bearing on each side of its very slender body three branches, the two terminals of which are slightly larger than the succeeding lateral ones, and each unequally bifid and digitate; first lateral sinus as large as the siphonal lobe, very narrow at its base, and profoundly divided at its extremity into two unequal branches, of which the one on the siphonal side is larger than the other, and, like the latter, deeply bifid, with sinuous and obtusely digitate margins; first lateral lobe as wide as the siphonal lobe, but somewhat shorter, and provided with two nearly equal, bifurcating, and digitate terminal branches; second lateral sinus not more than half as long, and little more than half as wide as the first, and somewhat similarly divided and subdivided; second lateral lobe about half as long and wide as the first, but tripartite at the extremity, the divisions being nearly equal and digitate; third lateral sinus small and merely provided with two nearly equal terminal branches, with more or less sinuous margins; third lateral lobe hardly more than half as large as the second, and bearing two very short, digitate, terminal divisions. Between the last-mentioned lobe and the umbilicus there is a minute, tridigitate lobe, very similar to the auxiliary lobe of the third lateral sinus, but smaller.

"Length, 3.13 inches; height, 2.65 inches; convexity, 1.90 inch.

"In the style of its ornamentation this species resembles our *S. Warreni*, but it differs, however, remarkably in form and size, being much larger, and proportionally very decidedly more gibbous, with a proportionally smaller umbilicus. As the septa of the type of *S. warreni* are yet unknown, I have not had an opportunity to compare their structure with those of the form under consideration; but it is probable that they will be found to present differences in their details. Certainly those of the Wyoming form, that I now regard as only a variety of *S. warreni*, are quite different."

Locality and position.—Chippewa point on the upper Missouri river, Fort Benton shales.

Scaphites mullananus Meek & Hayden (sp.).

Pl. XLV, Figs. 2–4.

Ammonites mullananus Meek & Hayden, 1862, Proc. Acad. Nat. Sci., Phila., p. 63.
Ammonites?? mullananus Meek, 1876, U. S. Geol. Sur. Terr., vol. IX, p. 607, Pl. 8, Figs. 1*a*–*c*.
Compare *Scaphites subglobosus* Whiteaves, 1885, Cont. to Can. Palaeont, vol. I, p. 52, Pl. 7, Fig. 3 and Pl. 8.

Meek's revised description is as follows:

"Shell compressed-subglobose; rounded on the periphery; umbilicus small, deep, and acutely conical, between one-third and one-half as wide as the breadth of the outer whorl from the dorsal to the ventral side, showing about one-third of each inner volution. Whorls increasing rather rapidly in size, particularly in convexity, sloping on each side from near the umbilicus (with a slightly convex outline) toward the periphery, and rounding abruptly into the umbilicus on the inner side, each of those within deeply embraced by the succeeding turn.

Aperture transversely reniform or sublunate. Surface ornamented by rather small, regular, rounded costæ, which pass nearly straight across the sides of the whorls, and arch slightly forward in crossing over the periphery, on which from thirty-six to forty of them may be counted to every turn; each of those commencing at the umbilicus, usually there a little enlarged, especially on the larger whorls, so as to form a small subnodose prominence. Beyond these they all (particularly on the inner whorls) bifurcate regularly once, near the middle of each side, and on the larger turns others are also intercalated between, so as to make the number on the peripheral side five or six times as great as at the umbilicus.

"The septa are rather crowded, and provided with branched and deeply sinuous lobes and sinuses. The siphonal lobe is about one-fourth longer than wide, nearly obovate in form, and ornamented with three principal branches on each side, the two terminal of which are larger than the others, and each provided on the outer side with two or three more or less digitate lateral branchlets, while the inner parallel margins are merely sharply serrated. The first lateral sinus is of about the same size as the siphonal lobe, a little oblique, nearly oblong in form, and divided at the extremity into two tripartite and obtusely digitate branches, of which the one on the outer side is larger than the other; behind these it is provided on each side with two alternating lateral branches with sinuous margins. The first lateral lobe is narrower and shorter than the siphonal lobe, and provided with two principal branches on each side, the two terminal of which are much larger than the others, and of unequal size, the one on the right or peripheral side being the larger. Both of these terminal branches are distinctly bipartite, the subdivisions being ornamented with several branchlets and smaller digitations. The second lateral sinus is about half as wide and nearly two-thirds as long as the first, more or less oblique, and rather deeply divided at the extremity into two subequal, bifurcating, and obtusely digitate terminal branches. The second lateral lobe is as long as the second lateral sinus, but a little narrower, and ornamented with three variously digitate terminal branches, the middle one of which is longer than the others, a little oblique, and not exactly central. The third lateral lobe is small, being less than half as long, and scarcely two-thirds as wide as the second lateral, and provided with three nearly equal, spreading, digitate, terminal branches. Between the third lateral lobe and the umbilical margin there are two other small, very unequal, lateral lobes, the first of which has two or three digitations on each side, while the second is nearly simple or but slightly sinuous on the margins."

The only examples of this species I have seen are the types, consisting of the specimen figured and a septate fragment of a much larger individual. As the body chamber is lacking these do not show whether the species had its last volution deflected and separated from the rest of the shell, still its apparently close relationship with *Scaphites ven-*

tricosus, as shown by similarity in form and in the character of the septa, seems to justify its reference to the same genus.

Scaphites subglobosus Whiteaves is probably identical with this species. The types of *S. mullananus* agree with the figures of *S. subglobosus* in every respect excepting that they do not show the small nodes near the periphery. The latter is reported from the "East Branch of the Poplar river, on the 49th parallel," where it is said to occur in the equivalents of the Montana formation.

Locality and position.—"Chippewa point, near Fort Benton, on the upper Missouri; Fort Benton group of the upper Missouri Cretaceous series."

ARTHROPODA.

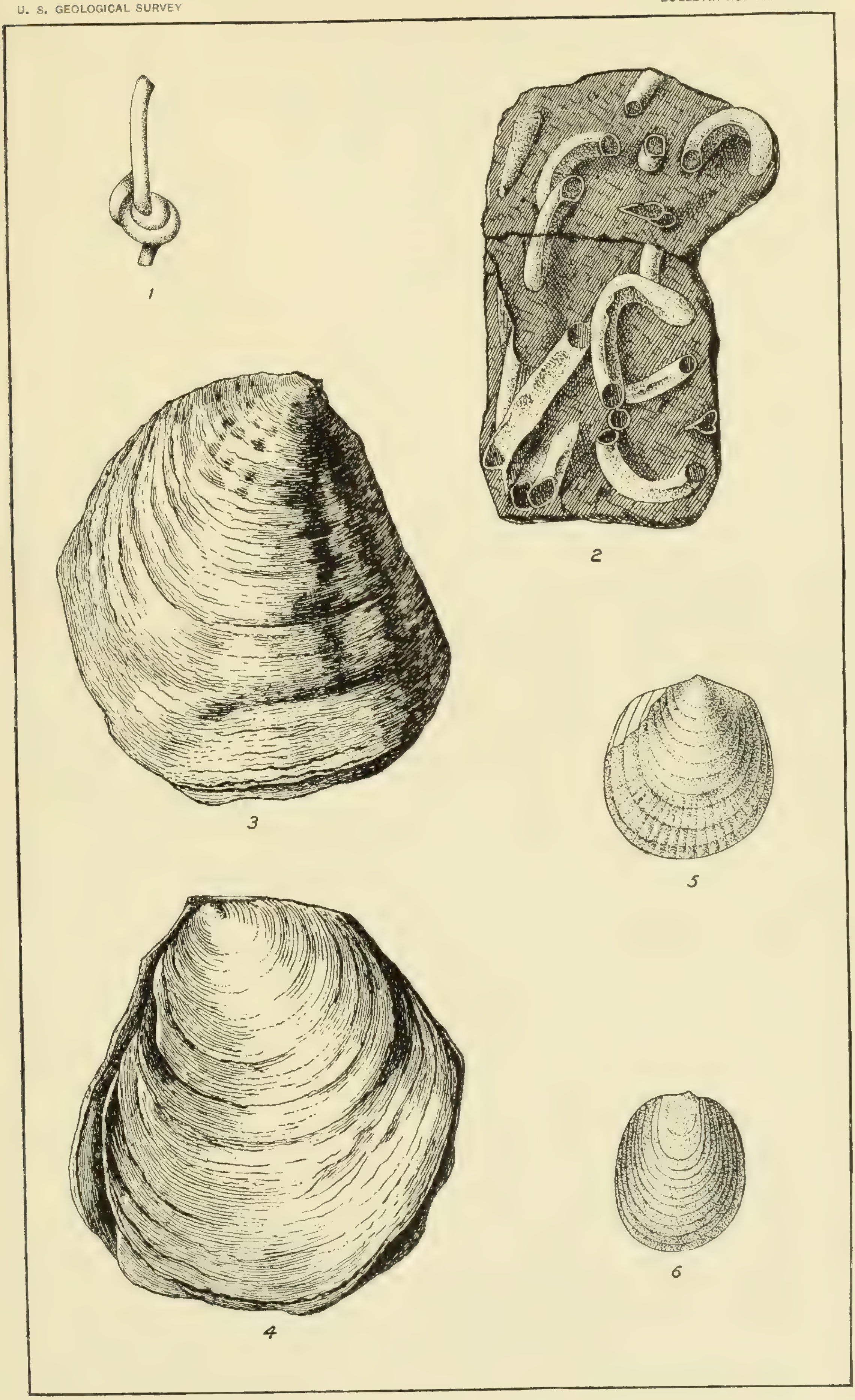
CRUSTACEA.

A few fragments of the legs of a decapod crustacean were found in the Pugnellus sandstone at Poison canyon, Huerfano park, Colorado. They do not show either the generic or specific characters and they are mentioned here simply to record the rare occurrence of crustacean remains in this formation.

PLATES.

PLATE I.

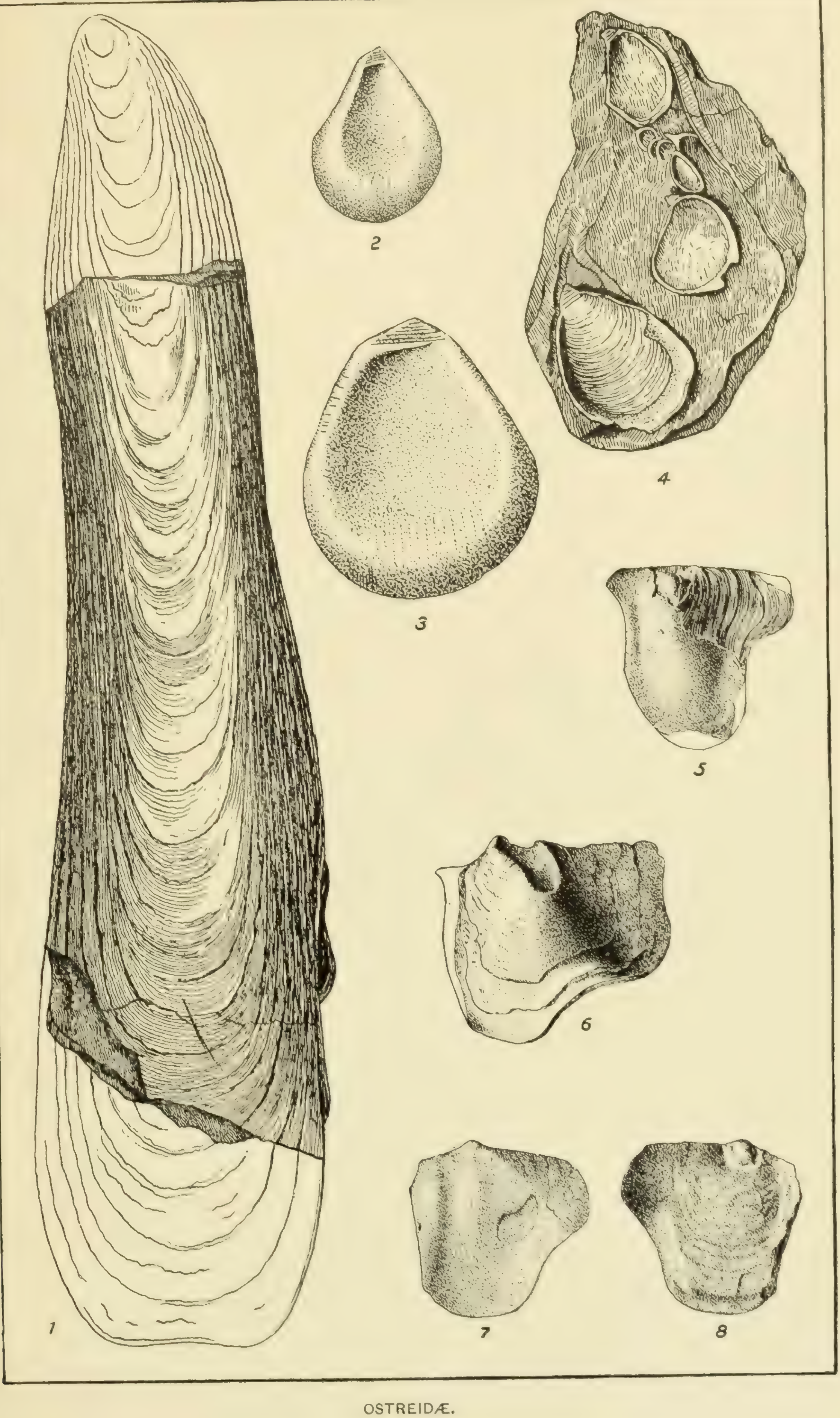
PLATE I.



SERPULIDÆ AND OSTREIDÆ.

PLATE II.

PLATE II.



OSTREIDÆ.

PLATE III.

PLATE III.

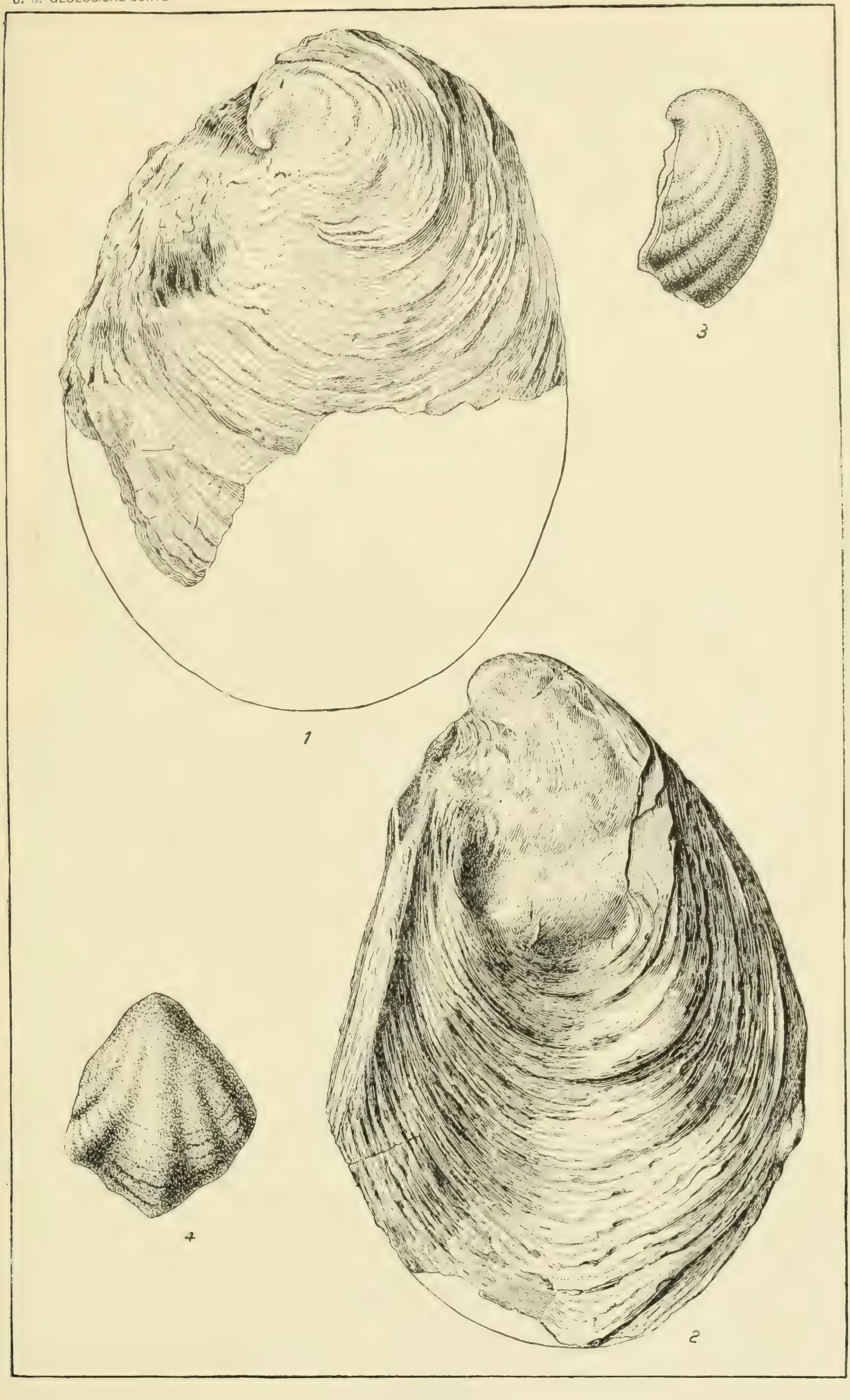
Page.

OSTREA SOLENISCUS Meek 56

Figs. 1, 2. External views of two broad exogyrate upper valves associated with the slender variety at Bear River city, Wyoming, and believed to belong to the same species. See Fig. 1 of Plate II.

OSTREA UNIFORMIS Meek 59

Figs. 3, 4. Two views of the lower valve of the type (after White).



OSTREIDÆ.

PLATE IV.

PLATE IV.

Page.

Ostrea lugubris Conrad 58

Fig. 1. A small lower valve from eastern New Mexico. Conrad's type specimen.
Nat. Mus. Cat. Invert. Foss., 9822.

2. A small upper valve from Huerfano park, Colorado.
Nat. Mus. Cat. Invert. Foss., 22860.

3, 5. External and internal views of small lower valves from Mancos, Colorado.
Nat. Mus. Cat. Invert. Foss., 22859.

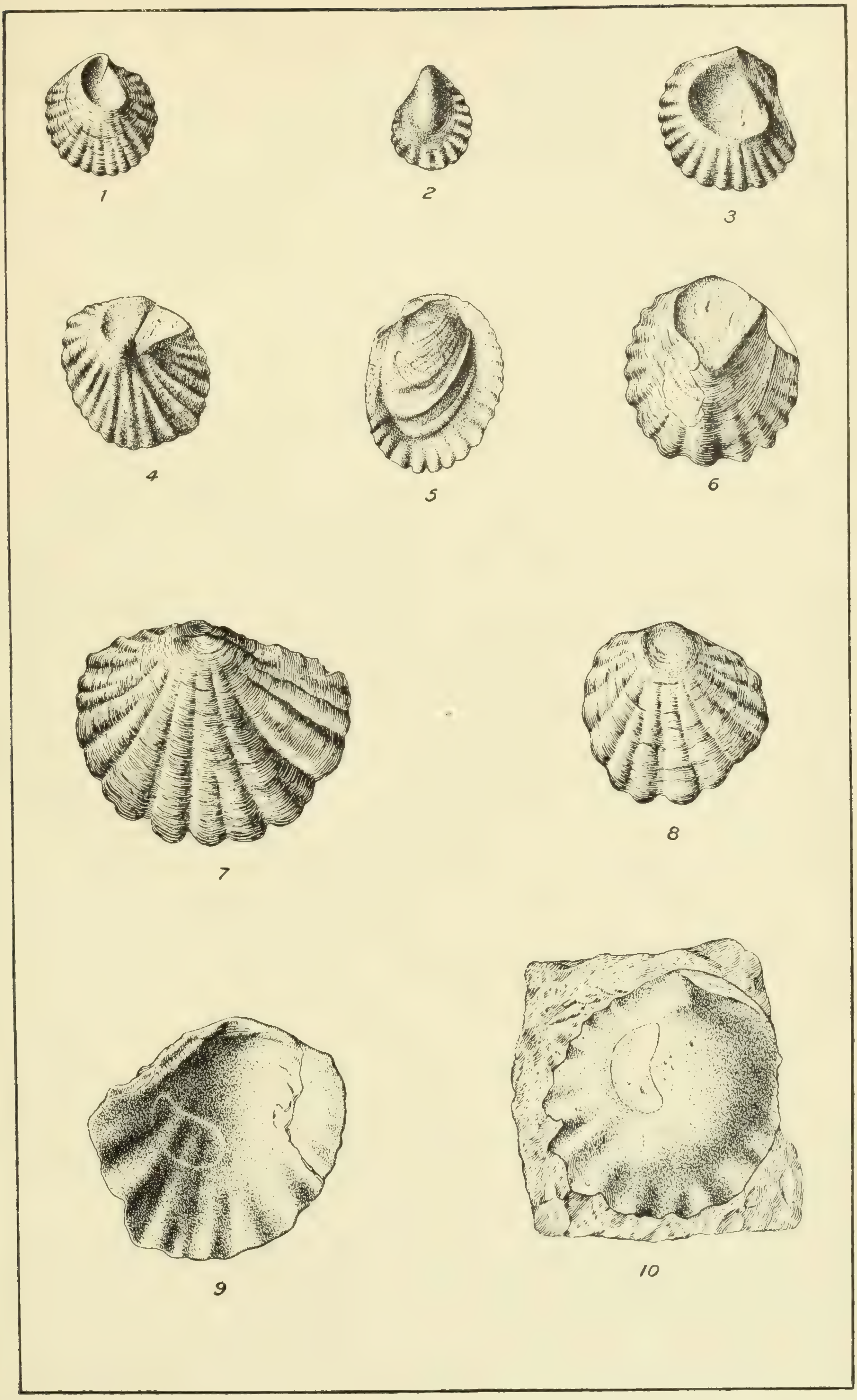
4, 6. Lower valves from Huerfano park, Colorado.
Nat. Mus. Cat. Invert. Foss., 22860.

7. A large lower valve from 20 miles above Pueblo, Colorado.
Nat. Mus. Cat. Invert. Foss., 22861.

8. A small lower valve of *Ostrea bellaplicata* from near Sherman, Texas, for comparison. Nat. Mus. Cat. Invert. Foss., 11882.

9. Interior of lower valve from Huerfano park, Colorado.

10. Cast of interior of upper valve from same region.
Nat. Mus. Cat. Invert. Foss., 22860.

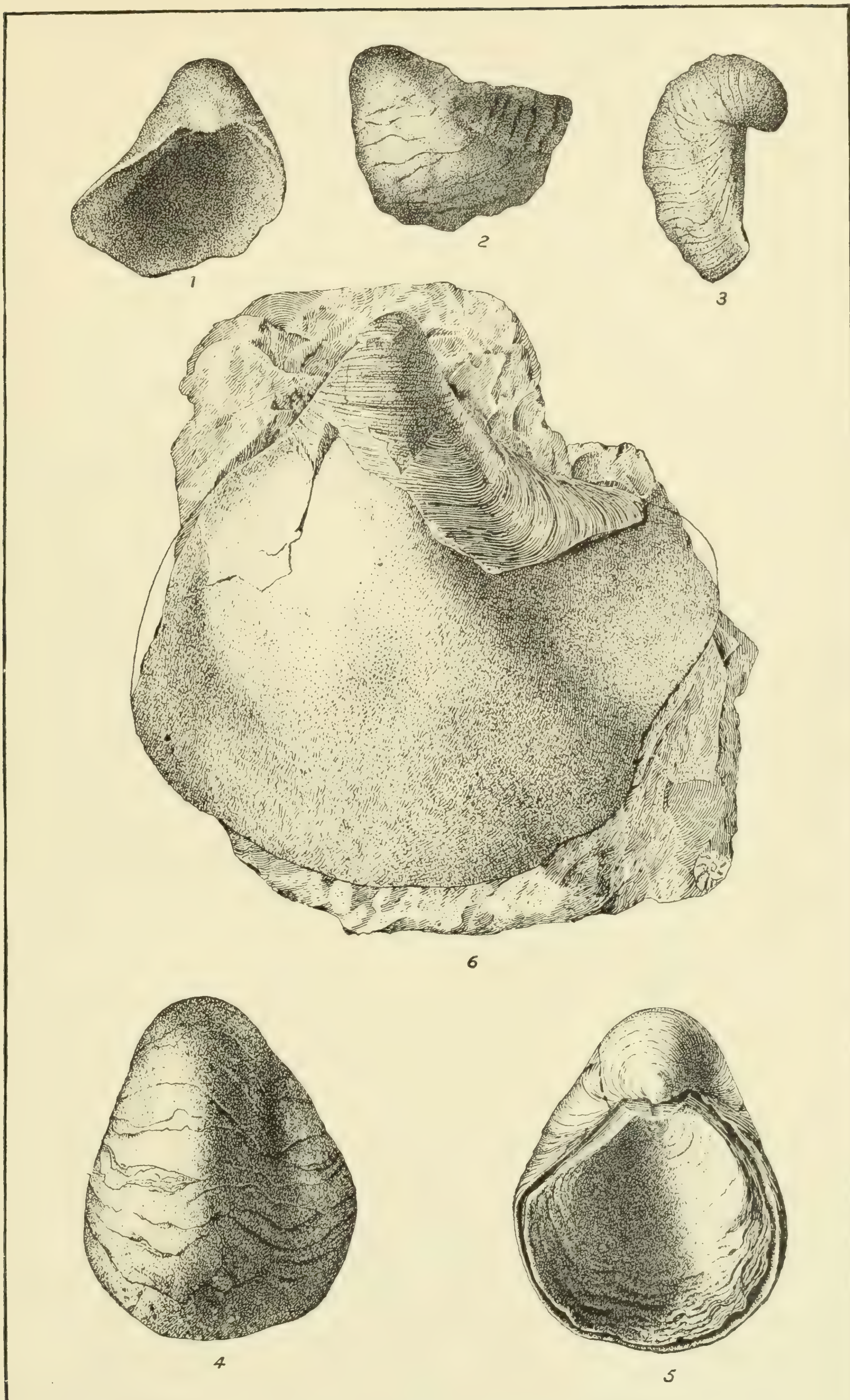


OSTREIDÆ.

PLATE V.

PLATE V.

	Page.
GRYPHÆA NEWBERRYI n. sp	60
Figs. 1, 2, 3. Different views of a small lower valve (after White).	
4, 5. Opposite views of a large specimen with both valves united.	
Nat. Mus. Cat. Invert. Foss., 8775.	
EXOGYRA SUBORBICULATA Lam	62
Fig. 6. Lower valve retaining a portion of the shell.	
(See Pls. VI and VIII for additional figures.)	
Nat. Mus. Cat. Invert. Foss., 22862.	



OSTREIDÆ.

PLATE VI.

PLATE VI.

Page.

EXOGYRA SUBORBICULATA Lam. .... 6?

Fig. 1. Posterior view of the specimen represented by Pl. V, Fig. 6.

2. Cast of another large lower valve. (See Pls. V and VIII for additional figures.)

Nat. Mus. Cat. Invert. Foss., 22862.

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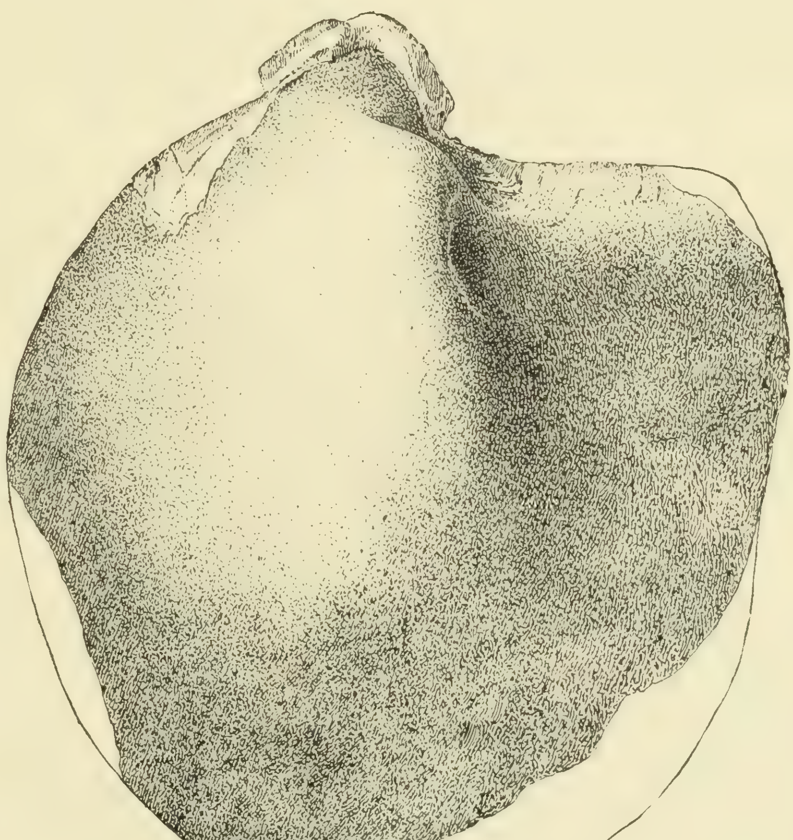


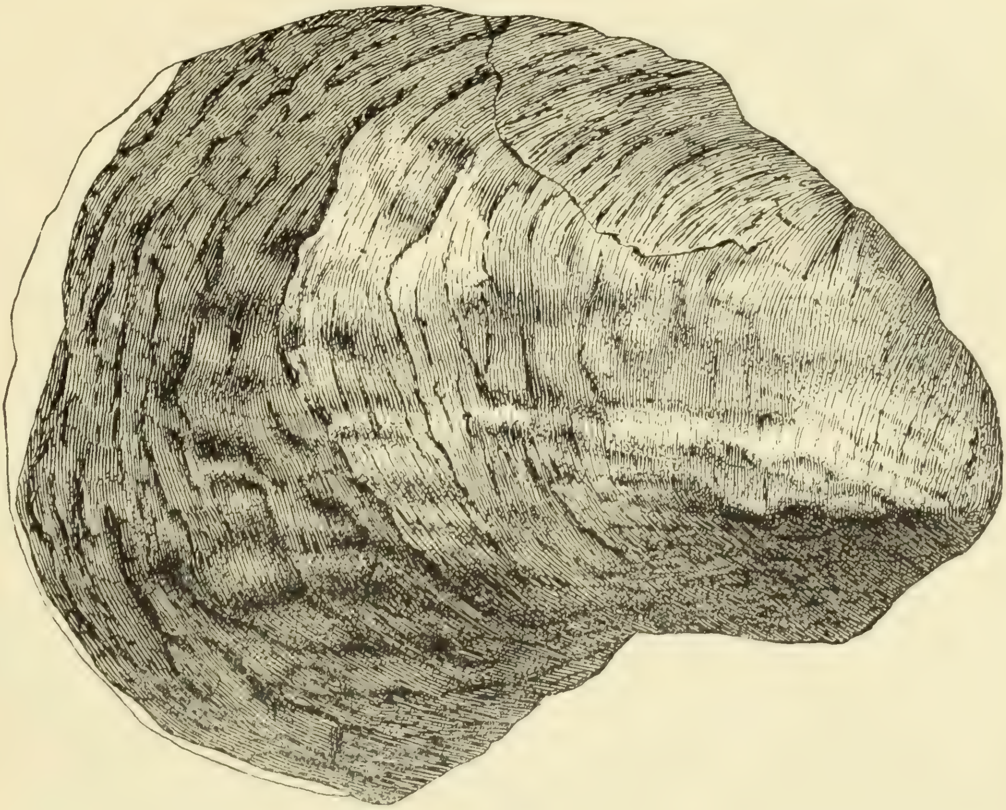
2

OSTREIDÆ.

PLATE VII.

PLATE VII.

1



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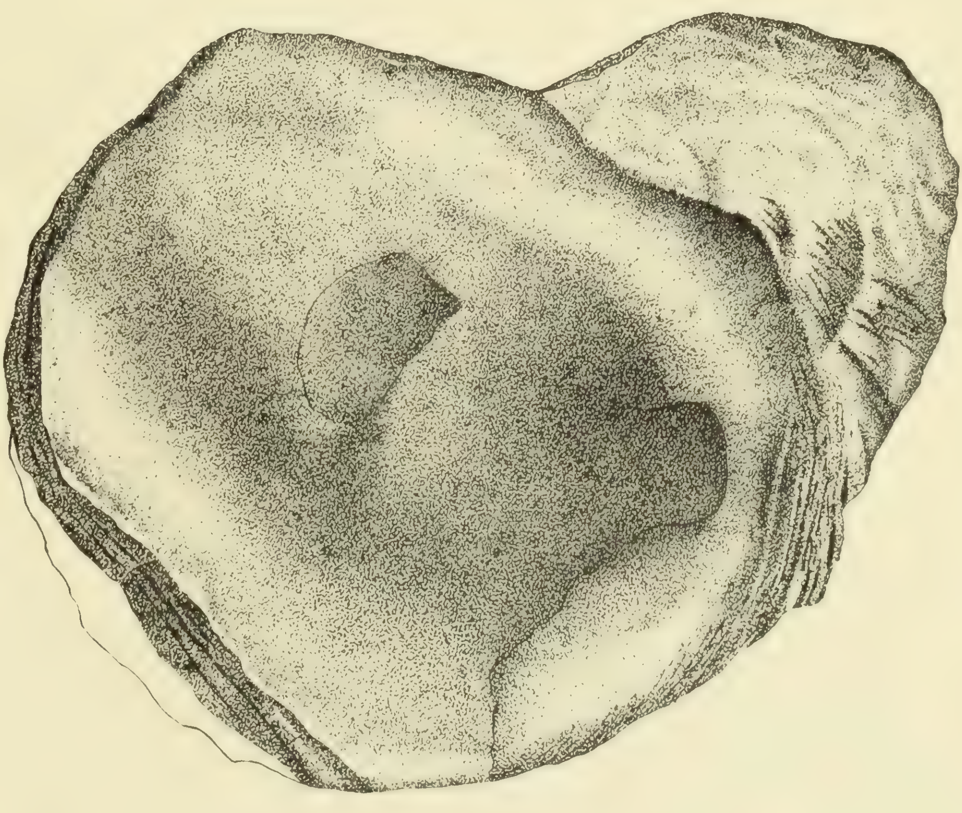

OSTREIDÆ.

PLATE VIII.

PLATE VIII.

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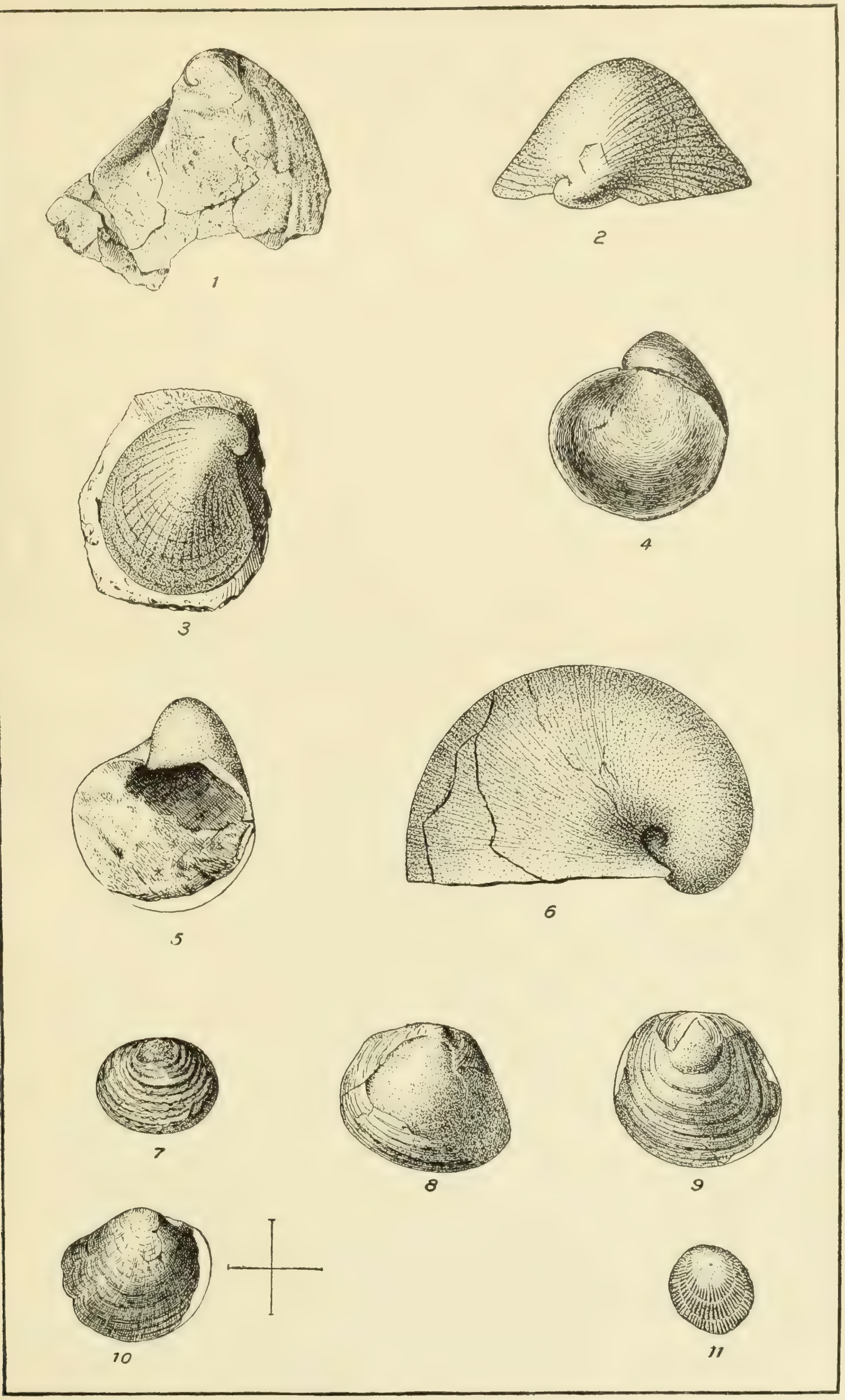
Exogyra suborbiculata Lam	62
Fig. 1. Fragment of an upper valve. Nat. Mus. Cat. Invert. Foss., 22863.	
Exogyra columbella Meek	63
Fig. 2. Dorsal view of a large lower valve (after White).	
3. Side view of lower valve (after White).	
4. Upper view of specimen with both valves united (after White).	
Exogyra læviuscula Roemer	64
Figs. 5, 6. Different views of lower valves (after White).	
Anomia concentrica Meek	67
Fig. 7. View of Meek's type specimen. Nat. Mus. Cat. Invert. Foss., 489.	
Anomia subquadrata n. sp	66
Figs. 8, 9. Casts of two upper valves retaining portions of the shell, and showing the variation in outline and convexity. Nat. Mus. Cat. Invert. Foss., 22864.	
Anomia propatoris White?	67
Fig. 10. Upper valve slightly enlarged. Nat. Mus. Cat. Invert. Foss., 22865.	
Placunopsis? hilliardensis White	68
Fig. 11. View of the type specimen (after White).	



OSTREIDÆ AND ANOMIIDÆ.

PLATE IX.

PLATE IX.

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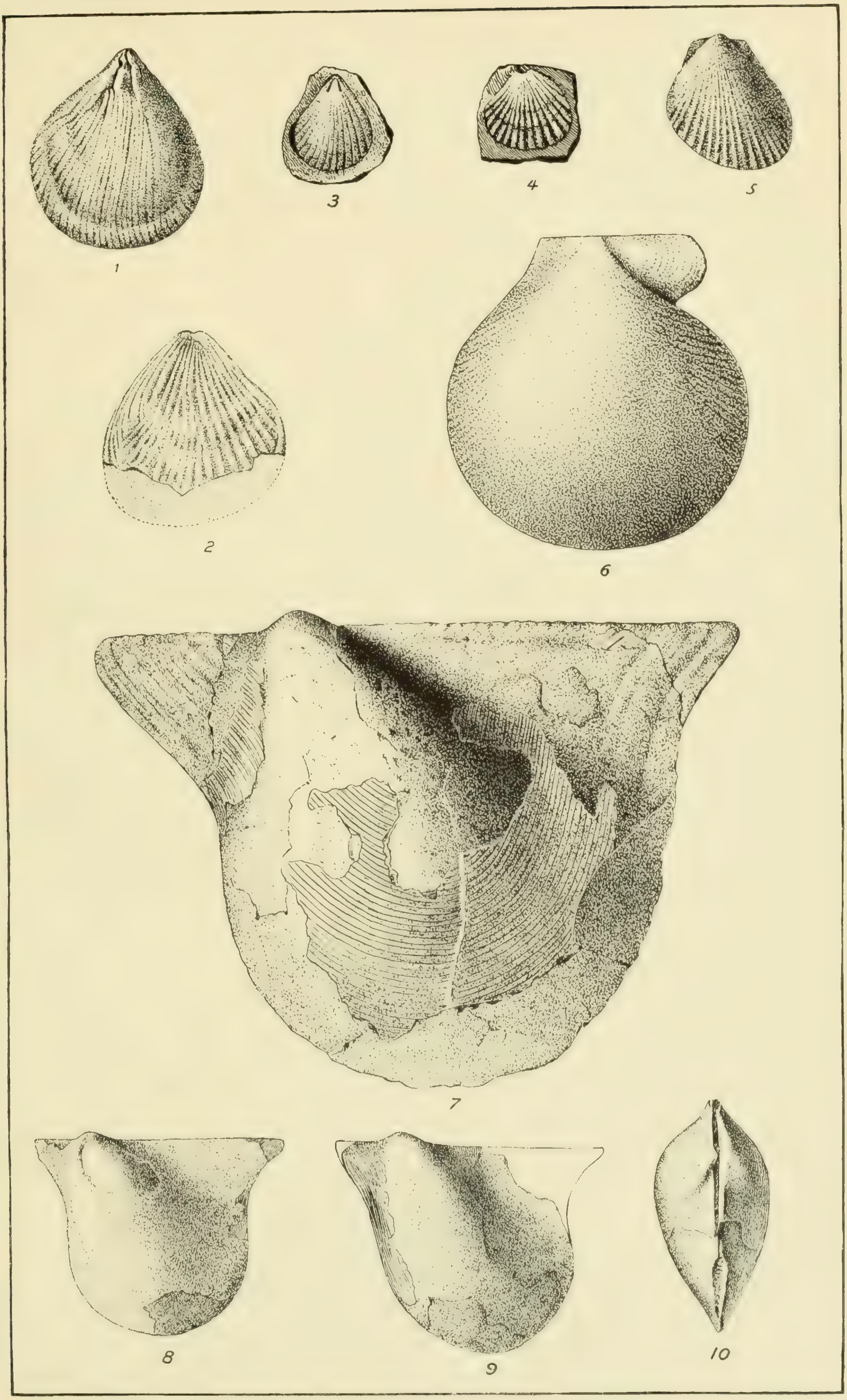
PLICATULA HYDROTHECA White	69
Figs. 1, 2. Views of the opposite valves (after White).	
PLICATULA ARENARIA Meek	70
Figs. 3, 4. Views of the under and upper valves (after Meek).	
LIMA UTAHENSIS n. sp	71
Fig. 5. Cast of a large left valve. Nat. Mus. Cat. Invert. Foss., 22942.	
CAMPTONECTES PLATESSA White	72
Fig. 6. Right valve of the type (after White).	
AVICULA GASTRODES Meek	72
Nat. Mus. Cat. Invert. Foss., 22866.	
Fig. 7. Large left valve restored from two specimens which together show all the features drawn.	
8. A small left valve.	
9. 10. Two views of a more oblique specimen.	

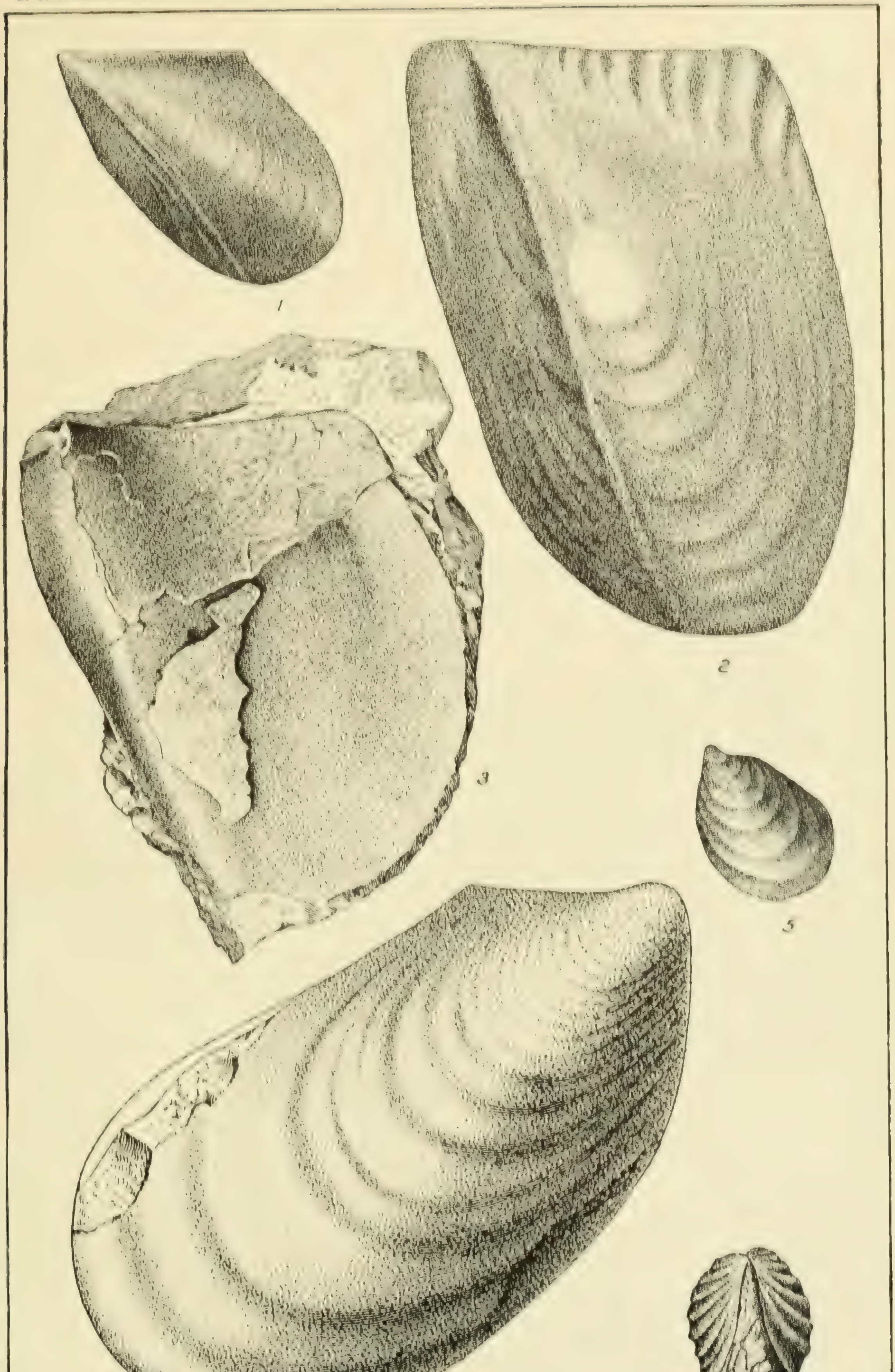


SPONDYLIDÆ LIMIDÆ PECTINIDÆ AND AVICULIDÆ.

PLATE X.

PLATE X.

	Page.
GERVILLIA PROPLEURA Meek	74
Fig. 1. A small oblique left valve; one of Meek's types (after White).	
2. Left valve of an adult less oblique example; Meek's type of *Avicula* (*Pseudoptera*) *rhytophora* (after White).	
3. An imperfect cast of a left valve retaining a portion of the shell, from Huerfano park, Colorado. Nat. Mus. Cat. Invert. Foss., 22876.	
INOCERAMUS LABIATUS Schloth	77
Fig. 4. Right valve of an elongated specimen (after Meek). (See Pl. XIV, Fig. 1.)	
INOCERAMUS DIMIDIUS White	78
Fig. 5. Left valve of a specimen of average size (after White).	
6. Front view showing convexity of both valves (after White).	



AVICULIDÆ.

PLATE XI.

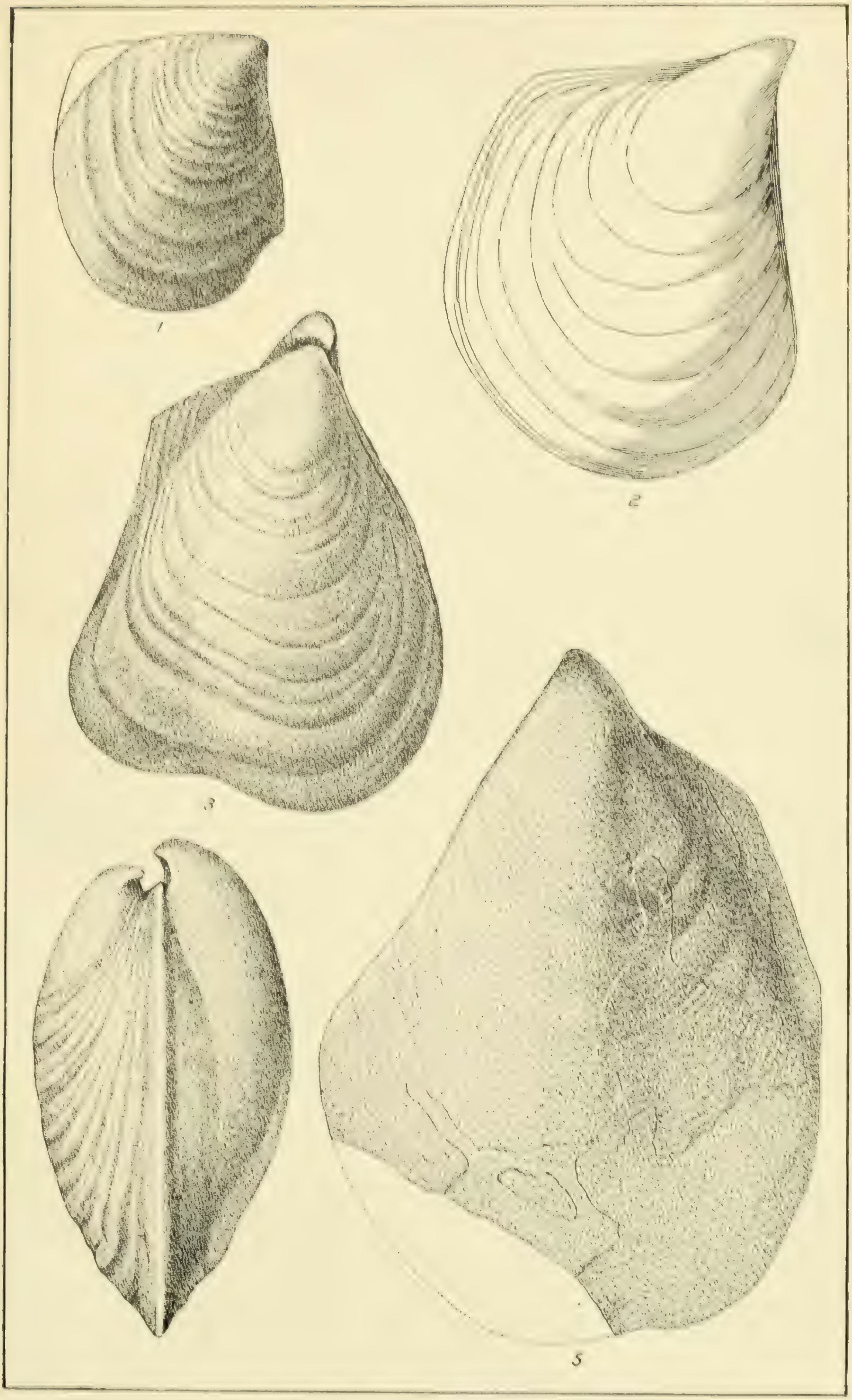
PLATE XI.

Fig. 1. Right valve of one of Whitfield's types of *Inoceramus perplexus*.
Nat. Mus. Cat. Invert. Foss., 12274.

2. A larger right valve (after Meek).

3, 4. Two views of one of the types of *Inoceramus howelli* (after White).

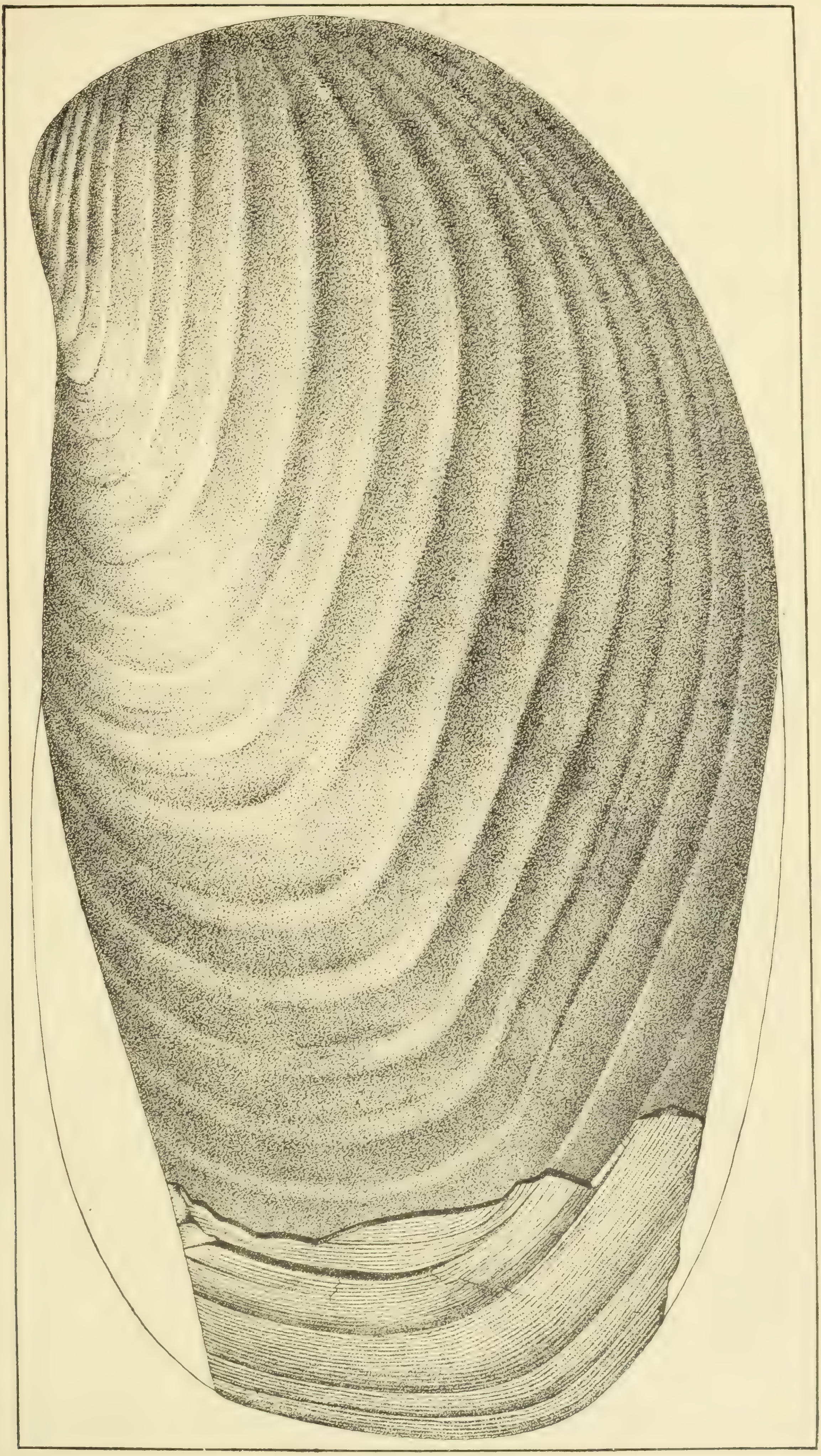
5. A large example selected from the types of *I. howelli* to show variation in form.
Nat. Mus. Cat. Invert. Foss., 8052.



AVICULIDÆ

PLATE XII.

PLATE XII.



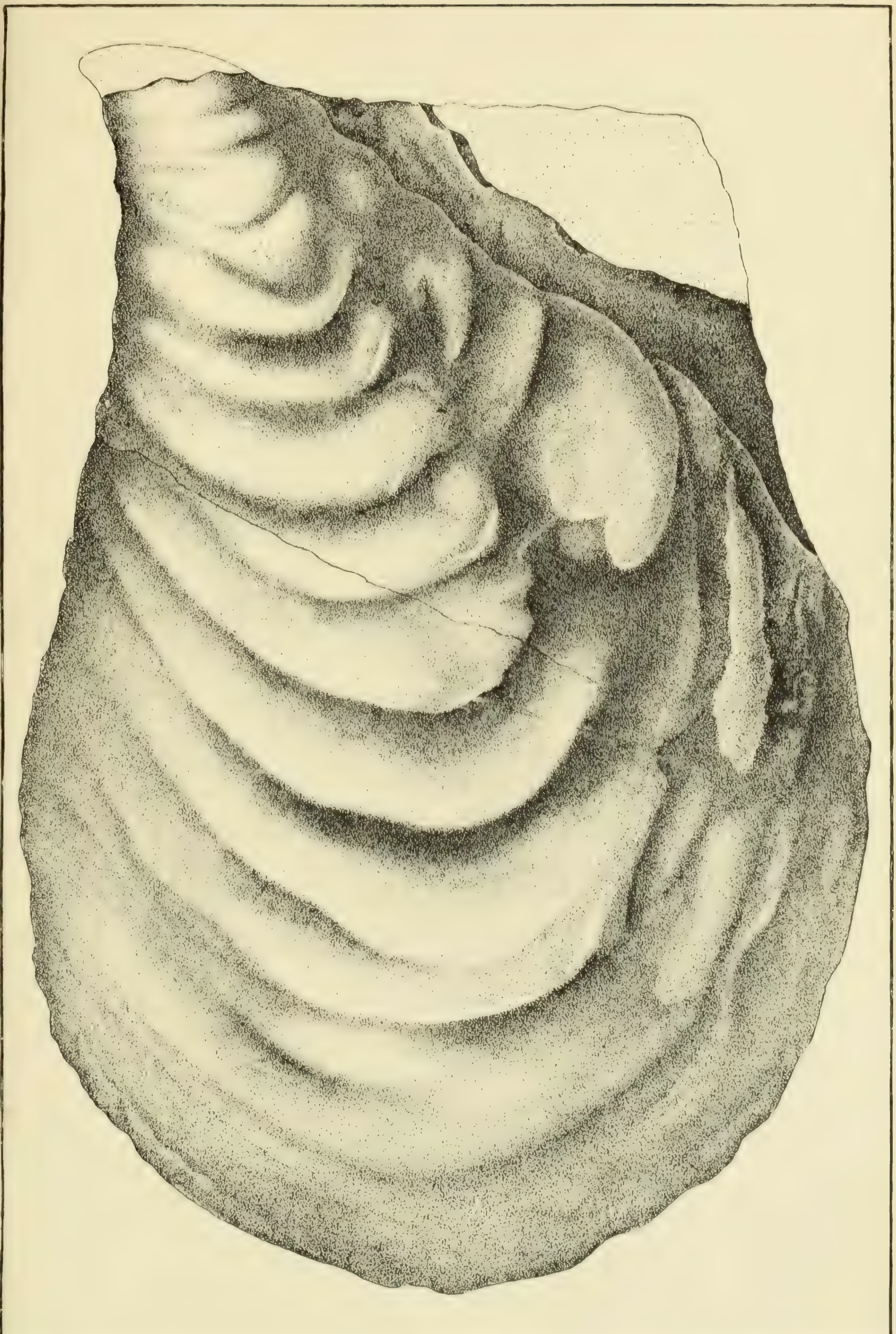
AVICULIDÆ.

PLATE XIII.

PLATE XIII.

	Page
INOCERAMUS FLACCIDUS White	80

Fig. 1. Left valve of type (after White).

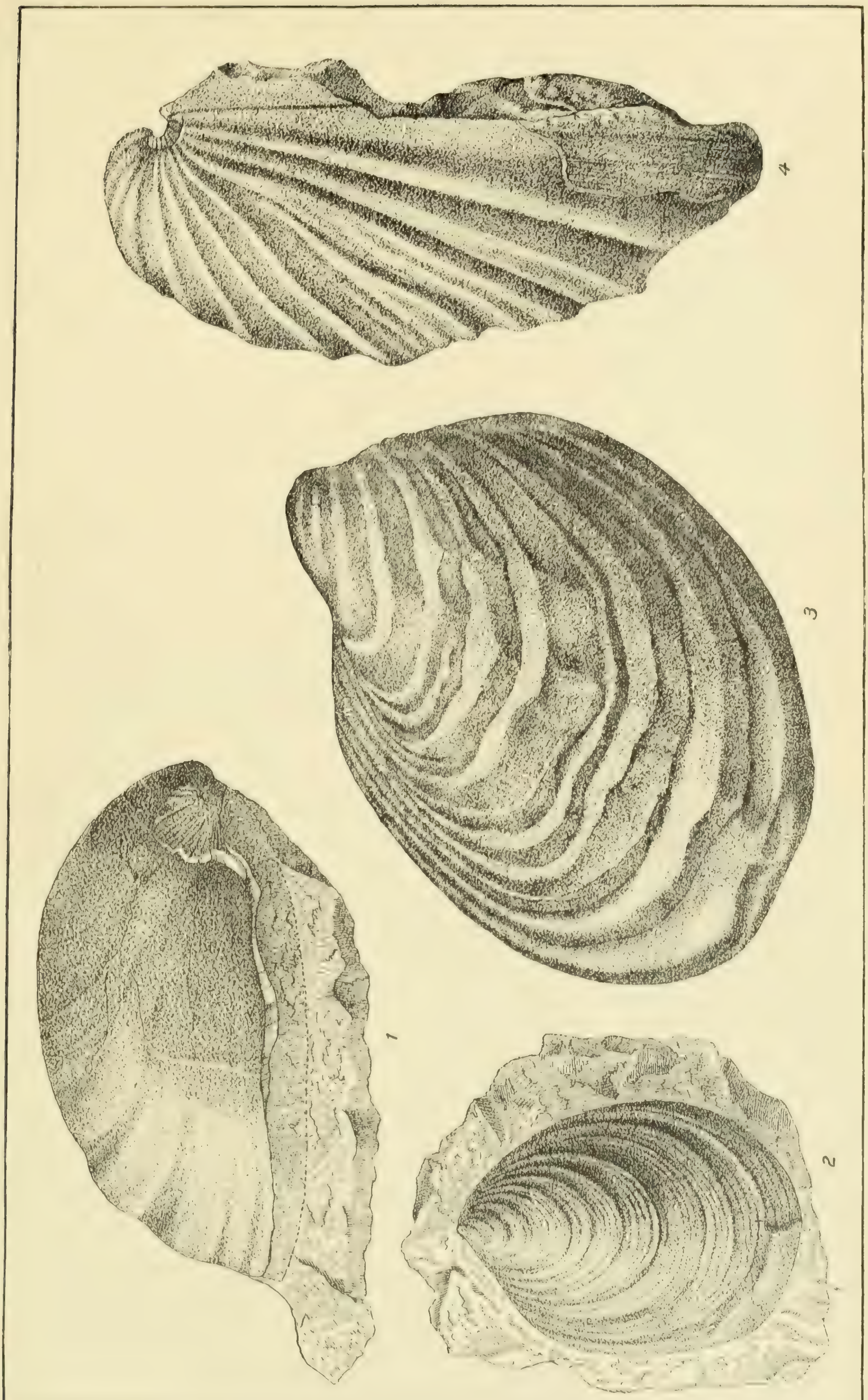


AVICULIDÆ.

PLATE XIV.

PLATE XIV.

	Page
INOCERAMUS DEFORMIS Meek	85
Fig. 1. Anterior view of small specimen. (See Pl. XV.) Nat. Mus. Cat. Invert. Foss., 21119.	
INOCERAMUS LABIATUS Schloth	77
Fig. 2. Small right valve with unusually strong concentric ridges. (See Pl. x, Fig. 4.) Nat. Mus. Cat. Invert. Foss., 22868.	
INOCERAMUS GILBERTI White	79
Figs. 3, 4. Two views of a left valve (after White).	



AVICULIDÆ.

PLATE XV.

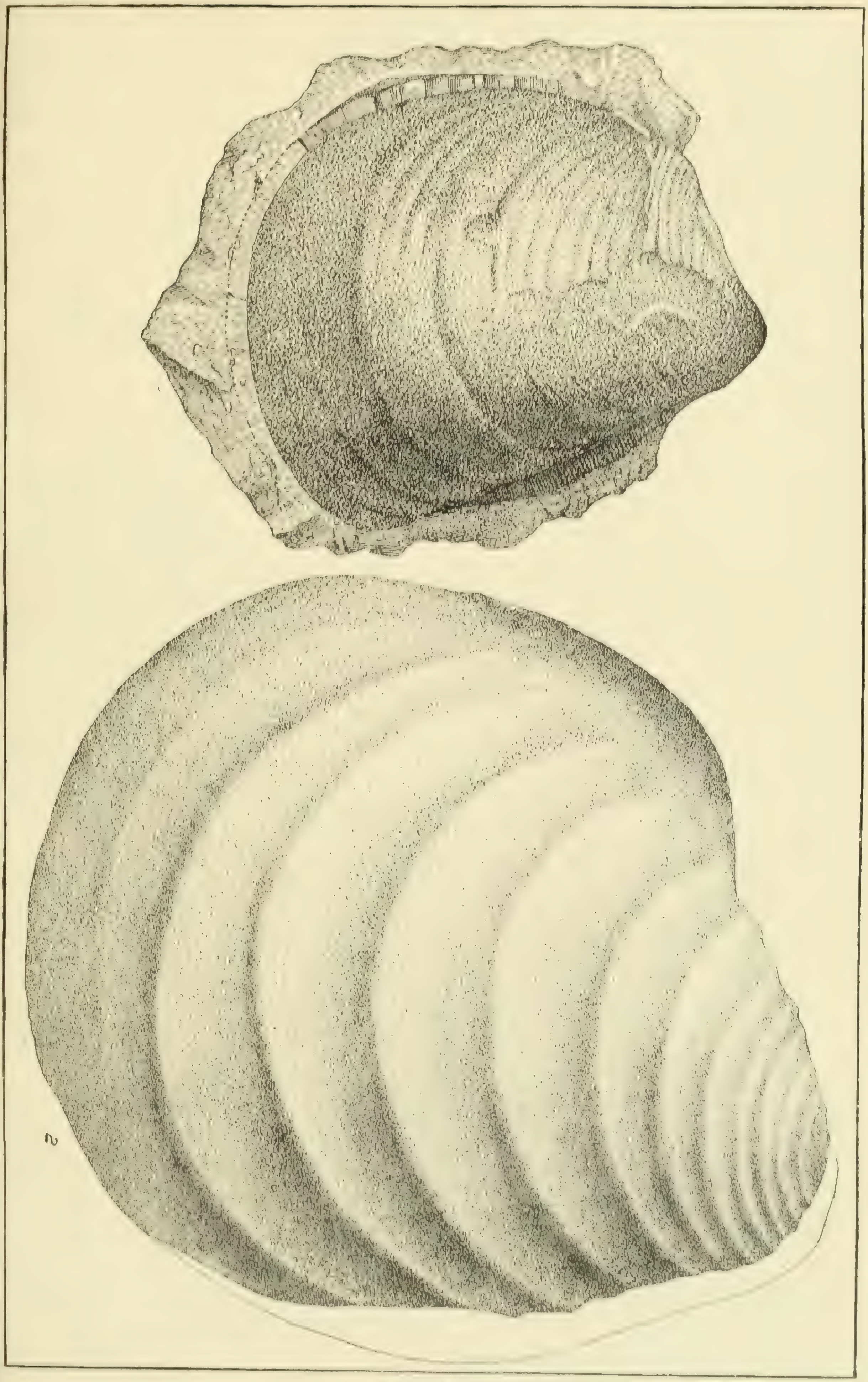
PLATE XV.

Page.

INOCERAMUS DEFORMIS Meek 85

Fig. 1. Another view of the small specimen represented by Pl. XIV, Fig. 1.

2. A larger right valve (after Meek).



AVICULIDÆ.

PLATE XVI.

PLATE XVI.

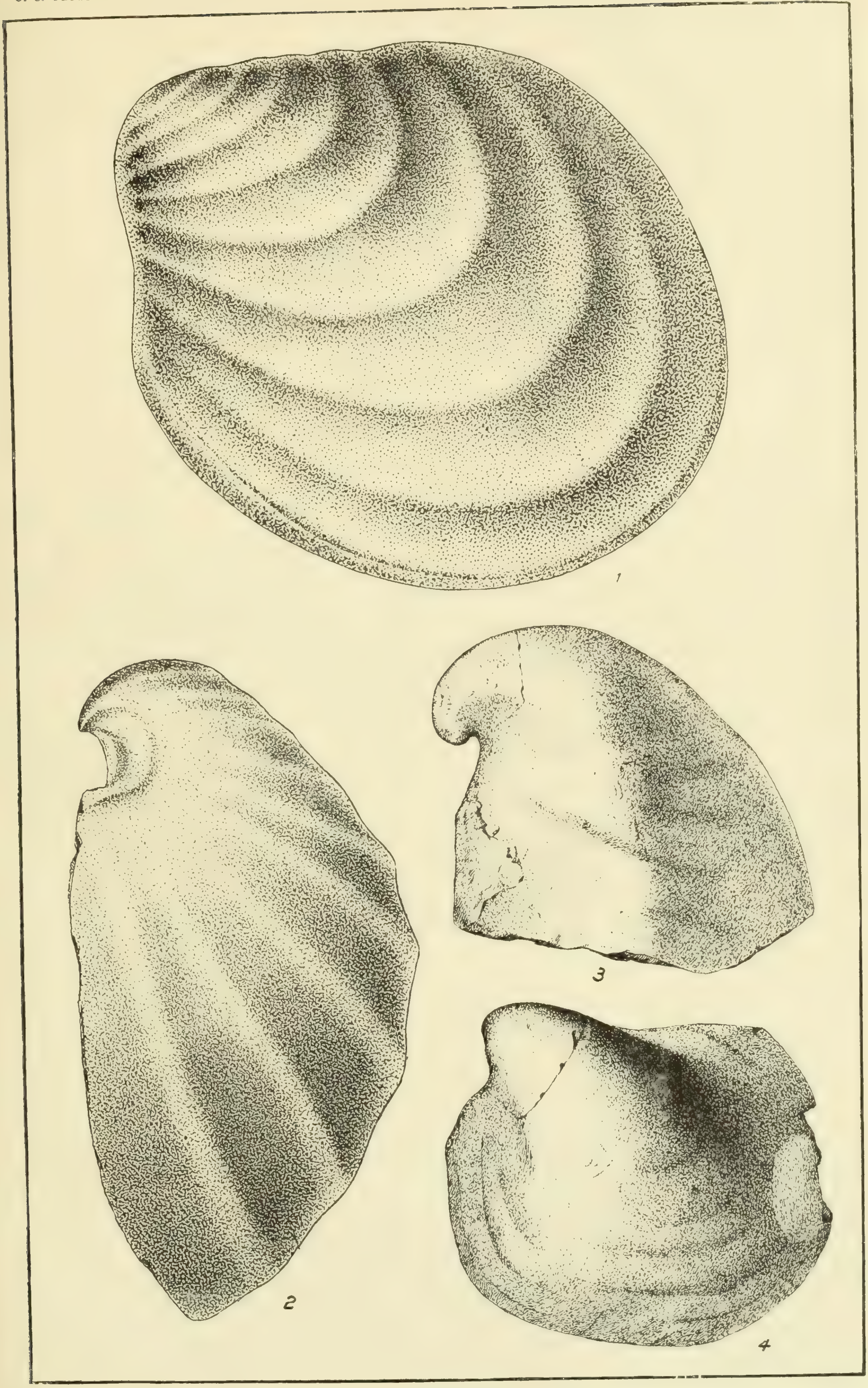
INOCERAMUS UNDABUNDUS M. & H. 84

Figs. 1, 2. Two views of a left valve (after Meek).

INOCERAMUS TENUIROSTRATUS M. & H. 83

Figs. 3, 4. Two views of the type specimen.

Nat. Mus. Cat. Invert. Foss., 1906.



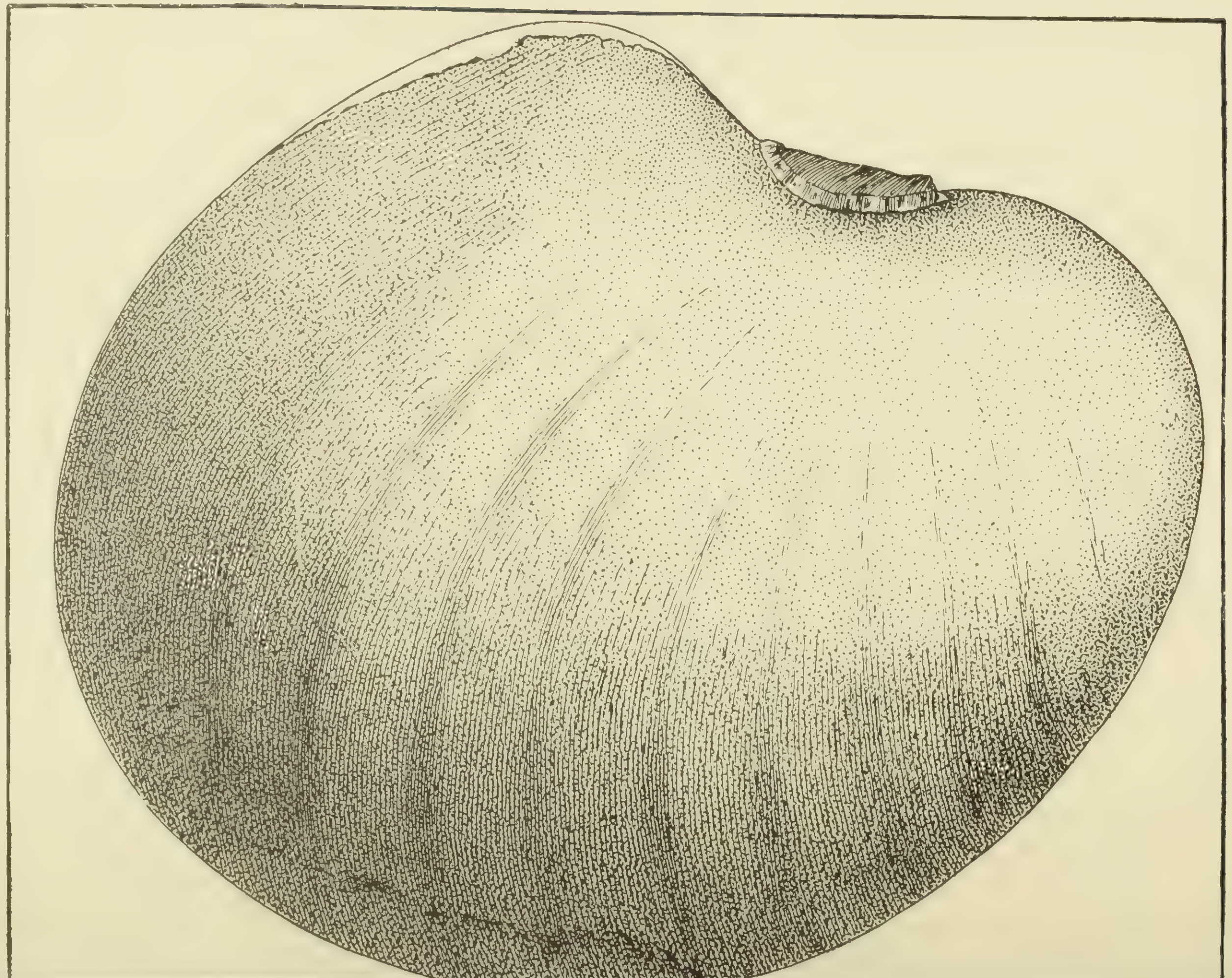
AVICULIDÆ.

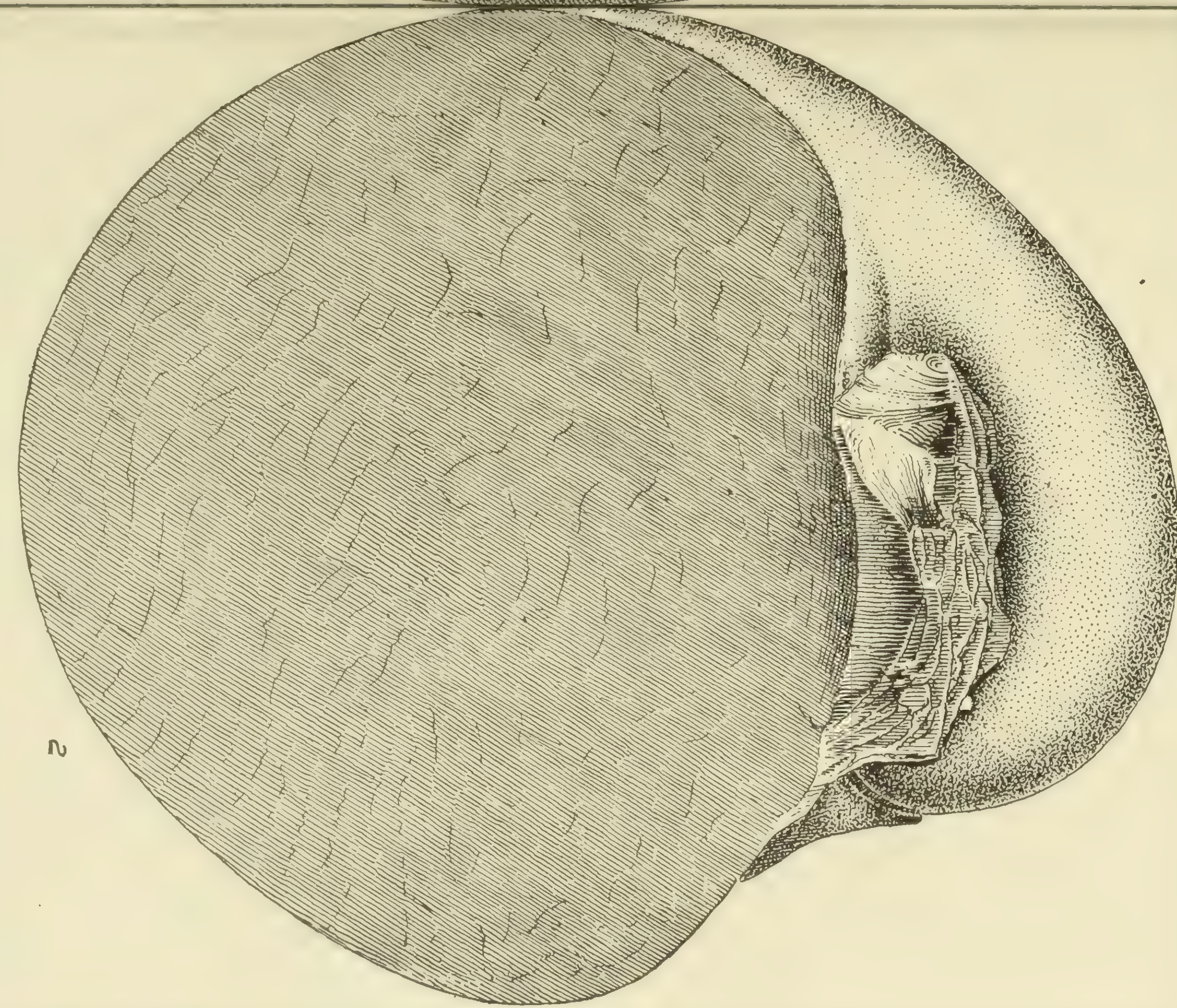
PLATE XVII.

PLATE XVII.

Inoceramus exogyroides M. & H. 83

Figs. 1, 2. Two views of an internal cast of the left valve (after Meek).





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AVICULIDÆ.

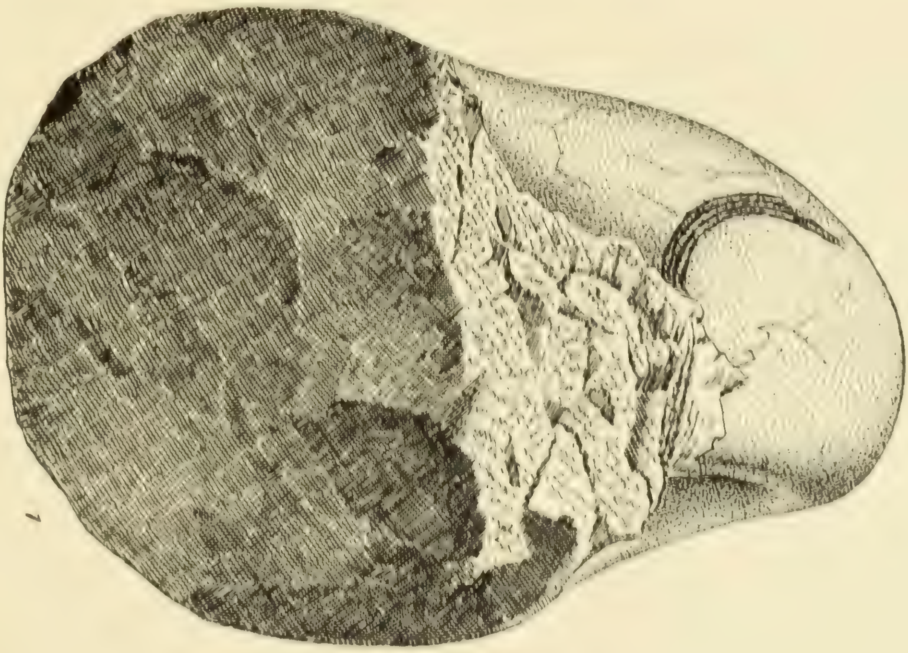
PLATE XVIII.

PLATE XVIII.

	Page.
INOCERAMUS UMBONATUS M. & H.	81

Fig. 1. Dorsal view of a cast of a left valve reduced in size (after Meek).

2. Anterior view of a cast of a left valve, retaining portions of the fibrous layer of shell in the umbonal region (after Meek).



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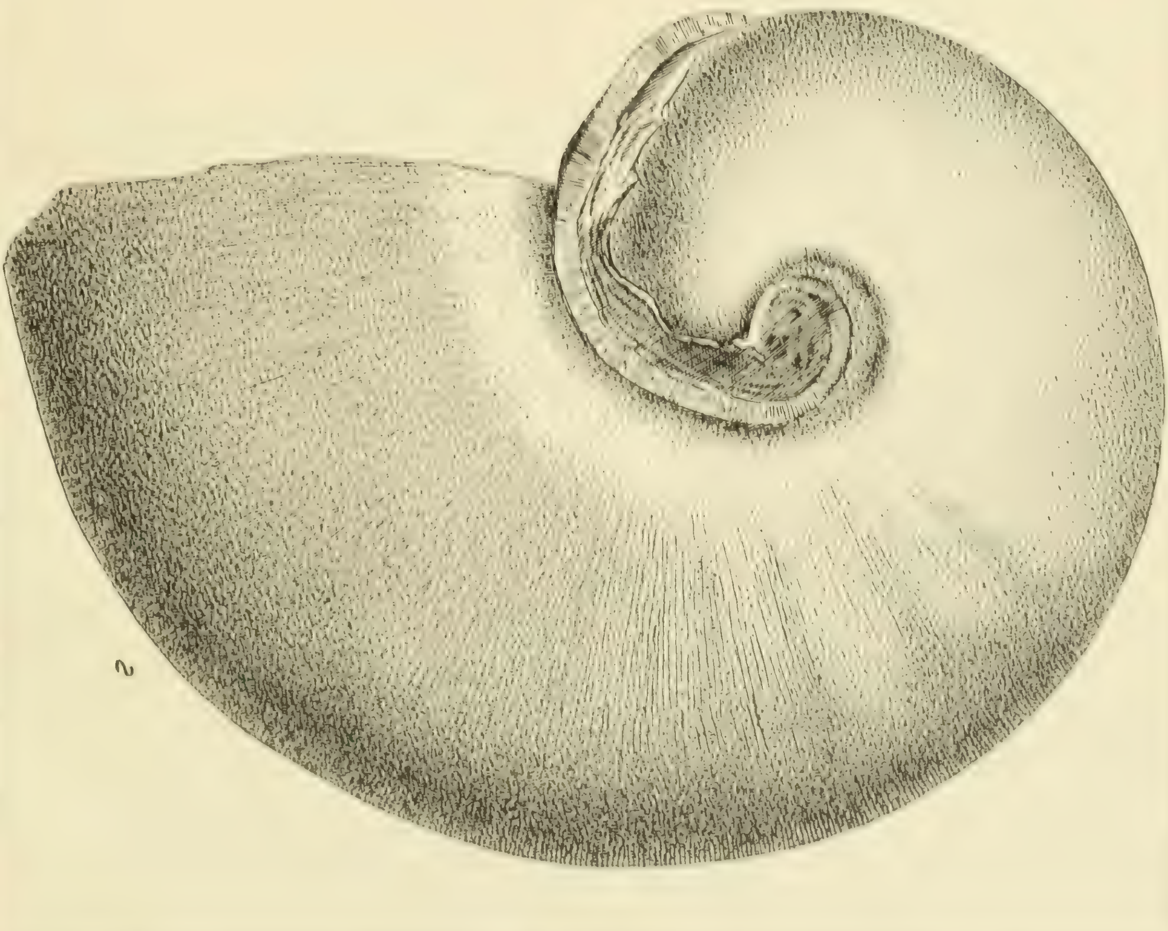

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AVICULIDÆ

PLATE XIX.

PLATE XIX.

Page.

TRIGONARCA OBLIQUA Meek 92

Fig. 1. Left valve of a short broad specimen, showing traces of radiating lines on the posterior region. (See other figures on Pl. xx.)
Nat. Mus. Cat. Invert. Foss., 22869.

TRIGONARCA DEPRESSA White 93

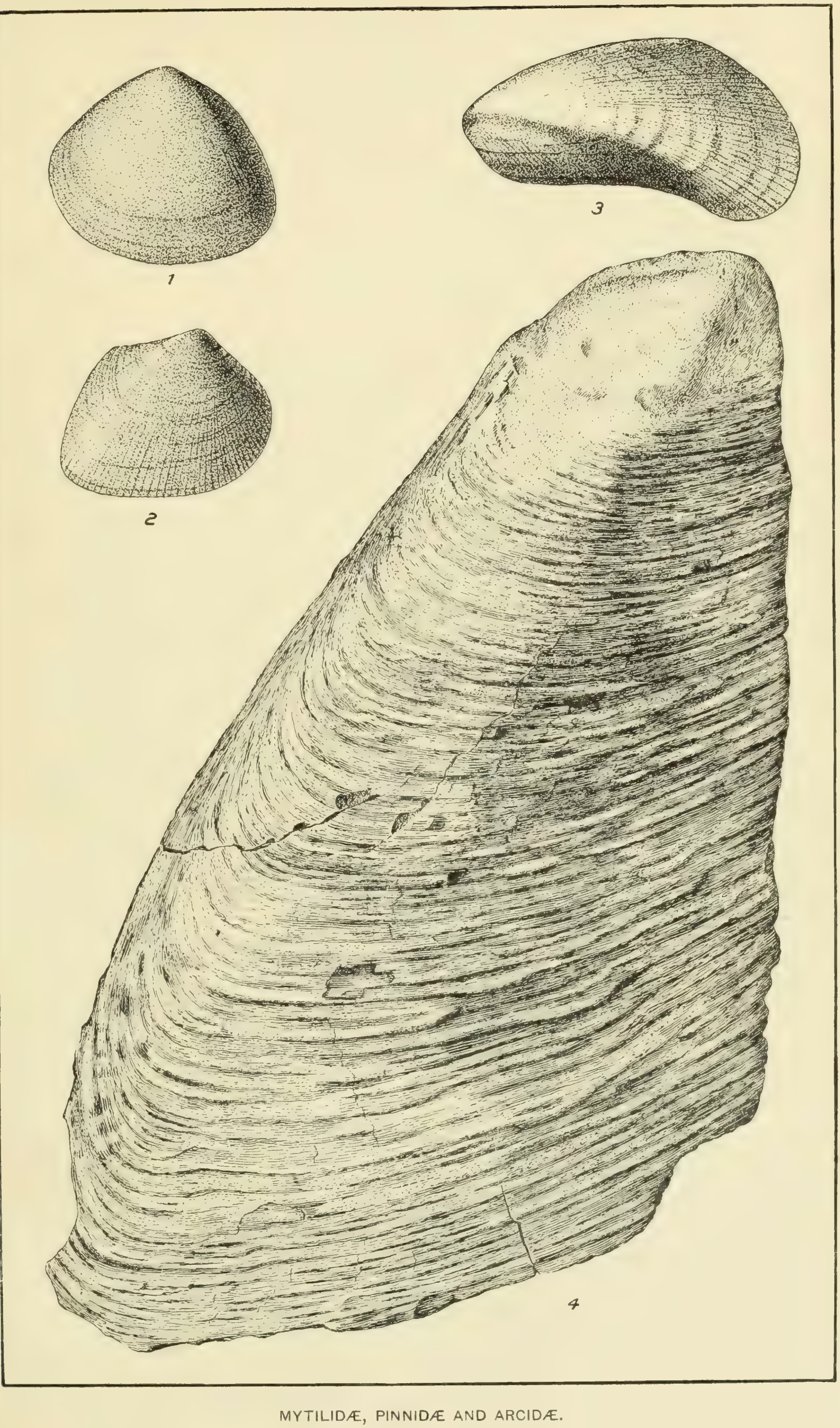
Fig. 2. Right valve of the type specimen.
Nat. Mus. Cat. Invert. Foss., 8645.

MODIOLA (BRACHYDONTES) MULTILINIGERA Meek 86

Fig. 3. Left valve (after White).

PINNA PETRINA White 88

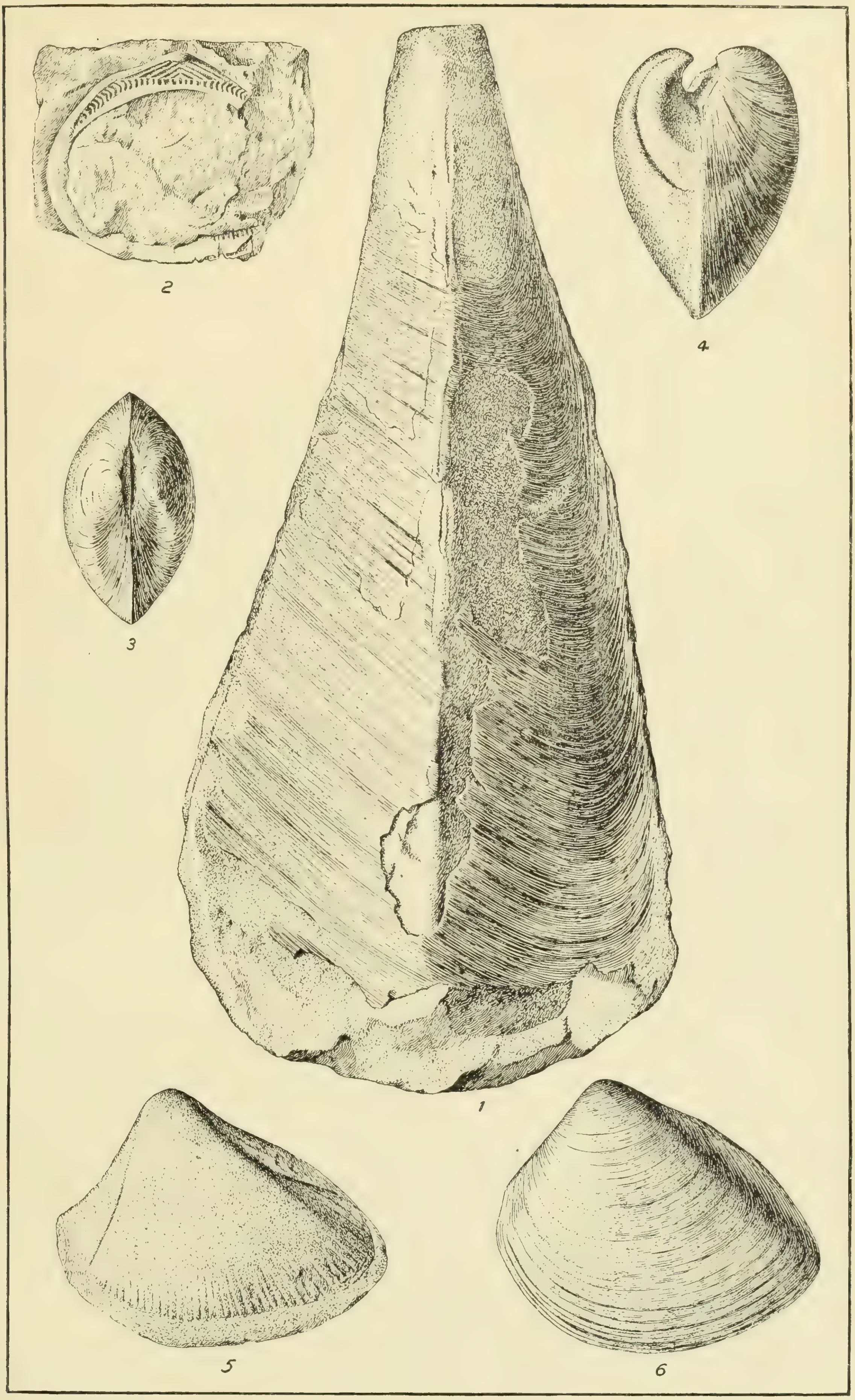
Fig. 4. Right valve of the type of *Pinna stevensoni*. (See Pl. XX, Fig. 1.)
Nat. Mus. Cat. Invert. Foss., 8101.



MYTILIDÆ, PINNIDÆ AND ARCIDÆ.

PLATE XX.

PLATE XX.



PINNIDÆ AND ARCIDÆ.

PLATE XXI.

PLATE XXI.

	Page.
BARBATIA MICRONEMA Meek	89

Fig. 1. Left side view of Meek's type of *Trapezium micronema*.
Nat. Mus. Cat. Invert. Foss., 7846.

2. Cast of a small broader left valve retaining the surface markings. This is like the types of *Barbatia coalvillensis*, and is from the same locality.
Nat. Mus. Cat. Invert. Foss., 22871.

3. Right valve of a rather broad specimen believed to belong to this species from Denton county, Texas.

4. Interior view showing hinge of a more elongate right valve from the same locality.
Nat. Mus. Cat. Invert. Foss., 22870.

NEMODON SULCATINUS E. & S.? ... 91

Fig. 5. Cast of left valve enlarged two diameters.
Nat. Mus. Cat. Invert. Foss., 22872.

YOLDIA SUBELLIPTICA n. sp ... 94

Figs. 6, 7. Opposite views of the type specimen enlarged.
Nat. Mus. Cat. Invert. Foss., 22873.

SOLEMYA? OBSCURA n. sp ... 95

Fig. 8. Cast of left (?) valve retaining portions of the shell.
Nat. Mus. Cat. Invert. Foss., 22874.

NUCULA COLORADOENSIS n. sp ... 94

Fig. 9. View of right valve enlarged.
Nat. Mus. Cat. Invert. Foss., 22876.

CRASSATELLA EXCAVATA n. sp ... 96

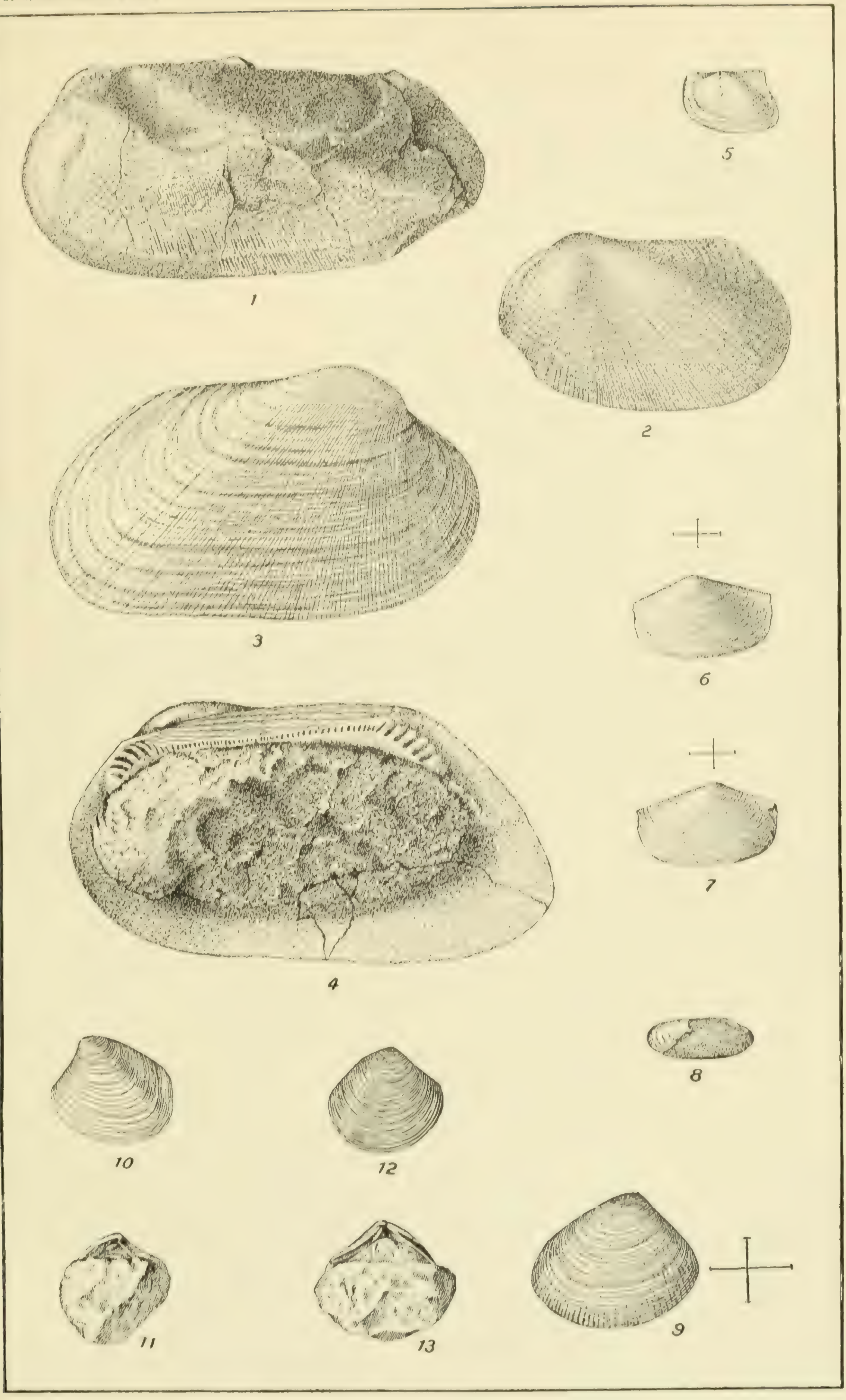
Nat. Mus. Cat. Invert. Foss., 22875.

Fig. 10. Left valve of the best preserved type.

11. Hinge of another left valve.

12. Right valve slightly distorted by pressure.

13. Hinge of same.



ARCIDÆ, NUCULIDÆ, SOLEMYIDÆ AND CRASSATELLIDÆ.

PLATE XXII.

PLATE XXII.

Page.

Unio sp 95

Fig. 1. A small right valve.

Nat. Mus. Cat. Invert. Foss., 22877.

Lucina juvenis n. sp 98

Nat. Mus. Cat. Invert. Foss., 22878.

Figs. 2, 3. Opposite views of one of the types, enlarged.

4. Left valve of another more convex specimen, enlarged.

Lucina subundata H. & M. ? 97

Nat. Mus. Cat. Invert. Foss., 22879.

Fig. 5. Small right valve retaining portions of the natural surface.

6. Left side view of one of the largest casts.

Cardium trite White 100

Fig. 7. Cast of right valve (after White).

8. Portion of the surface, magnified (after White).

Cardium pauperculum Meek 99

Fig. 9. Anterior view of both valves, enlarged.

Nat. Mus. Cat. Invert. Foss., 22880.

10. Left valve from Bear River city, Wyoming, enlarged. The surface is slightly eroded, so that the ribs appear unnaturally broad.

Nat. Mus. Cat. Invert. Foss., 22881.

11. Right valve from Huerfano park, Colorado, enlarged.

Nat. Mus. Cat. Invert. Foss., 22880.

12. Small right valve of broad variety from Coalville, Utah.

Nat. Mus. Cat. Invert. Foss., 22882.

Cyrena inflexa Meek 103

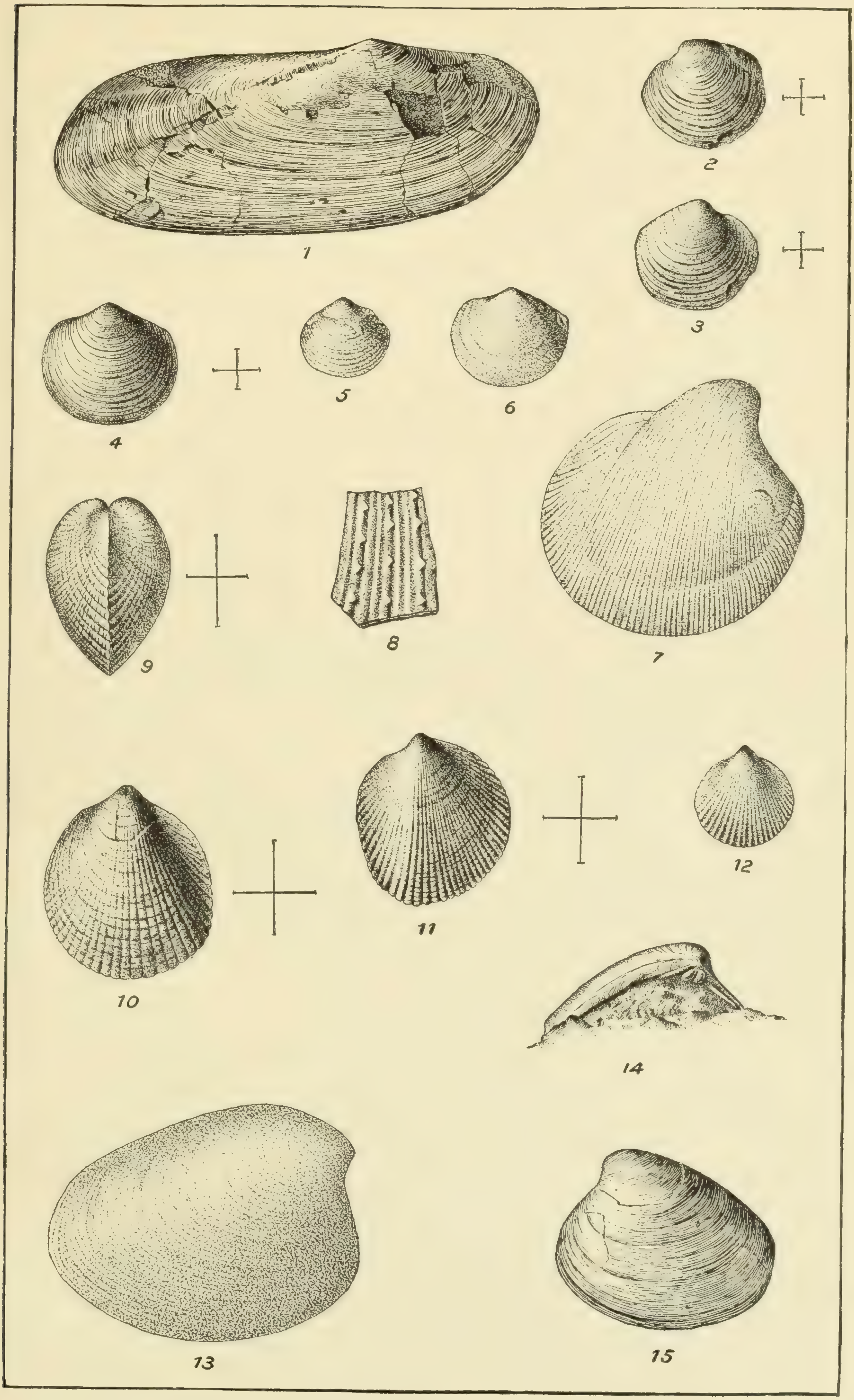
Fig. 13. Right valve of one of the types (after White).

Cyrena æquilateralis Meek? 102

Fig. 15. A left valve doubtfully referred to the species.

Nat. Mus. Ca. Invert. Foss., 22883.

14. Hinge of same.



UNIONIDÆ, LUCINIDÆ, CARDIIDÆ AND CYRENIDÆ.

PLATE XXIII.

PLATE XXIII.

	Page.
CYRENA SECURIS Meek	101
Fig. 1. Left valve.	
Nat. Mus. Cat. Invert. Foss., 22884.	
2. Hinge of same.	
3. Right valve of specimen from southern Utah believed to belong to this species.	
Nat. Mus. Cat. Invert. Foss., 22885.	
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Nat. Mus. Cat. Invert. Foss., 22886.	
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Nat. Mus. Cat. Invert. Foss., 22887.	
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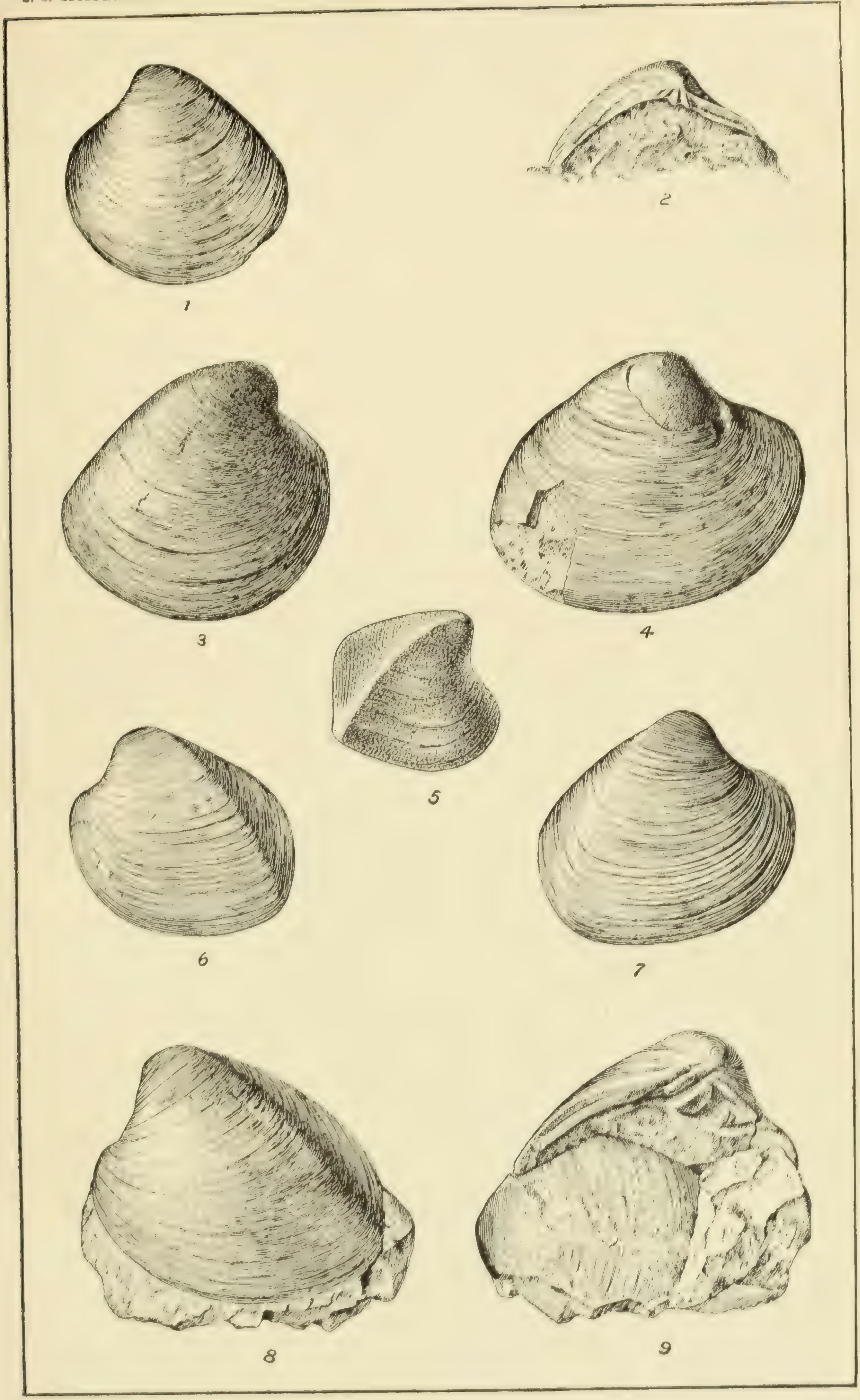

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Nat. Mus. Cat. Invert. Foss., 22890.

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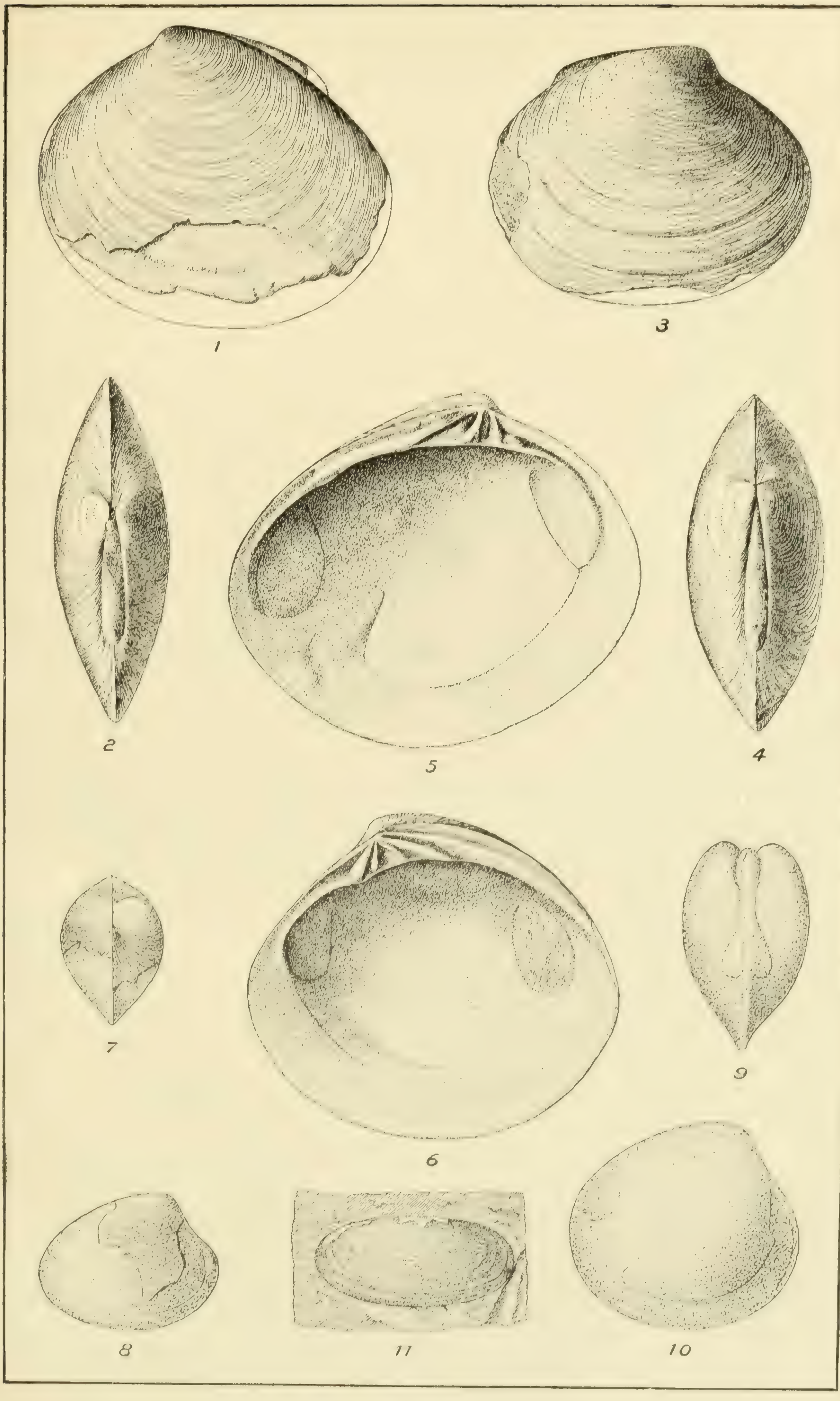
Nat. Mus. Cat. Invert. Foss., 22891.



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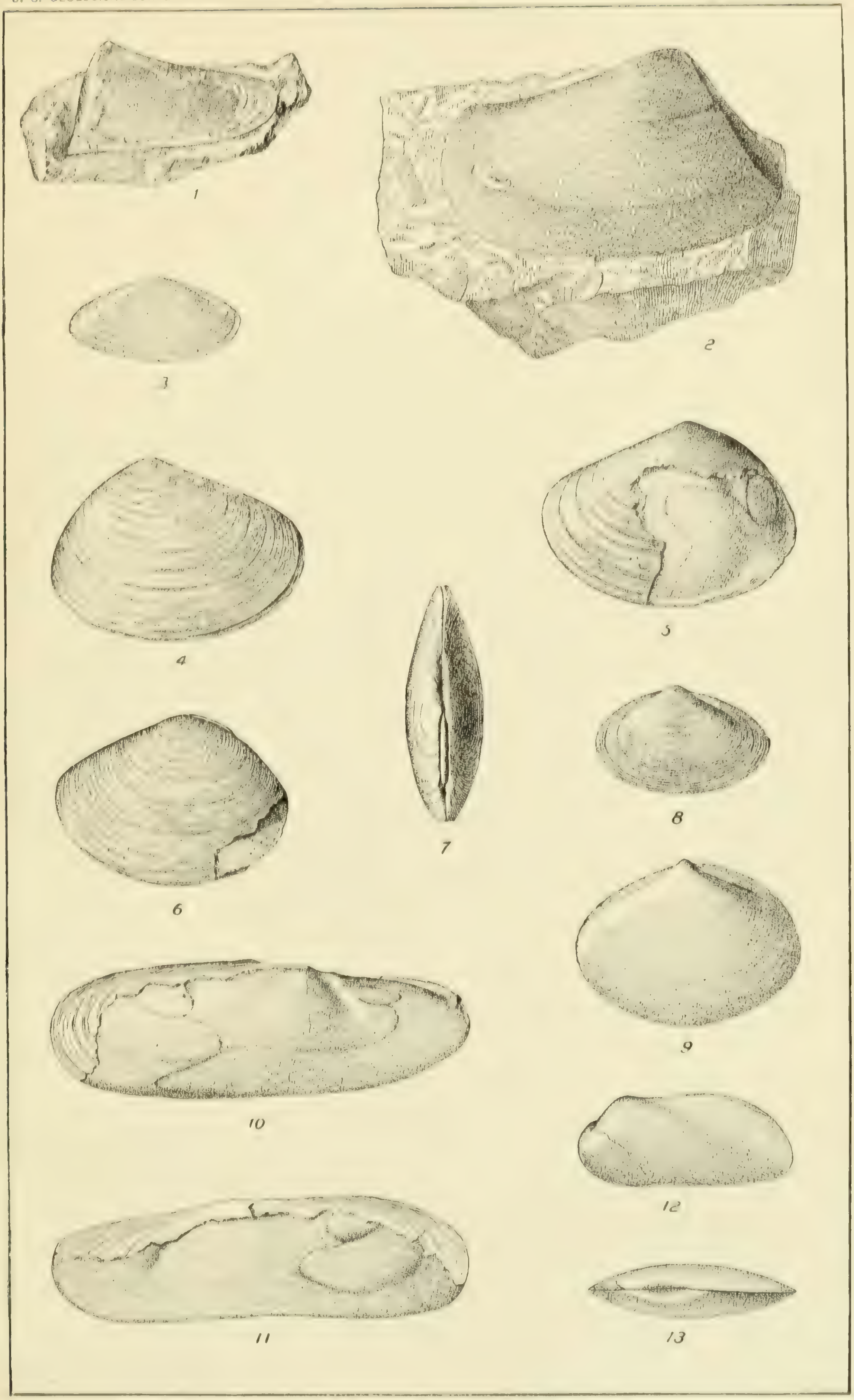

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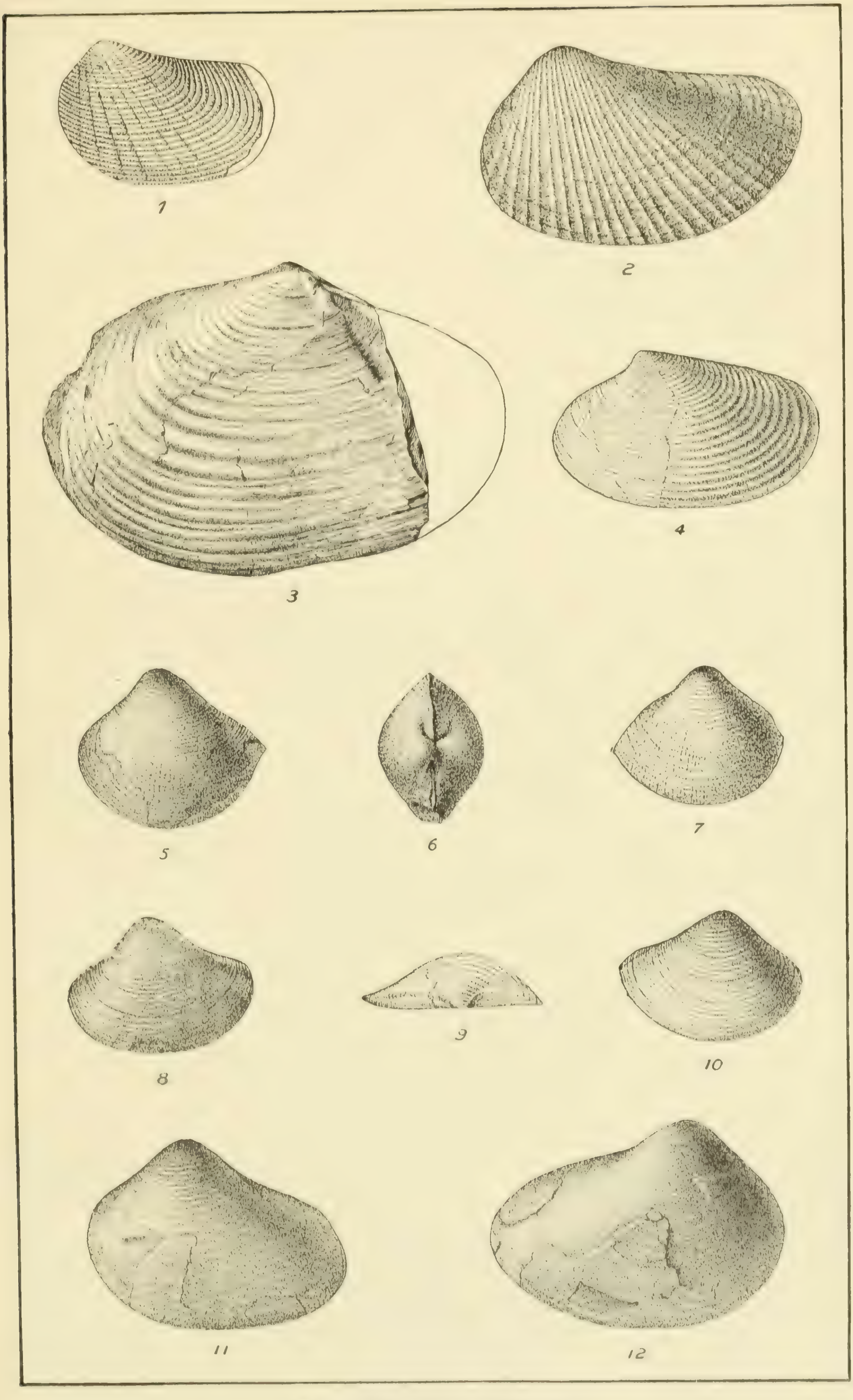

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Nat. Mus. Cat. Invert. Foss., 22900.

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CORBULA SUBTRIGONALIS M. & H.? 123

Nat. Mus. Cat. Invert. Foss., 22901.

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Nat. Mus. Cat. Invert. Foss., 22902 and 22903.

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MACTRA HUERFANENSIS n. sp 122

Nat. Mus. Cat. Invert. Foss., 22904.

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MACTRA (CYMBOPHORA) UTAHENSIS Meek 120

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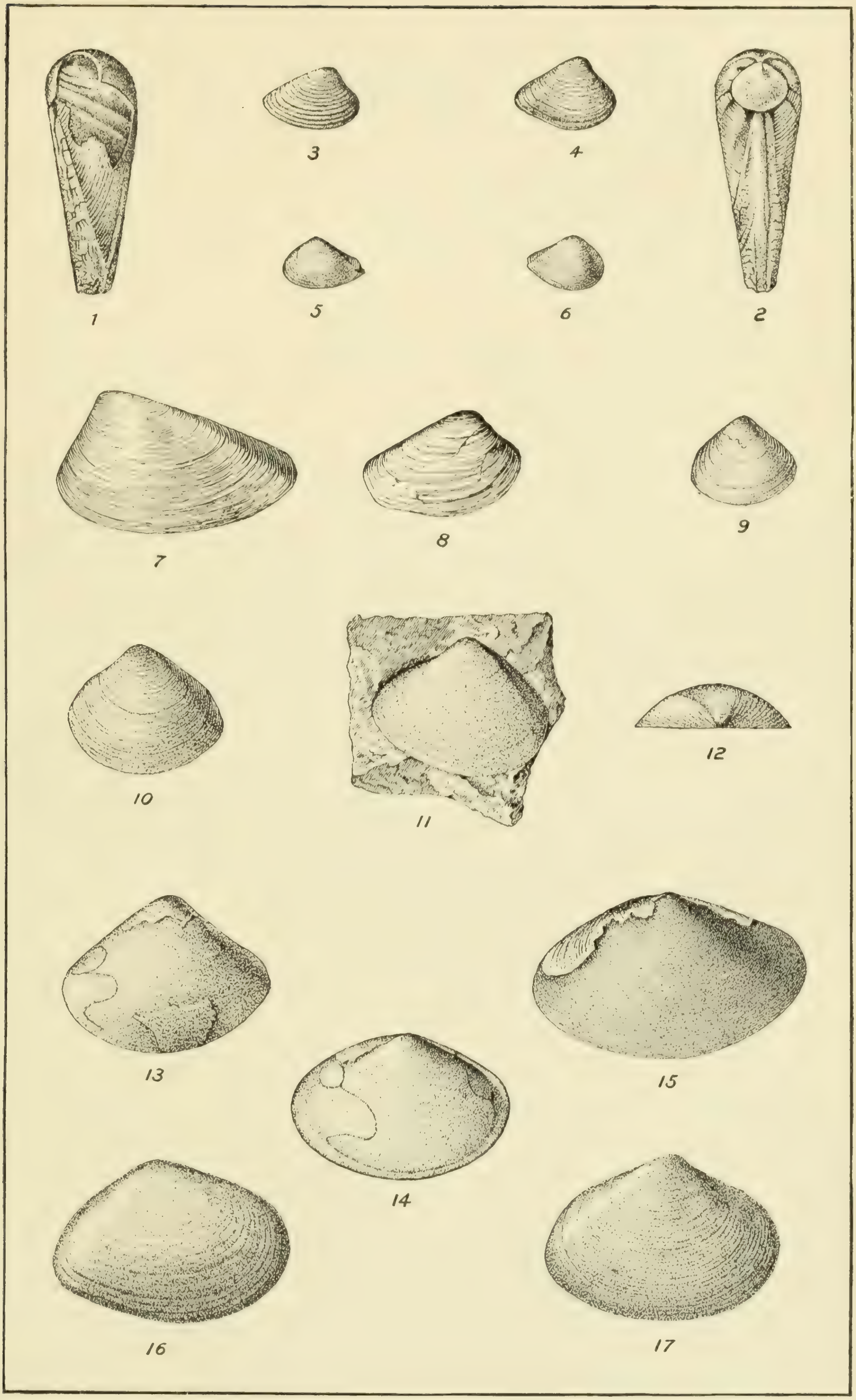

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Nat. Mus. Cat. Invert. Foss., 22906.	
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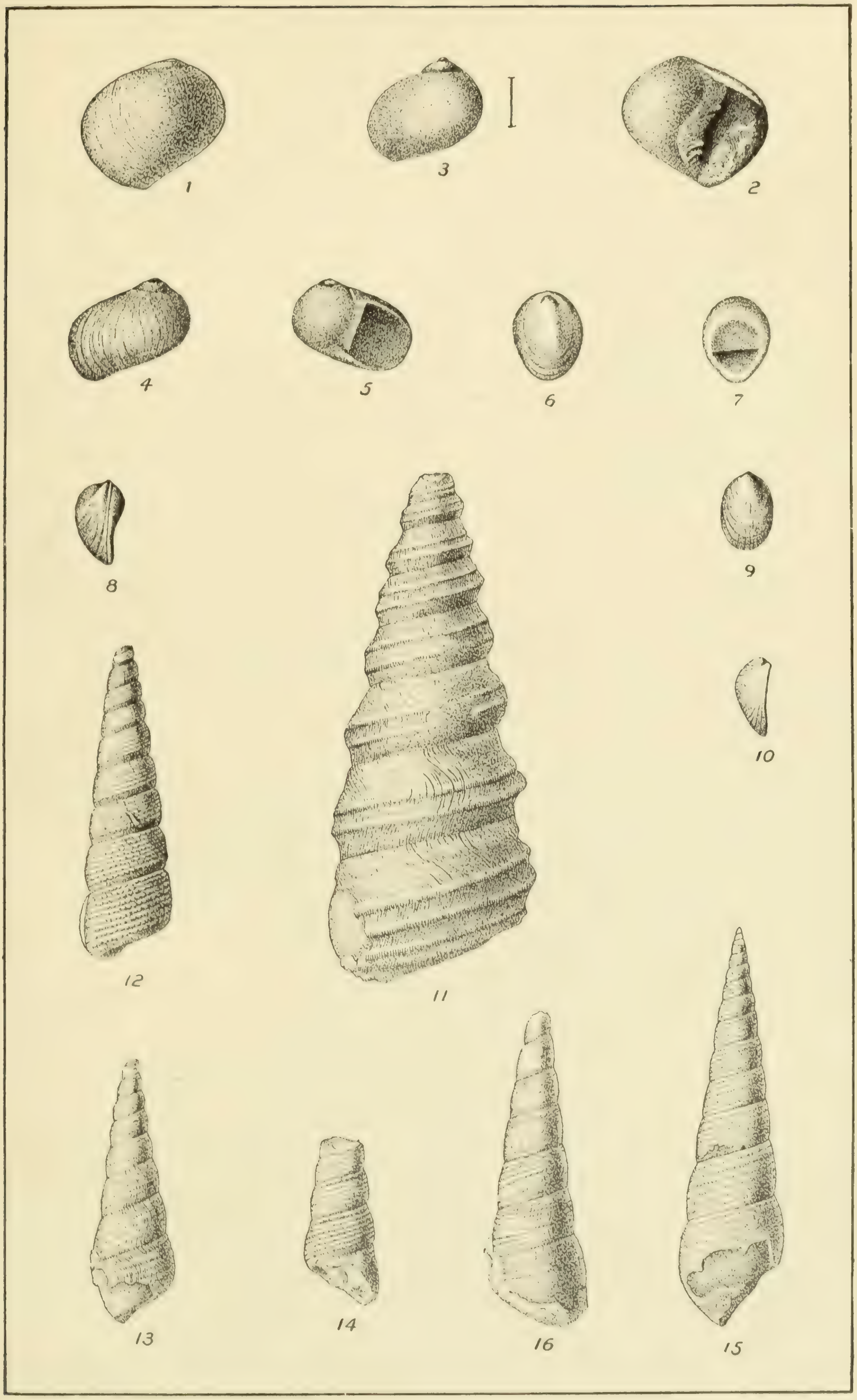
Nat. Mus. Cat. Invert. Foss., 22907.	



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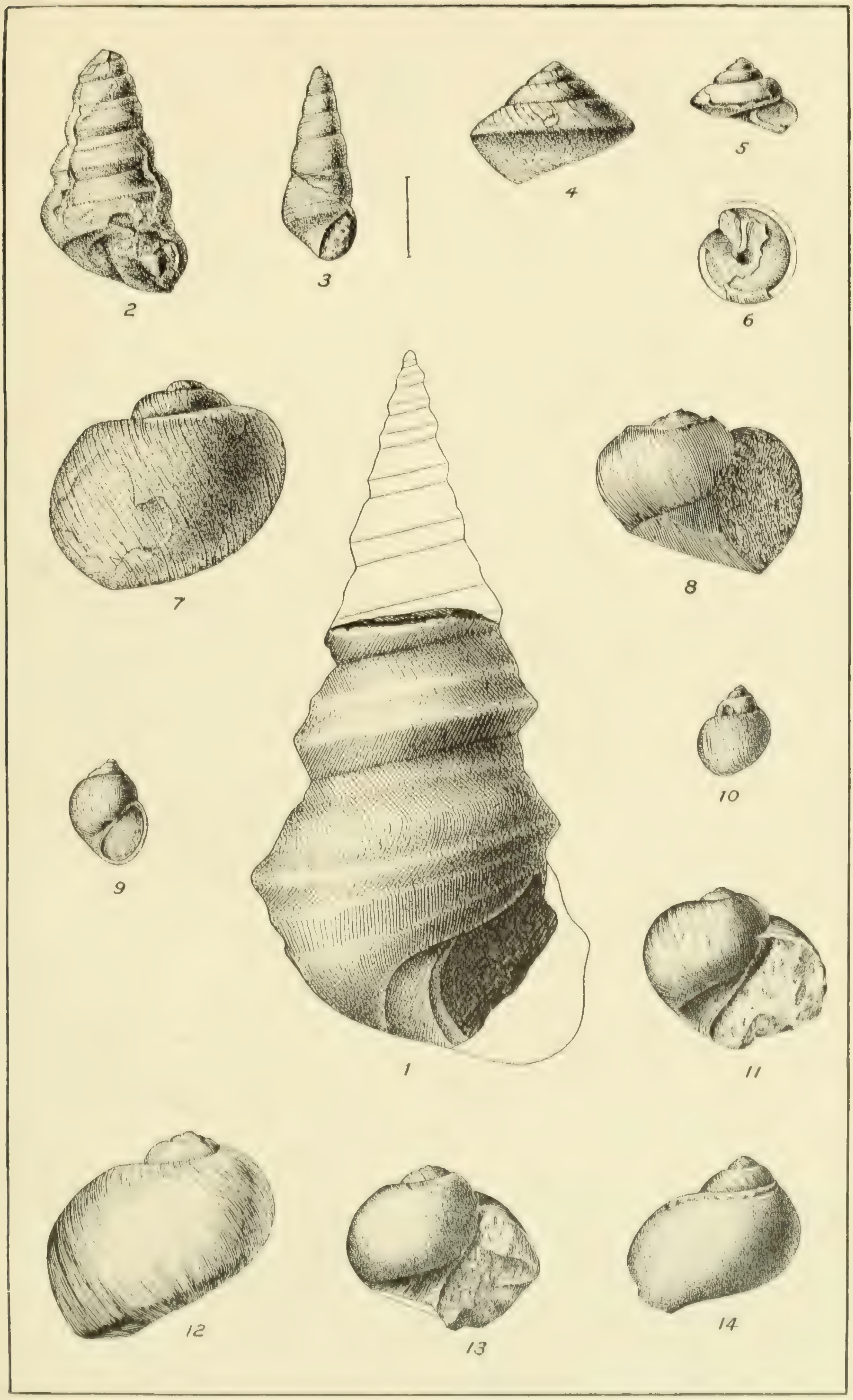

TURRITELLIDÆ, XENOPHORIDÆ AND NATICIDÆ.

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Nat. Mus. Cat. Invert. Foss., 22913.

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Nat. Mus. Cat. Invert. Foss., 22914.

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Nat. Mus. Cat. Invert. Foss., 22915.

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Nat. Mus. Cat. Invert. Foss., 22916.

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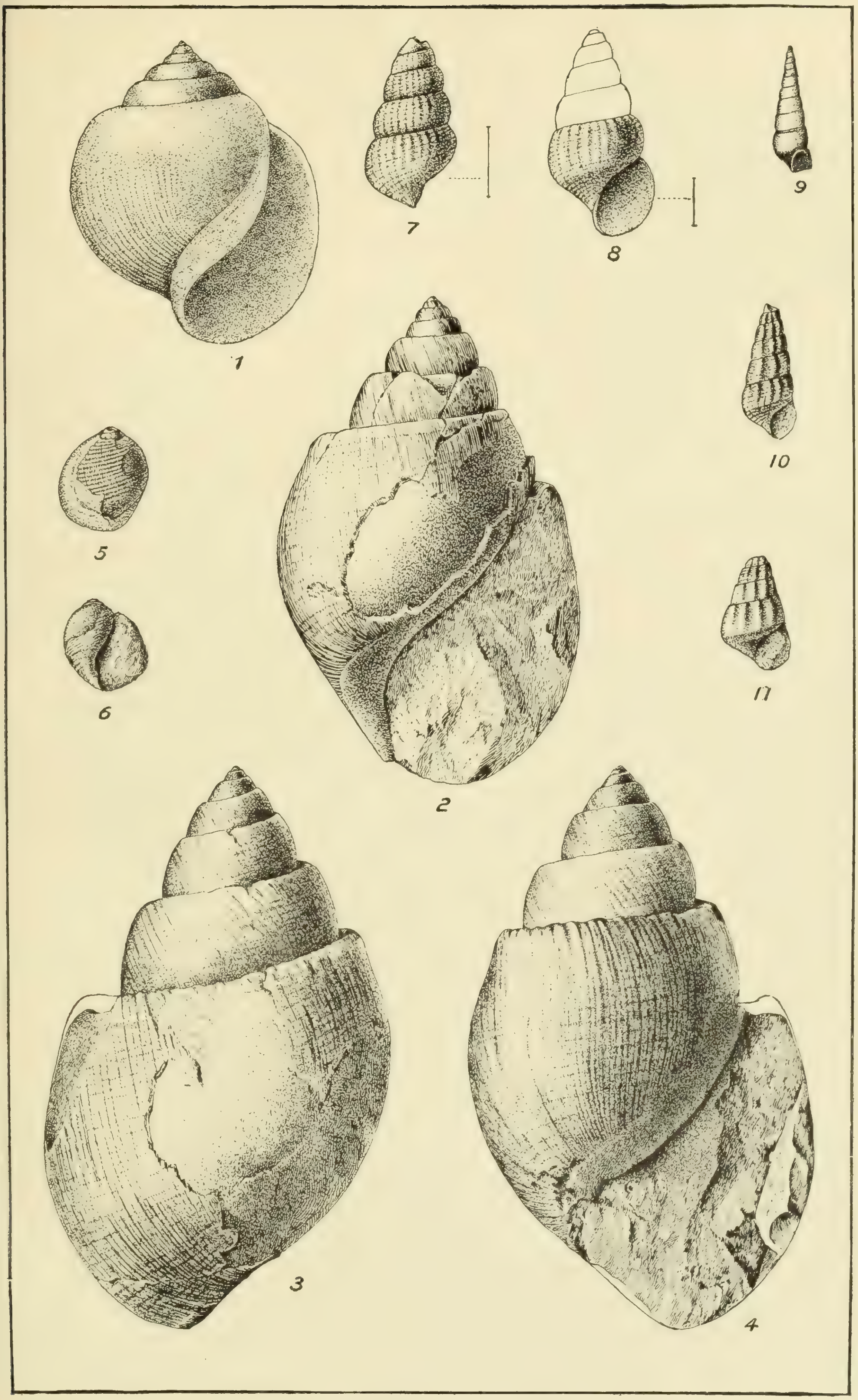

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Nat. Mus. Cat. Invert. Foss., 22917.

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Nat. Mus. Cat. Invert. Foss., 22918.

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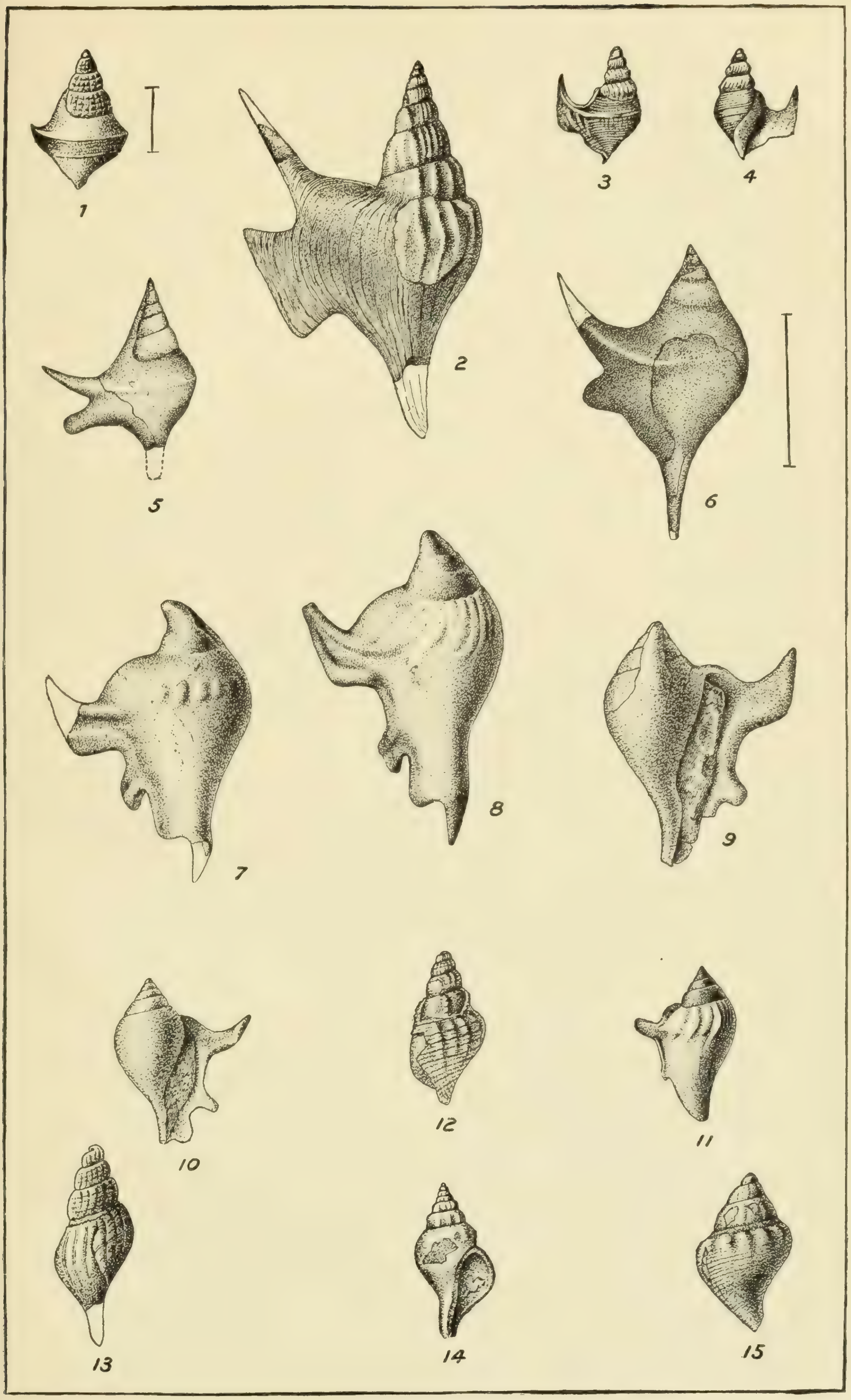
Nat. Mus. Cat. Invert. Foss., 22920.



APORRHAIDÆ, STROMBIDÆ, TRITONIDÆ AND FUSIDÆ.

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Nat. Mus. Cat. Invert. Foss., 22921.

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Nat. Mus. Cat. Invert. Foss., 22922.

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Nat. Mus. Cat. Invert. Foss., 22923.

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Nat. Mus. Cat. Invert. Foss., 22924.

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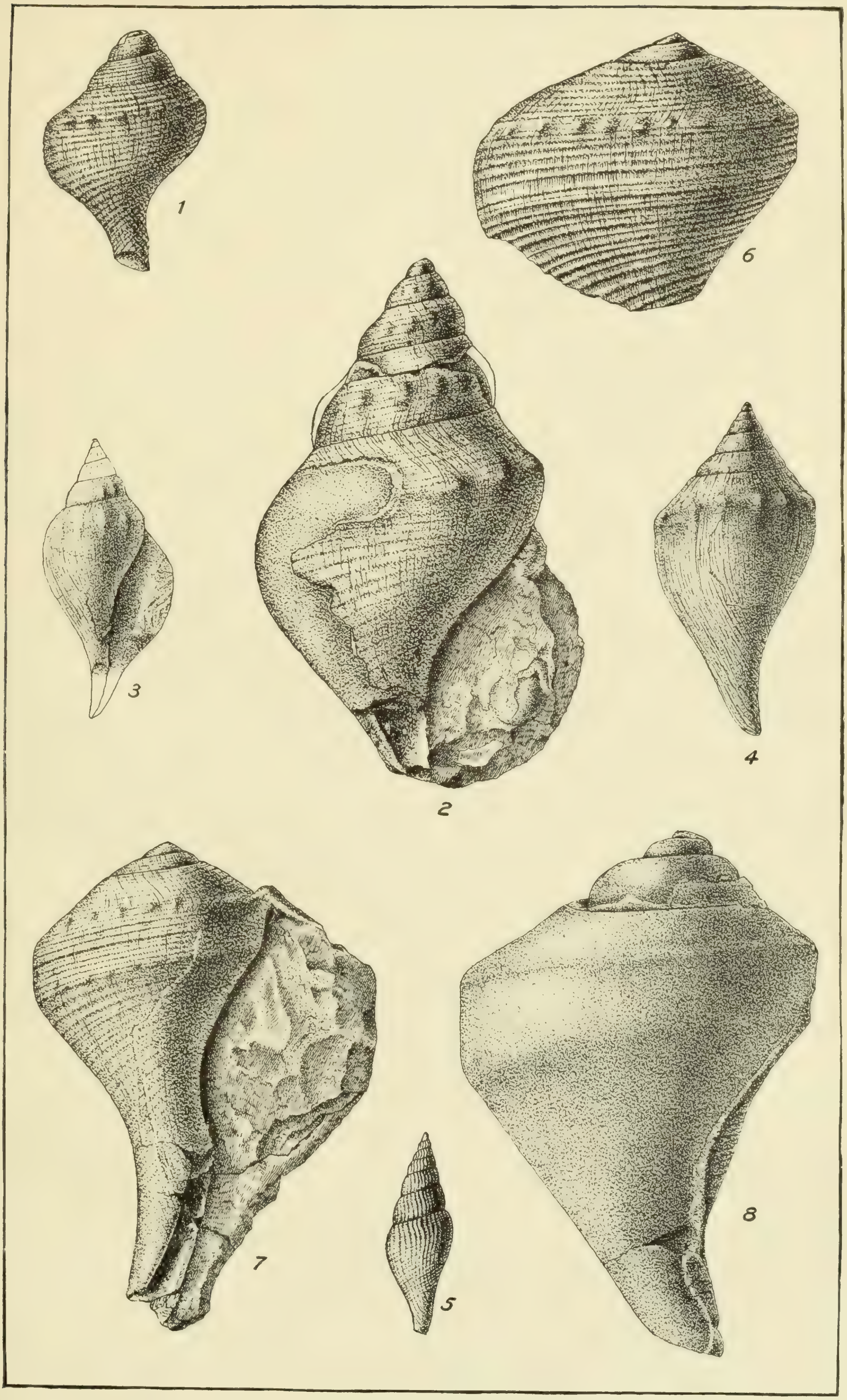

FUSIDÆ.

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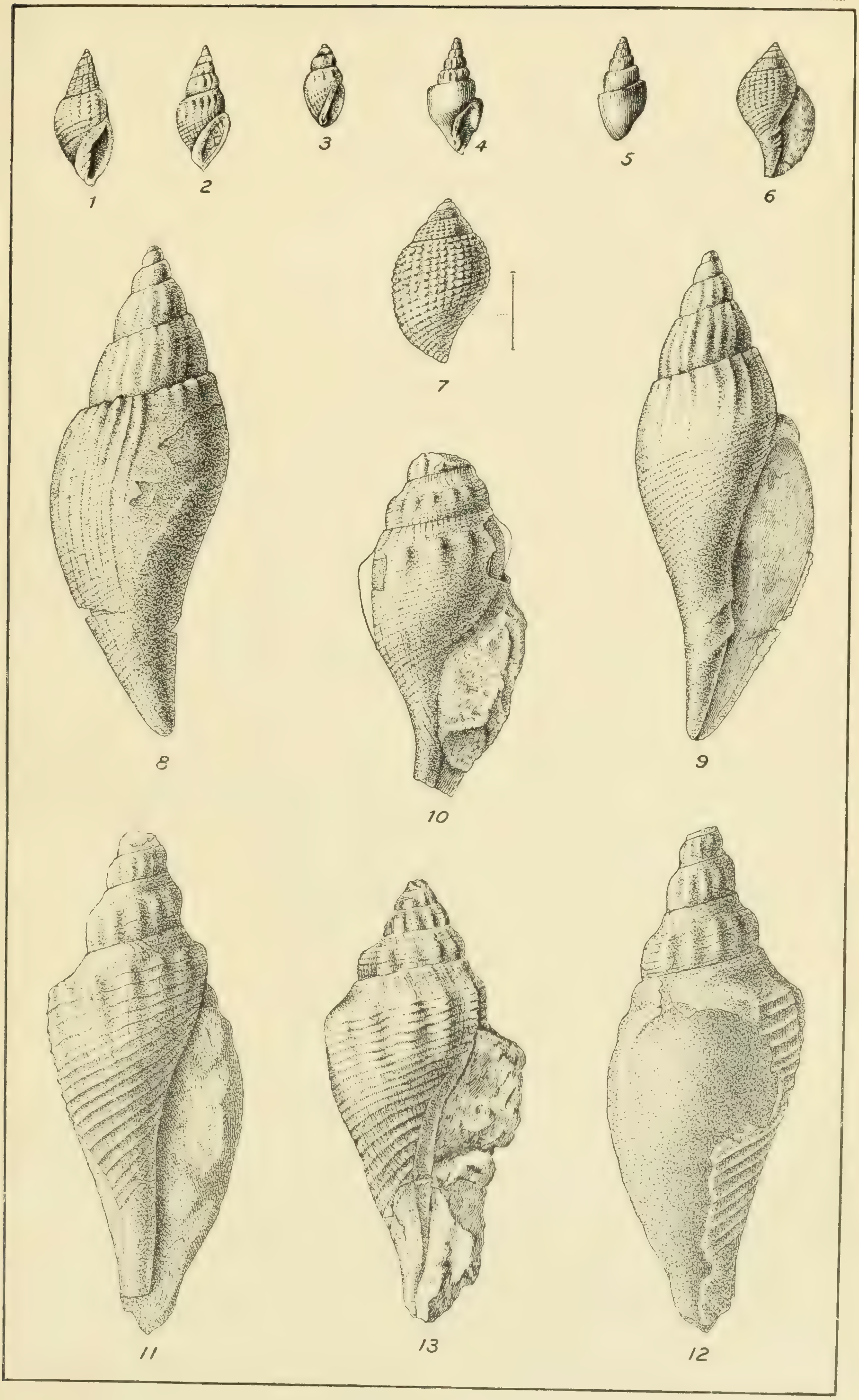

CANCELLARIDÆ AND VOLUTIDÆ.

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Nat. Mus. Cat. Invert. Foss, 22930.

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Nat. Mus. Cat. Invert. Foss, 22931.

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Nat. Mus. Cat. Invert. Foss, 22932.

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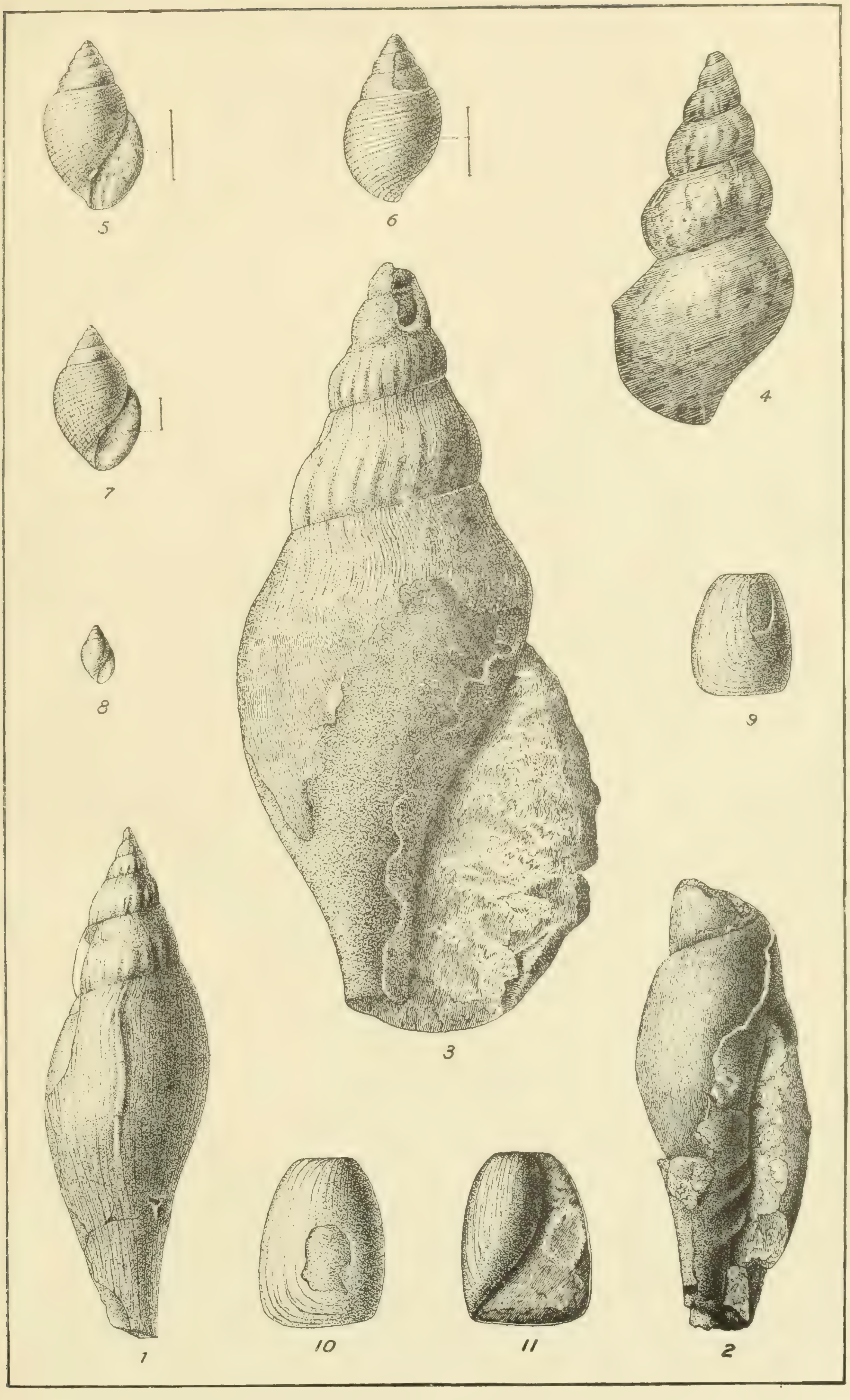

VOLUTIDÆ, PLEUROTOMIDÆ, ACTÆONIDÆ AND BULLIDÆ.

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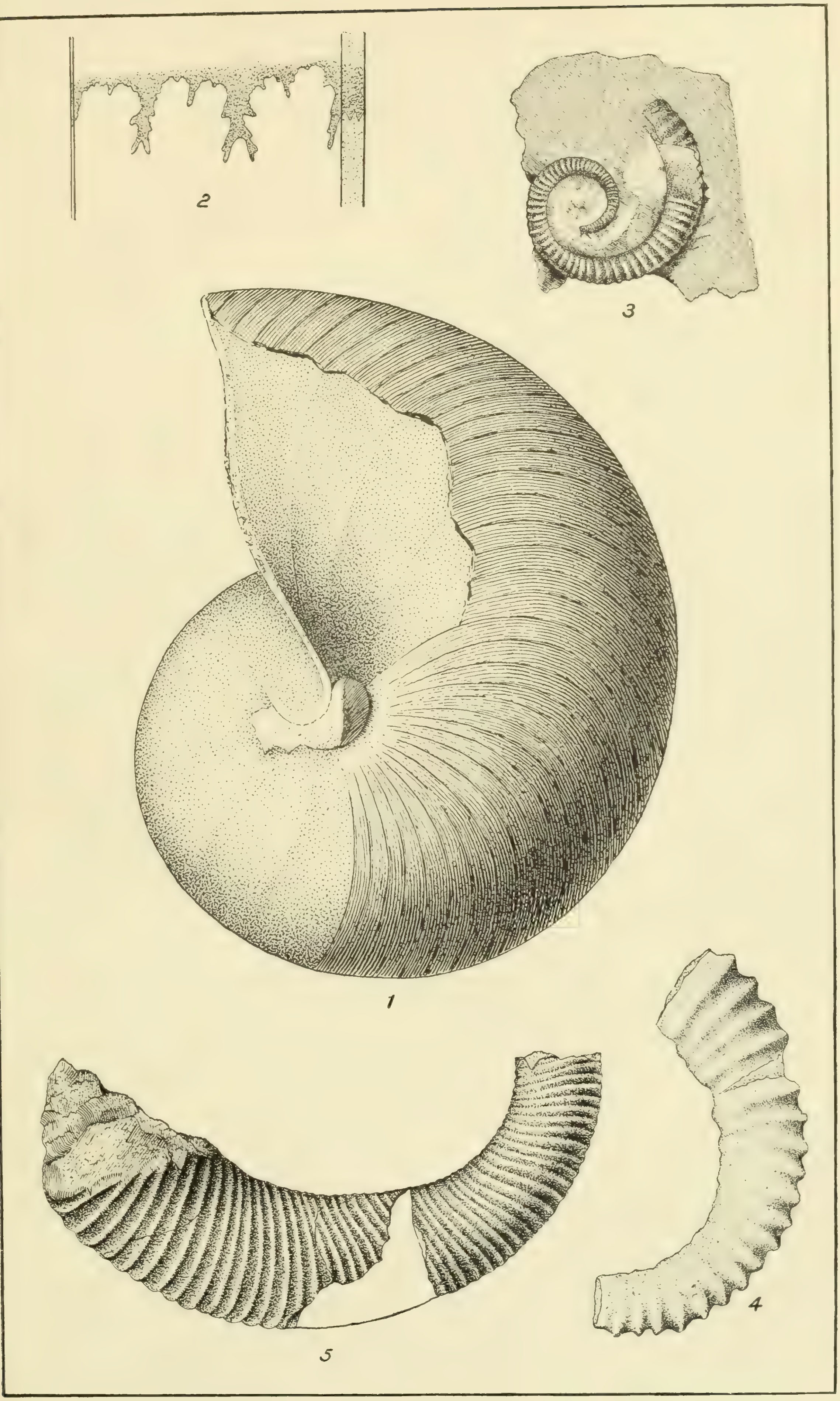

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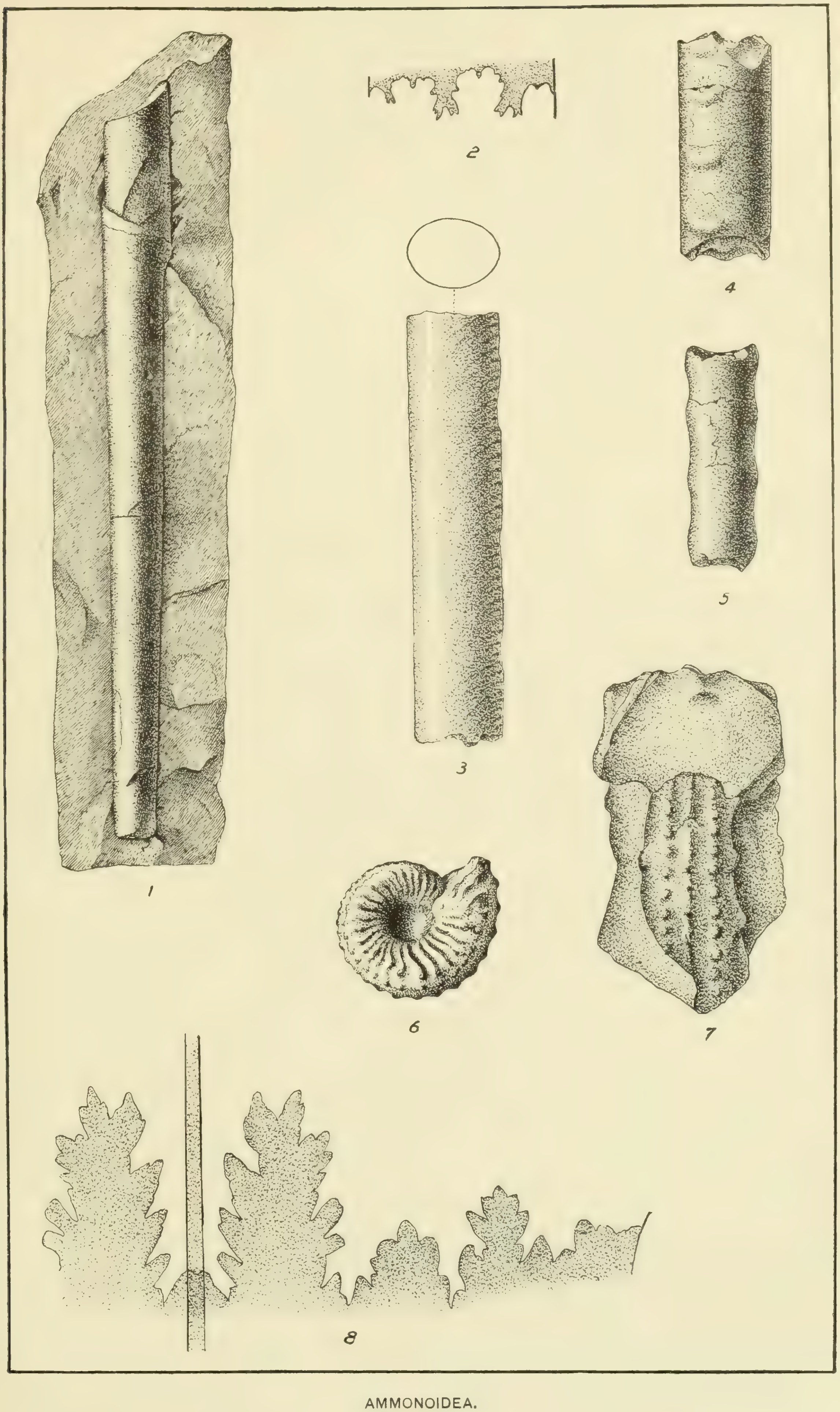

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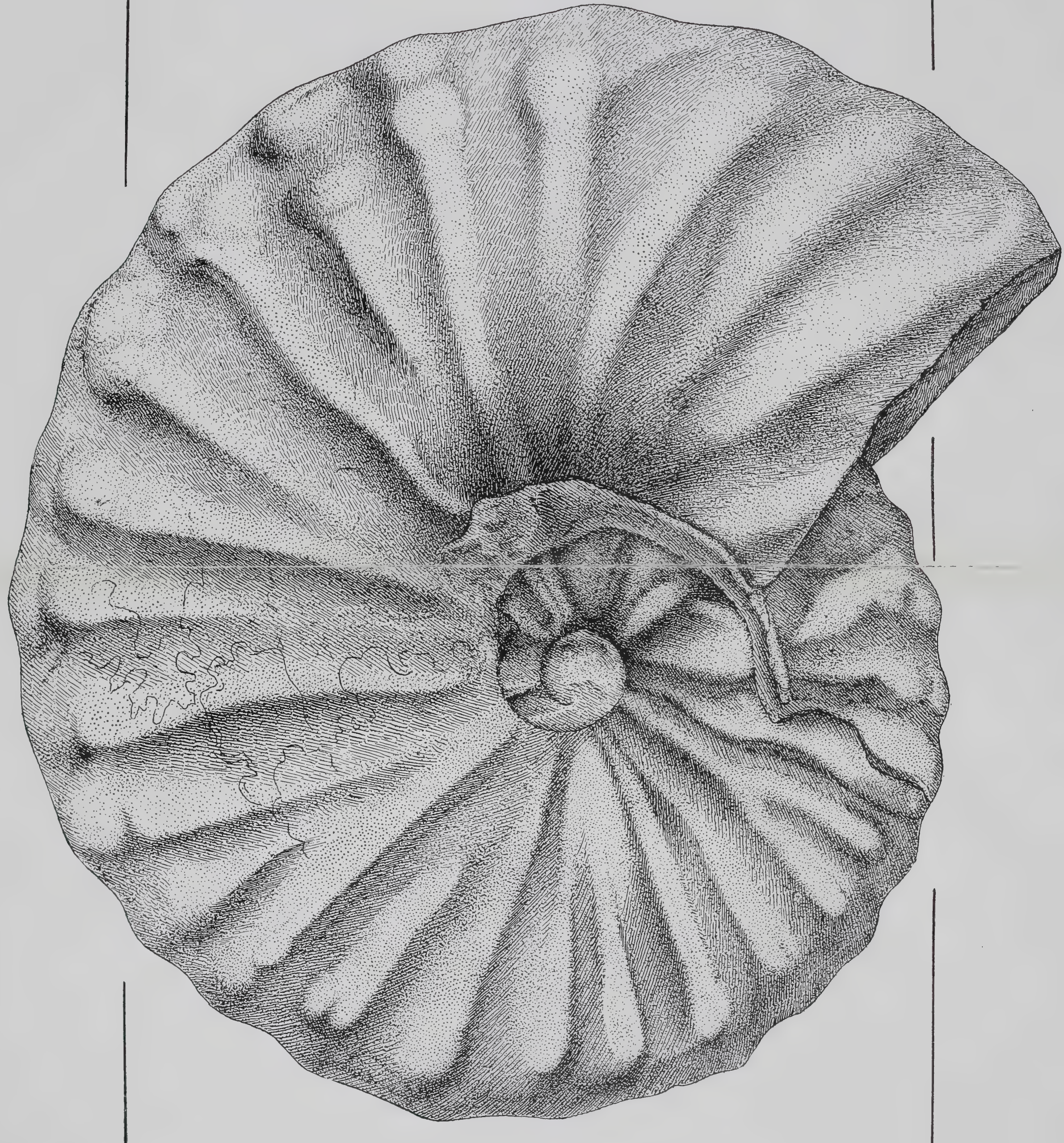

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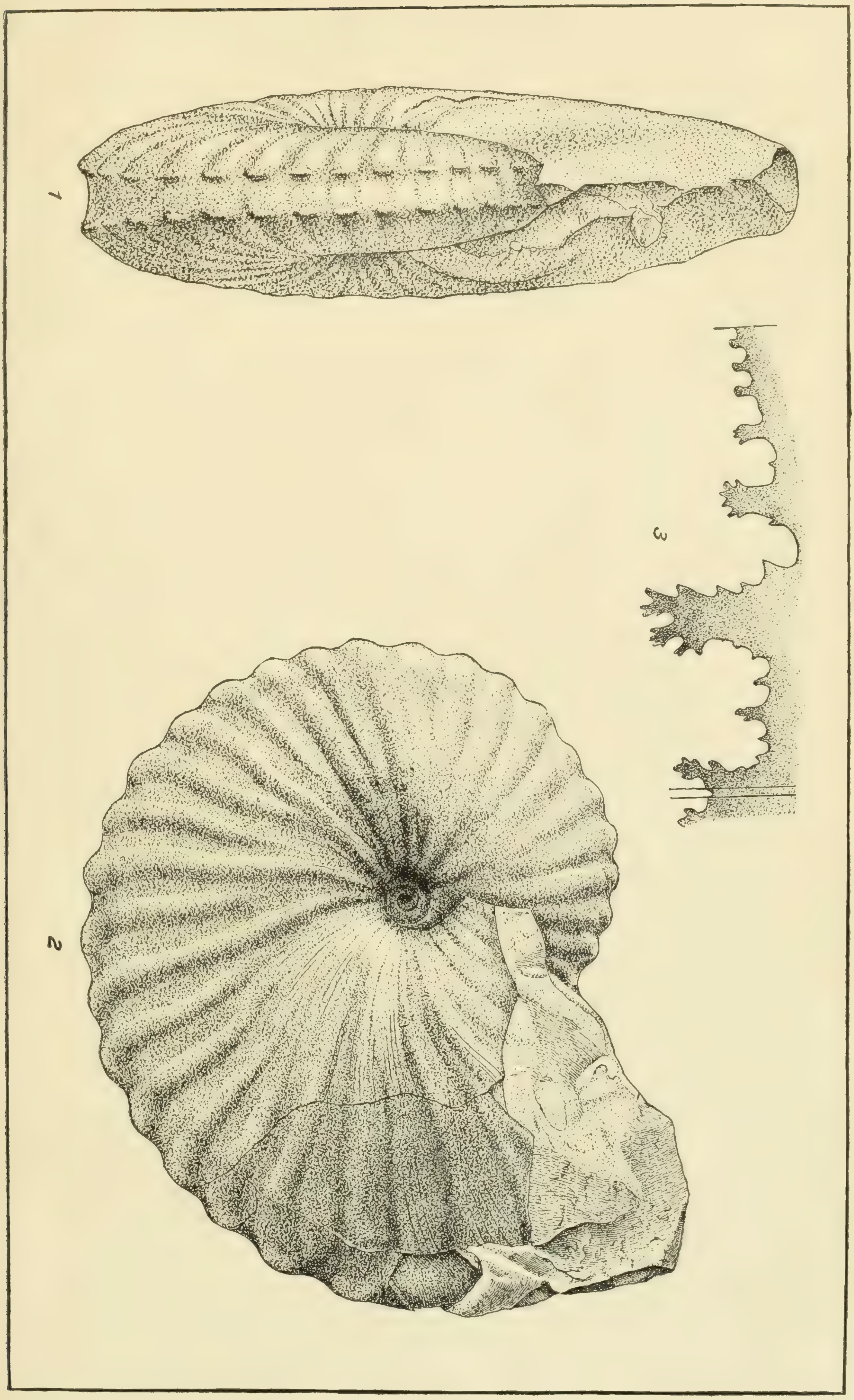
Nat. Mus. Cat. Invert. Foss., 22938.

Fig. 1, 2. Two views of a small specimen.

3. Septum of another example, slightly enlarged. (See Pl. xxxvii.)



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Nat. Mus. Cat. Invert. Foss., 22939.

Fig. 1. Septum of an inner volution of a large specimen, magnified.

2, 3. Two views of a small nodose specimen.

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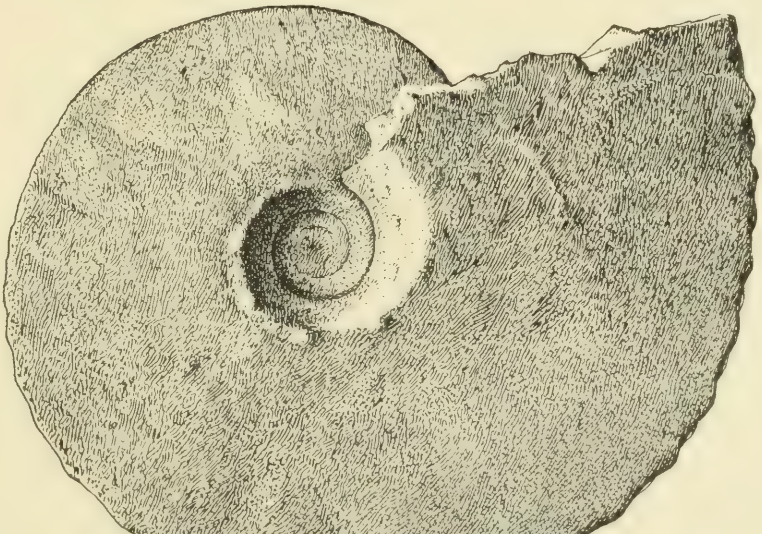

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2. Side view of a small example (after White).
3. Side view of a fragment showing portions of two volutions (after White).
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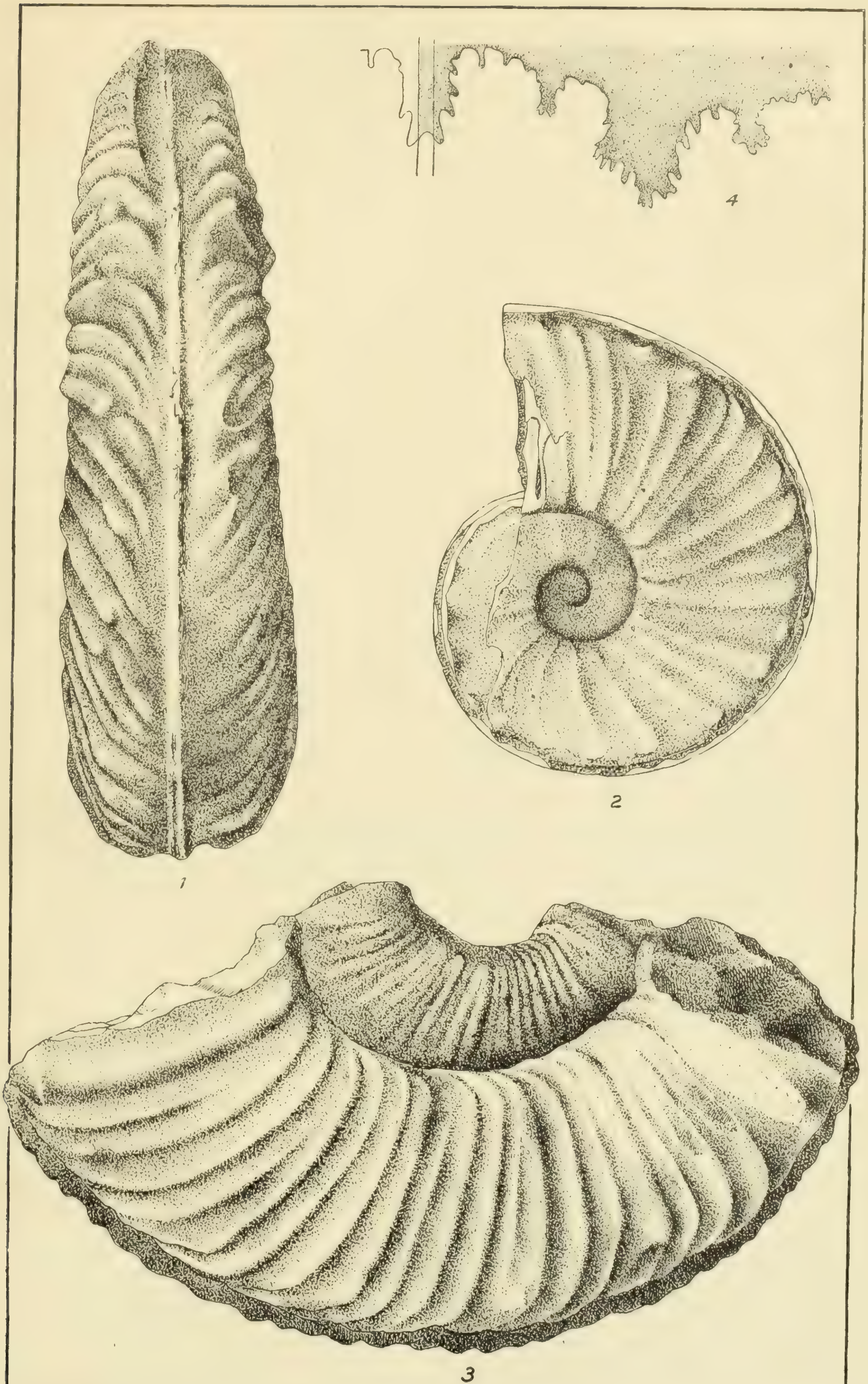
Nat. Mus. Cat. Invert. Foss., 7729.



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Nat. Mus. Cat. Invert. Foss., 22940.

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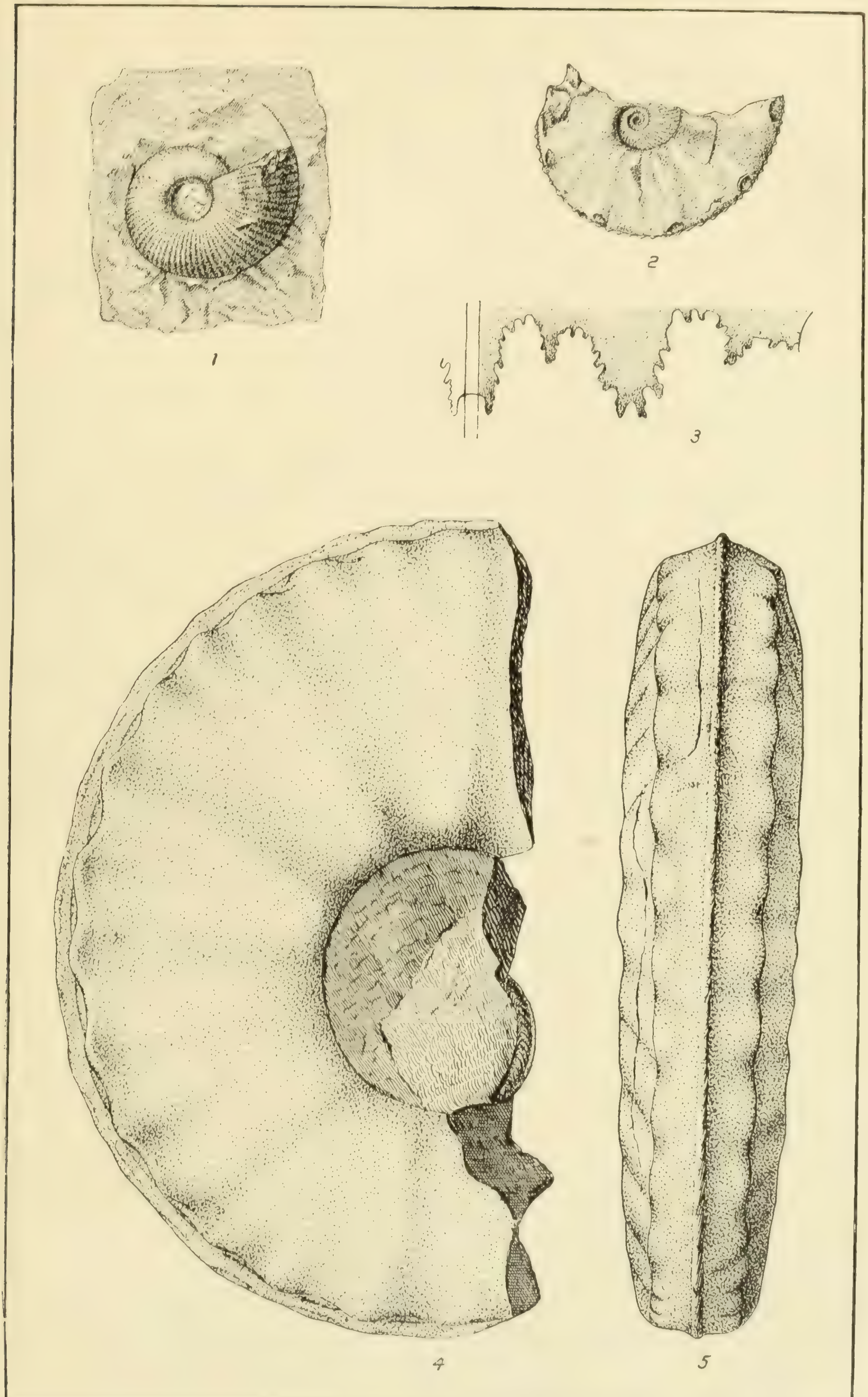
3. Septum of another specimen magnified.

4, 5. Two views of the type (after Meek).



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Nat. Mus. Cat. Invert. Foss., 22941.	
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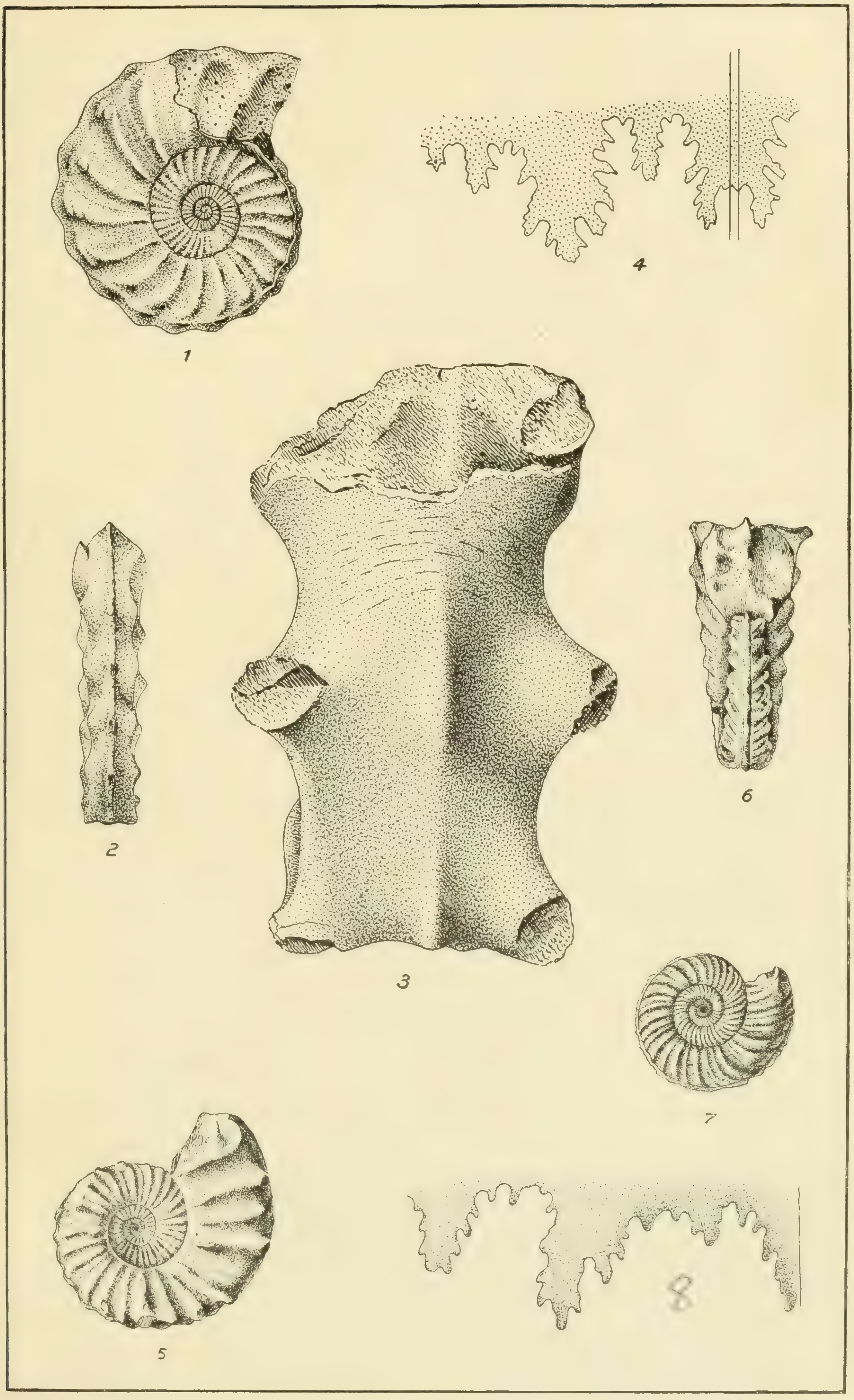

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Nat. Mus. Cat. Invert. Foss., 8629.	
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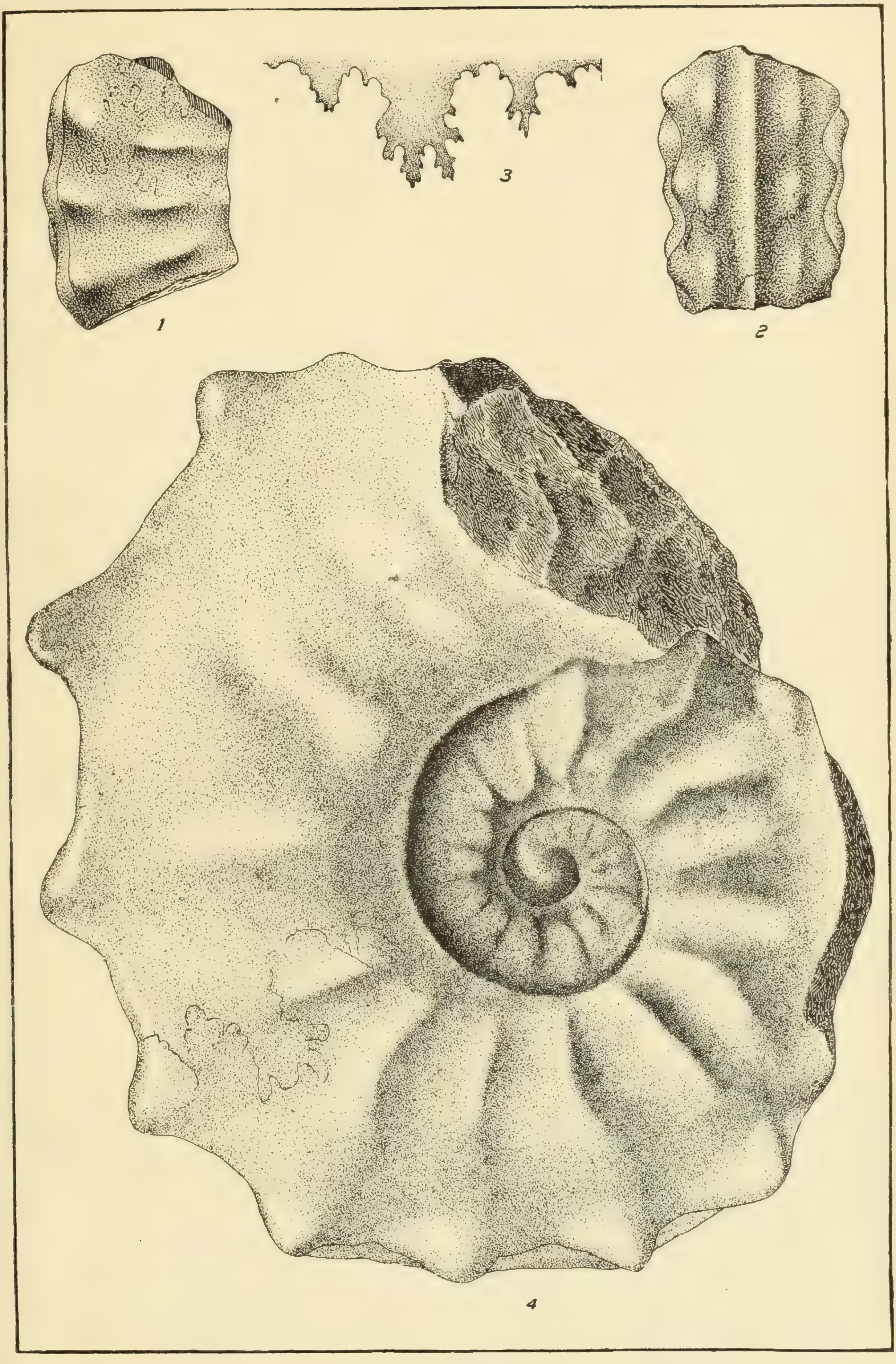

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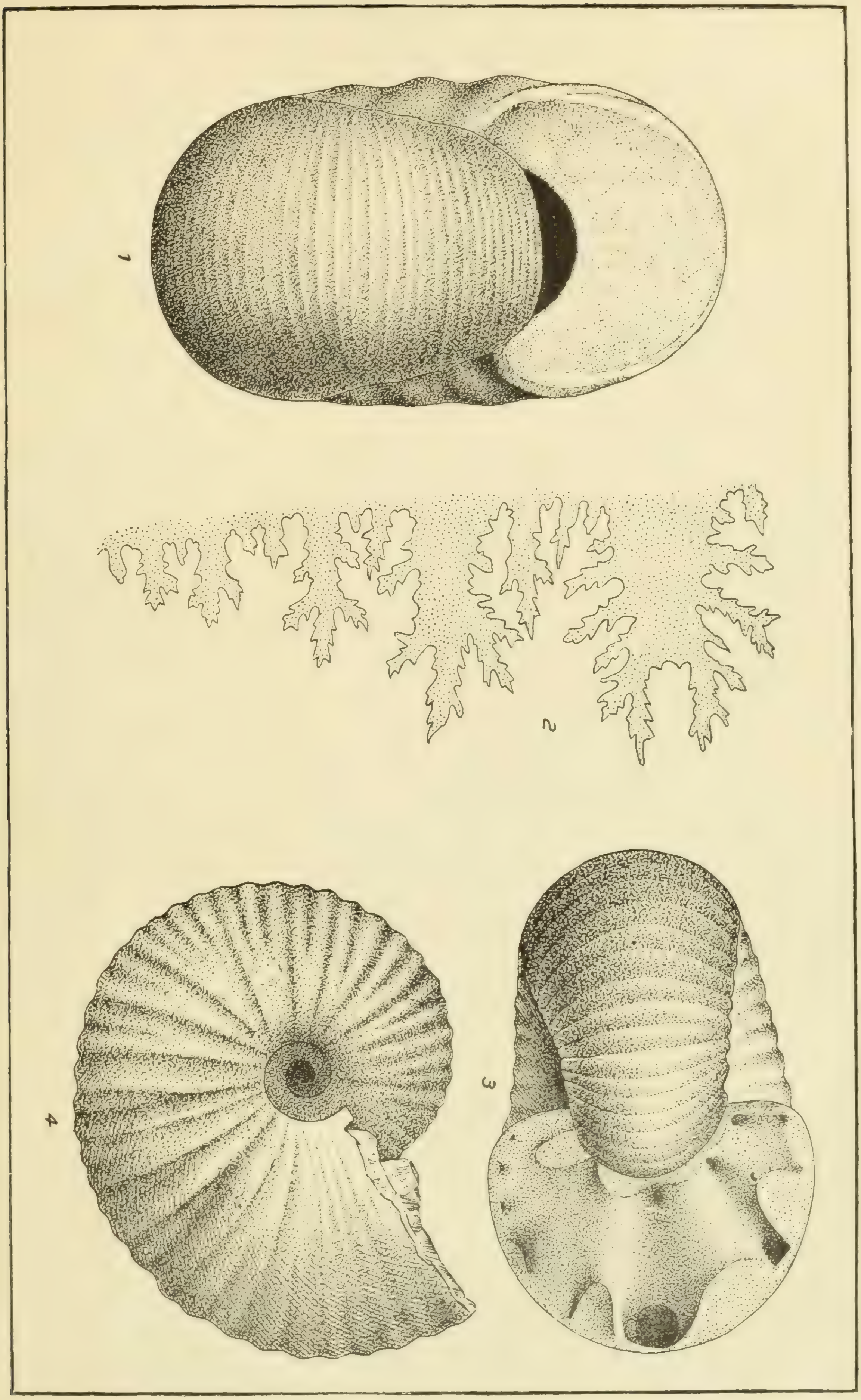

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